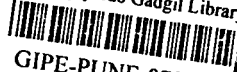




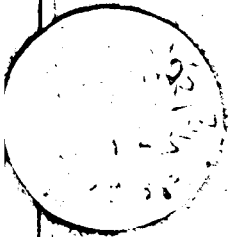
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PROCEEDINGS
of the
Meeting of the Advisory Board
of the
**Imperial Council of Agricultural
Research**

Held at Simla on the 18th, 19th, 20th, 21st, 22nd and 23rd July
1932.



SIMLA
GOVERNMENT OF INDIA PRESS
1933

Schedule of papers circulated to Members of the Advisory Board of the Imperial Council of Agricultural Research for its meeting held at Simla on the 18th, 19th, 20th, 21st, 22nd and 23rd July 1932.

Notes on subjects 1 to 41 of Agenda.

Proceedings of the
of the Imperial Cou
held at Simla from

Corrigenda

Page 18, line
the word 'flower'.

Page 165, column
'Kanred'.

Page 198, first

Page 402, under
mangoes from India to
read 'storage'.

Page 409, line
word 'Experiments'.

Page 443, under
6, for 'Export' read

Summary of papers circulated to Members of the Advisory Board of the Imperial Council of Agricultural Research for its meeting held at Simla on the 18th, 19th, 20th, 21st, 22nd and 23rd July 1932.

Notes on subjects 1 to 41 of Agenda.

**AGENDA FOR THE MEETING OF THE ADVISORY BOARD OF THE
IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, HELD AT
SIMLA, FROM THE 18TH TO 23RD JULY 1932.**

1. Decisions of the Governing Body on the recommendations of the Advisory Board in January 1932.

2. Appointment of the following committees:—

- (i) *Ad hoc* Committee on Tractor Operating Costings.
- (ii) Committee to examine fruit schemes.
- (iii) Committees to examine Progress Reports on:—
 - (a) Dacca University Scheme ;
 - (b) Dr. Bhatnagar's Scheme ;
 - (c) Prof. Mahalanobis' Scheme ; and
 - (d) Dr. Puri's investigation.
- (iv) Committee in connection with the framing of an All-India Legislation for the control of Animal Diseases.
- (v) Committee to consider the question as to the holding of the next meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry.
- (vi) Committee to consider the improvement of curriculum for veterinary education in the veterinary colleges in India.

3. An application from Dr. S. Higginbottom, Principal, Agricultural Institute, Allahabad, for a grant of Rs. 8,000 spread over a period of 2 years for research on the composition of milk.

4. (a) Application from the Government of Madras for a grant of Rs. 1,39,510 spread over a period of five years for a dry farming scheme for the Ceded Districts of Madras Presidency.

(b) Application from the Government of the Punjab for a grant of Rs. 1,65,430 spread over a period of five years for a dry farming research scheme for the South-East Punjab.

(c) Application from the Government of His Exalted Highness the Nizam for a grant of Rs. 59,383 spread over a period of five years for a dry farming research scheme.

5. Proposal by the Bombay Government for the importation of certain insects from Australia for the destruction of Prickly Pear.

6. Application from Prof. J. B. Seth, M.A., I.E.S., Professor of Physics, Government College, Lahore, for a grant of Rs. 1,800 per annum, for a period of 2 years for investigating an electric method of Hygrometry.

7. Application from Dr. A. N. Puri, Ph.D., D.Sc., A.I.C., Physical Chemist, Irrigation Research Laboratory, Lahore, for a grant of Rs. 13,500 spread over five years, to continue his work on "The standardization of Physico-Chemical Single Value Measurements" most suitable for Indian soils.

8. Cheapening the cost of wire fencing used for the protection of crops against wild animals.

9. Application from the Government of the Punjab for a grant of Rs. 6,60,000 spread over a period of five years for a scheme for the development of scientific research in the Irrigation Branch, Public Works Department, Punjab.

10. Application from the Government of Bihar and Orissa for a grant of Rs. 78,680 spread over a period of five years for a scheme of research on the economics of irrigation from tube wells.

11. Investigation of the traffic of livestock through the Province of Bihar and Orissa.

12. Recommendations of the Indian Oil-Crushing Industry Committee, 2nd Meeting, December 1931:—

(a) Cultivation of *Mahua*, and introduction of new varieties of oil-seeds and the question of improved storage.

(b) Import duty on oil-mill machinery and spare parts.

(c) Helping village presses and larger scale oil factories.

(d) Organisation and development of the manufacture of soaps, candles, lubricants and edible products, etc., such as ghee and vegetable substitutes for which there is a demand, also steps to increase the demand for edible oil.

13. Application from the Annamalai University for a grant to investigate the problems of the marketing of the ground-nut crop of the South Arcot District.

14. Application from Professor J. C. Ghosh, D.Sc., Chemistry Department, Dacca University, Dacca, for a grant of Rs. 11,200 spread over a period of five years for the investigation of the organic constituents of Indian soils.

15. Application from the Dacca University for a grant of Rs. 2,000 on account of apparatus, etc., for the year 1932-33 in connection with the scheme for agricultural research already sanctioned by the Council.

16. Application from the Madras University for a grant of Rs. 25,830 spread over three years for a scheme of research in the cytological study of Indian crop plants.

17. Recommendations of the Committee appointed to examine the Report on Hemp Marketing in India prepared by Mr. T. S. Sabnis.

18. A scheme for the continuance of investigations on different aspects of the cereal rust problem and the recommendation of the Special Committee of Mycologists thereon.

19. Application from the Government of Bombay for a grant of £500 (Rs. 6,667) on account of Deputation of Dr. B. N. Uppal, Plant Pathologist to Government, to foreign countries to study virus diseases of plants.

20. Question of compilation by the Imperial Council of Agricultural Research annually for circulation to all concerned, of a list of research work

completed or under investigation in the Agriculture and Veterinary Departments or in the Universities of India.

21. Participation of India in the Congress of the Far Eastern Association of Tropical Medicine.

22. Application from Dr. B. K. Singh, Professor of Chemistry, Ravenshaw College, Cuttack, for a grant of Rs. 8,260 spread over three years for research work on the nature of organic compounds present in the rice soils of India and the factors influencing their decomposition with special reference to Bihar and Orissa soils.

23. Application from the Government of Madras for a grant for research work on potatoes.

24. The Punjab Veterinary Department scheme for investigation into the most suitable and economic methods of combating different types of parasitic infection in ruminants in the field, concurrently with experiments to determine whether certain mineral deficiencies tend to lower animal resistance to parasitic infection.

25. Scheme for research on sugarcane in the Madras Presidency.

26. (a) Scheme for the establishment of a sugarcane research station in the Punjab.

(b) Application from the Government of the United Provinces for a grant for investigation into various problems of sugar industry in the United Provinces.

(c) Scheme for a Research and Testing Station for the indigenous system of *gur* and sugar manufacture, drawn up by the Sugar Technologist, Imperial Council of Agricultural Research.

27. Application from the Government of Assam for a grant of Rs. 48,000 spread over five years for the proposed extension of sugarcane work at the Jorhat Experiment Station, Assam.

28. Application of Mr. A. R. Srinivasa Rao for a grant for conducting certain experiments in sugarcane.

29. *Tractor operating costings*.—Forms prepared by the Burmah Shell Oil Storage and Distributing Co. of India, Ltd., Bombay.

29 (a) Report on the results of Tractor work conducted during the last session (1931-32) by the Burmah Shell Oil Storage and Distributing Co. of India, Ltd., Bombay.

30. Progress Reports on Research Schemes :—

(a) Scheme for research into properties of colloid soil constituents by Dr. J. N. Mukherjee, Khaira, Professor of Chemistry, University of Calcutta.

(b) Scheme for statistical investigations on experimental error in field trials, by Mr. P. C. Mahalanobis, Professor, Presidency College, Calcutta.

- (c) Report for the year 1931-32 on the ' Effect of Ions on the Growth of Plants ' by Dr. S. S. Bhatnagar.
 - (d) Report for the period 1st July 1931 to 31st March 1932, in respect of the scheme for investigation of the ' Wither Tip ' of Citrus trees by Dr. H. C. Chowdhury.
 - (e) Report on the work done in the Agricultural Research Section of the Department of Chemistry, Dacca University, Dacca, during 1930-31 and 1931-32, in connection with the scheme for agricultural research sanctioned by the Imperial Council of Agricultural Research.
 - (f) Report of the investigations carried out by Dr. A. N. Puri, on the standardization of Physico-Chemical Single Value Measurements most suitable for Indian soils.
31. Participation of India in the Fifth World Poultry Congress, Rome, 1933.
 32. Application from the Government of the Punjab for a grant of Rs. 38,800 spread over a period of five years for a scheme for the improvement of the tea industry in the Punjab.
 33. Report of the Fruits Sub-Committee.
 34. Marketing of Agricultural Produce.
 35. Application from Lt.-Col. R. N. Chopra of the School of Tropical Medicine, Calcutta, for a grant for research in systematic cultivation of medicinal plants and study of food poisons in India.
 36. Classification of Research Schemes.
 37. Election of two members of the Advisory Board to the Governing Body of the Imperial Council of Agricultural Research.
 38. Assistance to be given by the Indian Railway Central Publicity Bureau in the promotion of agricultural and veterinary development.
 39. Scheme for carrying on research work at the Anand Creamery in the manufacture of products and bye-products of milk.
 40. Recommendation of the Committee appointed to consider the improvement of curriculum for veterinary education in the Veterinary Colleges in India.
 41. Application from the Government of the Punjab for an additional grant of Rs. 5,000 for conducting experiments on designing a small power sugarcane crushing mill.
 42. Mr. Carpenter's resolution.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD
AT SIMLA ON MONDAY, THE 18TH JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman.*
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK.
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. G. K. DEVADHAR.
7. Mr. E. S. FARBROTHER.
8. Professor J. C. GHOSH.
9. Dr. G. P. HECTOR.
10. Dr. L. K. HYDER.
11. Mr. NIZAMUDDIN HYDER.
12. Mr. P. J. KERR.
13. Mr. T. F. MAIN.
14. Dr. W. McRAE.
15. Mr. D. MILNE.
16. Col. A. OLVER.
17. Captain Nawab RAIS JUNG BAHADUR.
18. Mr. S. V. RAMAMURTY.
19. Major P. B. RILEY.
20. Mr. P. T. SAUNDERS.
21. Mr. D. R. SETHI.
22. Mr. F. J. F. SHAW.
23. Mr. G. T. TAIT.
24. Mr. W. TAYLOR.
25. Mr. F. WARE.
26. Brigadier A. J. WILLIAMS.

Rai Sahib Malik CHARAN DAS, *Secretary.*

The following attended as visitors :—

1. Mr. Z. R. KOTHAWALA.
2. Dr. V. N. LIKHITE.
3. Dr. K. C. MEHTA.
4. Mr. C. V. SANE.
5. Mr. W. SAYER.
6. Mr. C. P. G. WADE.

The meeting lasted from 11 A.M. to 1-20 P.M. and adjourned till 10-30 A.M. on the 19th July to allow the Sub-Committee on the Tractor Operating Costings to meet in the afternoon.

2. Before taking up the subjects on the agenda the Chairman welcomed all the members present and specially welcomed to the meeting Messrs. Sane and Likhite, representatives from the Baroda State who had come to the meeting for the first time and announced that, following the excellent lead given by the Hyderabad and Mysore States, Baroda State had also decided to join the Council as a constituent State. He also welcomed Rao Bahadur Bhimbhai Ranchodji Naik representative of the Indian Central Cotton Committee who had also attended the meeting for the first time. The Chairman added that in accordance with the wishes of the Advisory Board expressed at its meeting in June 1931 this meeting of the Board was held about a month later than previously.

3. Mr. Allan suggested that if the financial position of the Council were explained it would be convenient to the Board in considering various schemes that had been placed on the agenda. The Chairman, in reply, said that, in his opinion, it would be better if the Board examined the schemes on their merits from the scientific point of view on the assumption that funds would be available and that the question of funds might be considered when the subject of classification of research schemes came up for consideration.

4. *Decisions of the Governing Body on the recommendations of the Advisory Board in January 1932 (Subject No. 1 of the Agenda). (Appendix I).*—In answer to Rao Bahadur Bhimbhai Ranchodji Naik, the Chairman explained that the Joint Committee of the Indian Central Cotton Committee and the Imperial Council of Agricultural Research had been appointed for the purpose of instructing the Chief Economist. When the Chief Economist is appointed and after he had about a fortnight's look round he will come up to this Committee which will give instructions. The appointment had been made by the Public Service Commission and the Chief Economist was expected to join shortly. The Chairman also informed the members of the Board that the meeting of the Joint Committee would very probably be held about the end of August. Rao Bahadur Bhimbhai Naik hoped that the enquiry would be exhaustive and thorough.

5. *Appointment of Committees (Subject No. 2 of the Agenda).*—(Appendix II).—The Chairman announced the personnel of the following Committees :—

- (1) Committee on Tractor Operating Costings.

(2) Fruits Committee.

(3) Committee to examine Progress Reports.

He also referred to the informal meetings of the Veterinary Members of the Board to discuss.

(4) The improvement of curriculum in veterinary colleges in India.

(5) Holding of the next meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, and

(6) All-India Legislation for the Control of Animal diseases.

The Board added the Director of Agriculture, Madras, to the Committee on Tractor Operating Costings and Directors of Agriculture, Punjab, and Bihar and Orissa and Mr. G. T. Tait to the Fruits Committee.

6. *Application from Dr. Sam Higginbottom, Principal, Agricultural Institute, Allahabad, for a grant of Rs. 8,600 spread over a period of 2 years for research on the 'Composition of Milk' (Subject No. 3 of the Agenda). (Appendix III).*—Colonel Olver, in introducing the scheme, said that he had satisfied himself that the necessary facilities for carrying out the proposed research were available at the Agricultural Institute, Allahabad, and commended the scheme to the favourable consideration of the Board. Mr. Milne expressed the view that as nutrition played a large part in the scheme, it had to be considered whether the Military Dairies of Bangalore would not be more suitable for the proposed research. He doubted whether two years was a sufficient period to show satisfactory results in as it was important to have general lactation periods to discover the quantities and qualities of milk, and variations in those quantities and qualities among the different breeds of cattle which were kept for milk in India. He thought that the object of this enquiry was to provide information which would help people in laying down standards of qualities of pure milk and lead to the improvement of milk supplies in large towns. He thought that investigations should be conducted only on breeds of cattle which contributed largely to the supply of milk in India and did not see why Swiss 'Brown' cattle should be in the investigation. Mr. Allan, in supporting the scheme, said that Dr. Higginbottom had only asked for two men to conduct the scheme, the Institute intended to employ two more men from its own staff. The scheme was passed for two years, but the Institute undertook to extend it beyond this if necessary at their own expense, if further funds were not available from the Council. Mr. Devadhar asked whether the results of the investigations would be made available to the breeder as well as the consumer and the Gowalas also by propaganda. He enquired also in what respects the present application deserved better treatment than the application of the Dayalbagh Dairy Farm which was discussed by the Board at its meeting in June 1931. Colonel Olver, in reply to the second question said that the Dayalbagh scheme only dealt with the transportation of milk from the village to Agra which was a purely local problem, while the present application dealt with a problem of interest to the whole country. In reply to the first question the Chairman stated that as a matter of fact anybody who accepted a grant from the Council agreed to the condition that the results were to be supplied to the Council which was at liberty to publish them so that there

was no question of the results not being available to anybody. Mr. Kothawala supporting the scheme said that information on the subject of the composition of Indian milks was scanty and more was wanted. Referring to Mr. Milne's point regarding the suitability of Allahabad for the research he said that the Institute at Allahabad was suitable for such work so far as equipment and other facilities were concerned. He, therefore, saw no reason why Allahabad should not be allowed to begin this sort of work when it was the first to ask for a grant of this kind. Mr. Taylor also supported the scheme.

In the result the Board recommended the scheme for sanction.

7. *Application from the Government of Madras for a grant of Rs. 1,39,510 spread over a period of five years for a dry farming scheme for the Ceded Districts of the Madras Presidency. (Subject No. 4(a) of the Agenda). (Appendix IV).*—Mr. Ramamurty in introducing the scheme, stated that some work of a tentative character had been done already in Madras and that what they now wanted was an experienced and well-trained officer at the head knowing exactly what to include and what to eliminate in the course of experimental work. Conditions of soil and crop were different in Manjri and Hagari and the Madras scheme could rightly be regarded as complementary to the Bombay Dry Farming scheme which the Board has already recommended for sanction. The Government of Madras were already spending about Rs. 1,20,700 per annum on this work: but to develop it the Government needed the extra assistance now applied for. As regards the question of quarters, for staff, Mr. Ramamurty pointed out that the quarters were purely temporary and would not last beyond the duration of the scheme and were therefore a legitimate charge on the funds of the Council. Mr. Main supported the scheme: but had certain points of criticism. Regarding the structure of the scheme he felt that the ultimate technical head of the scheme should not be a Deputy Director of Agriculture who was generally a touring officer but should rather be a resident research officer who should take charge of the work and be responsible for its proper conduct. He, therefore, preferred that the gazetted Superintendent provided for in the scheme on Rs. 250—750 should be the Chief Officer, with a considerably higher starting pay, say, not less than Rs. 500 per mensem. As regards the detailed estimates of cost he thought that some economy should be possible under the head "Non-recurring". He also wanted that a definite assurance should be given that the Hagari Station would be handed over for the research scheme and not kept on as a general departmental farm. Mr. Devadhar raised the question whether the Council would be in order in recommending Rs. 48,510 for non-recurring expenditure. Mr. Allan thought that it was a good enough scheme, but would personally prefer some better form of co-ordination; one aspect of the work could be carried out in Bombay, another in Madras and quite a different one in Hyderabad. He also hoped that it would be possible to effect a reduction in the cost of the scheme. Professor Ghosh wondered at the necessity for a separate and independent scheme when the results at Manjri should be applicable to the comparatively more easy soil at Hagari. Mr. Ramamurty, in replying to the various points of criticism, stated that there were differences between Manjri and Hagari in soil and other conditions necessitating experiments not only on plant-breeding but on such important questions as deep-ploughing, size of bunds,

etc. It was only by carrying out work in both stations that one could decide what was purely accidental and eliminate it. On the question of scales of pay for staff, Mr. Ramamurty thought that it would be a very good thing if the Council in sanctioning schemes, while keeping in view the differing scales of Provincial pay, tried to obtain a certain measure of uniformity and explained that the reason why a scale of Rs. 250—750 has been proposed was that this was the grade for the gazetted Superintendents in Madras and that the man the Local Government had in view was getting just over Rs. 250. As regards non-recurring expenditure he stated that the Local Government had already spent something like Rs. 75,000 to Rs. 1,00,000 on this scheme. Answering Mr. Main, Mr. Ramamurty stated that the Hagari farm would practically be a dry farming station barring certain small exceptions.

On being put to vote, the Board recommended the scheme for sanction.

8. *Application from the Government of the Punjab for a grant of Rs. 1,65,430 spread over a period of 5 years for a dry farming research scheme for the South-East Punjab [Subject No. 4 (b) of the Agenda]. (Appendix V).*—Mr. Milne introduced the scheme and stated that while a large part of the Punjab was secure, a still larger part was insecure. He explained that the special sub-committee of the Advisory Board which met in June 1931 to examine the Bombay dry farming scheme had stated that conditions in the Punjab were so different in character that the Punjab scheme could not be linked with the Bombay scheme, but that that should not prevent the Punjab putting up a dry farming scheme to suit Northern Indian conditions. It was precisely in accordance with this that the Punjab had submitted its present scheme. It was proposed to open the dry farming station at Rohtak. He stated that the receipts from sale of surplus produce which he estimated at Rs. 10,000 over five years, the equivalent of which would be credited to the Council, would reduce the cost of the scheme to roughly over a lakh and a half. Mr. Main supported the scheme but added that one of the three officers provided for in the scheme should act as the chief officer apart from the Director of Agriculture who would have the general responsibility for the scheme and that the Rohtak farm should be wholly given over to the scheme. Mr. Ramamurty pointed out that the Local Government had not made any contribution on account of recurring staff. After Messrs. Allan and Kerr and Dr. Hyder had spoken, the Chairman put the following alternative propositions to vote:—

- (1) that the scheme be sanctioned subject to negotiations with the Punjab Government as to the proportion of recurring expenditure that they would meet,
- (2) that the scheme be sanctioned on condition that the local Government bear 33 1/3 per cent. of the recurring expenditure,
- (3) that the scheme be sanctioned on condition that the local Government bear 50 per cent. of the recurring expenditure, and
- (4) that the scheme be sanctioned unconditionally.

On a vote being taken the first proposition was carried and the scheme, as thus amended, was recommended for sanction.

9. *Application from the Government of H. E. H. the Nizam for a grant of Rs. 59,383 spread over a period of five years for a dry farming research scheme [Subject No. 4(c) of the Agenda]. (Appendix VI).*—Mr. Nizamuddin Hyder in introducing the scheme explained that it was framed practically on the basis that the Hyderabad Station would be a sub-station to the Bombay main Station at Manjri. Messrs. Main, Ramamurty and Milne supported the scheme. In view of the fact that the results obtained at the Hyderabad Station would be of use to Bombay as well, Dr. McRae considered that it should be possible to omit one sub-station from the Bombay dry farming scheme already recommended by the Advisory Board. Mr. Main accepted this proposal.

The Board recommended the scheme for sanction.

10. The Chairman then read out a letter (not printed) from the Government of H. E. H. the Nizam recommending the appointment of a Joint Committee to make out a programme of work for Madras, Bombay and Hyderabad with a view to avoid unnecessary duplication of work. After some discussion in which Messrs. Nizamuddin Hyder, Main and Ramamurty and Dr. Mehta participated, the Board decided that the question should be left over for the consideration of the Chairman when the schemes had actually started.

11. *Proposal by the Bombay Government for the importation of the insect Cactoblastis Cactorum from Australia for the destruction of prickly pear (Subject No. 5 of the Agenda). (Appendix VII).*—Mr. Main in initiating the discussion on the subject stated that the species of prickly pear with which they were concerned in Bombay was the *Opuntia elatior*. It was not first realised that the Australian species (*Opuntia inermis*) on which the insect flourished was different, he did not, therefore, particularly wish to press his proposal to import the insect. Mr. Ramamurty explained that in Madras the *Cochineal insect* (*Dactylopius Tomentosus*) had been introduced and that it was very effective in getting rid of the local variety of prickly pear (*Opuntia Dillenii*) while at the same time it was harmless to crops and other useful vegetation. Messrs. Milne, Allan, Sethi and Sane and Rao Bahadur Bhimbhai Ranchodji Naik said that prickly pear was not considered a nuisance in Northern India: rather it was of value for hedges. Mr. Milne stated that one large farmer in the Punjab had asked his advice regarding the introduction of an insect from Australia to destroy the prickly pear. Mr. Milne had warned him that it might possibly exterminate the prickly pear and attack other economic plants. He reminded him of the case of rabbits in Australia. Mr. Blascheck was against the importation of the insect as after destroying the prickly pear it might destroy the forests in India. Dr. McRae pointed out that in Australia it has been observed that heat waves before the summer rains having commenced, kill the cocoons of *Cactoblastis cactorum* in large numbers and moths may live for only a few hours and die before depositing eggs and the eggs themselves may suffer desiccation. In India, therefore, with a hot dry weather before the monsoon it might possibly be difficult to establish the insect. Again in Australia a rigorous series of tests with other plants that grow there was conducted before the insect was released. Similar tests would have to be conducted in India to make sure that the insect could not feed and complete its life-history on any other plant than prickly pear. To test crop plants and forest trees in this way would lead to very considerable expense. It would really be better for

the present to be content with such insects as destroy prickly pear comparatively slowly in Madras. The Chairman summarised the discussion in two propositions, viz.—

- (1) that while prickly pear was considered to be a nuisance in Madras, South Bombay and Hyderabad it was held to be useful in Gujerat, Baroda and Northern India ; and
- (2) that the importation of the insect *Cactoblastis cactorum* from Australia was attended with risks to crops and forests in India, and that Bombay which made the proposal was now willing to drop it.

The Board agreed to the above remarks being communicated to the Government of India.

12. *Application from Professor J. B. Seth, M.A., I.E.S., Professor of Physics, Government College, Lahore, for a grant of Rs. 1,800 per annum for a period of two years for investigating an electric method of Hygrometry (Subject No. 6 of the Agenda). (Appendix VIII).*—Mr. Milne explained the scheme, and drew attention to authorities in cold storage of fruits, Entomologists, etc., who had given their opinion that it would be of use in their work. Dr. MacRae read out a note* from Dr. Normand in which he stated that the investigation proposed by Professor Seth would certainly be of scientific interest but it had yet to be established that if an instrument based on the investigation were perfected it could be successfully applied to the determination of soil moisture. Continuing he said that the investigation was certainly of interest and might lead to the development of an instrument that would be of great use in a variety of ways as in fruit and food preservation in obtaining standard conditions for cold storage, in entomological work in rearing insects to discover the re-action to atmosphere and soil humidity and in mycological work in studying the conditions of longevity, germination and penetration of spores of parasitic fungi. Mr. Devadhar and Rao Bahadur Naik enquired how this instrument would be of use to the average agriculturist. Mr. Ramamurty said that this instrument would be very useful to them in Madras in research work and that the agriculturist would have the benefit of the results obtained by the research. Professor Ghosh considered the scheme very important as a piece of research work so far as the humidity of air was concerned but as regards soil moisture he had his own doubts. Dr. Shaw, in stating that the scheme would be very useful to the agriculturists, explained that the instrument would be useful in determining the conditions under which the seeds could be stored and would also be helpful in the case of tobacco curing. He added that the instrument would be of use to the agriculturist in the same way as microscopes and the other complicated things which are to be found in scientific laboratories and which while by themselves were not of use to the agriculturist, the things discovered with their aid, were.

The Board recommended the scheme for sanction.

13. *Application from Dr. A. N. Puri, Ph.D., D.Sc., A. I. C., Physical Chemist, Irrigation Research Laboratory, Lahore, for a grant of Rs. 13,500, spread over five years, to continue his work on "The Standardisation of Physico-Chemical 'Single Value' Measurements most suitable for Indian soils." (Subject No. 7 of*

*Not printed.

the Agenda). (*Appendix IX*).—Mr. Milne introduced the scheme. Dr. McRae stated that with a distinguished Soil Chemist like Dr. Puri working the scheme himself he would have unhesitatingly recommended it for sanction, but the pity was that Dr. Puri was not available and he proposed to carry out the investigations through his assistants. He did not therefore feel inclined to support the scheme. Professor Ghosh stated that the Puri Method needed to be revised by assistants, it was not time consuming but it was still a point whether it was exact. He therefore, supported the proposal for an assistant to ascertain the scientific importance of the method. After the Chairman had summed up the position, the Board decided that it was not in a position to recommend the scheme until such time as Dr. Puri was in a position to devote his whole time to the work.

14. *Cheapening the cost of wire fencing used for the protection of crops against wild animals (Subject No. 8 of the Agenda)*. (*Appendix X*).—The Chairman explained the action that was taken on the Board's recommendations on the subject made at its meeting held in June 1931. Dr. Hyder said that the further progress of the matter should be watched, though in present financial circumstances they could not ask for total removal of the duty on wire fencing. The Board agreed.

SIMLA,
The 18th July 1932.

CHARAN DAS,
Secretary.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD
AT SIMLA ON TUESDAY, THE 19TH JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman*.
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK.
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. P. H. CARPENTER.
7. Mr. G. K. DEVADHAR.
8. Mr. E. S. FARBROTHER.
9. Professor J. C. GHOSH.
10. Dr. G. P. HECTOR.
11. Dr. L. K. HYDER.
12. Mr. NIZAMUDDIN HYDER.
13. Mr. P. J. KERR.
14. Mr. T. F. MAIN.
15. Dr. W. McRAE.
16. Mr. D. MILNE.
17. Colonel A. OLVER.
18. Captain Nawab Rais JUNG BAHADUR.
19. Mr. S. V. RAMAMURTY.
20. Major P. B. RILEY.
21. Mr. P. T. SAUNDERS.
22. Mr. D. R. SETHI.
23. Mr. F. J. F. SHAW.
24. Mr. G. T. TAIT.
25. Mr. W. TAYLOR.
26. Mr. F. WARE.

Rai Sahib Malik CHARAN DAS, *Secretary*.

The following attended as visitors:—

1. Mr. R. P. HADOW.
2. Mr. Z. R. KOTHAWALA.
3. Dr. V. M. LIKHITE.
4. Dr. K. C. MEHTA.
5. Mr. C. V. SANE.
6. Mr. W. SAYER.
7. Mr. C. P. G. WADE.

The meeting lasted from 10-30 A.M. to 12-45 P. M. and adjourned till 10-30 A.M. on the 20th July to allow the Fruits Sub-Committee to meet in the afternoon.

2. *Application from the Government of the Punjab for a grant of Rs. 6,60,000 spread over a period of five years, for a scheme for the development of scientific research in the Irrigation Branch, Public Works Department, Punjab. (Subject No. 9 of the Agenda). (Appendix XI).*—Mr. R. P. Hadow, Chief Engineer, Public Works Department, Punjab, who attended the meeting of the Board, on invitation, as a representative of the Central Board of Irrigation, introduced the scheme. The Irrigation Department were interested in canal water as applied to land. The proposed investigations, namely, solutions of such problems as prevention or cure of progressive salinity of soils with a rising water table, or the treatment of unproductive alkaline soils so as to render and maintain them fertile, were of enormous importance to the Punjab, economically and socially. Mr. Hadow then traced the history of the development of scientific research in the Irrigation Branch and pointed out that the problems they had to tackle were to find out what happened when canal water was put on soil and what evil results happen and how we ought to overcome them especially water-logging which was unfortunately the usual result of irrigation. The proposed scheme would be of practical advantage also to the United Provinces, Sind and a few other places. It was an extraordinarily complicated problem and the staff which they had was not sufficient to cope with the vastly enlarged scope of work contemplated in the scheme. Referring to the relation of the Agriculture Department to the scheme Mr. Hadow explained that the problem of the Agriculture Department was one of rain water crop while they, in the Irrigation Department, were concerned with canal water soils. The Government of India had not so far devoted enough attention to this question. The Institute proposed was already in being, as it were, in skeleton. It was now only required to fill in the gaps to make it a suitable research institute. The estimates were very modestly framed and in view of the fact that the Government of the Punjab were already spending a not inconsiderable amount on this Institute and as the grant applied for only represented about one-half of the anticipated increased expenditure, he hoped that the Board would see its way to recommend the scheme for sanction of funds. In answer to a query from Rao Bahalur Naik, Mr. Hadow stated that the total budget of the Irrigation Department in the Punjab was about 4 crores of rupees receipts as against an expenditure of roughly Rs. 2 crores.

Mr. Ramamurty stated that Madras came next to the Punjab in the matter of canal irrigation. The problem was of an all-India importance ; but if it was dealt with in one province the results obtained would only be applicable there. The task of the Council should be to evolve a co-ordinated scheme as had been done in the case of rice, sugar and fruits. Soil surveys conducted in the Punjab would be only useful to the Punjab as soil and climatic conditions differed widely from place to place. The problems of water-logging and salinity of soils were so important that he suggested that the Board should refer the scheme to a special committee of Directors of Agriculture and Chief Engineers of the various provinces with instructions to amend it on a more modest scale and make it useful to all provinces. Rao Bahadur Naik did not like to make any subsidy whatever in view of the favourable financial returns obtained by the Irrigation Department in the Punjab. The Punjab Government is spending large sums on Irrigation and it can spend six lacs more. If, however, the scheme was recommended, it should be made to include the Bombay Presidency as well. Professor Ghosh read with approval paragraph 288* of the Report of the Royal Commission on Agriculture in India and emphasised that it was necessary that research into irrigation problems should be carried out by Provincial Governments in all provinces in which irrigation was of importance ; but the Council should only concern itself with the question of establishing a Central Bureau of information. Canal irrigation was not so much of a paying proposition in Madras or Bombay ; but it gave a profit of about 15·8% in the Punjab. The demand on the Council was therefore untenable and the Council would not be well advised to finance the scheme. Mr. Devadhar referred to paragraph 6 of the Local Government's letter (Appendix XI) and enquired which other parts of the British Empire the scheme would benefit. Mr Hadow replied that it would benefit Egypt, Soudan, Australia and Canada. Mr. Allan thought that there was overlapping between the Punjab Water Requirements scheme approved at the last meeting of the Board and the present one. Dr. Hyder approved of the idea underlying the scheme but felt that it was conceived on much too generous a scale. He wanted to have information regarding the total area which was water-logged and whether it showed any tendency to increase. Mr. Devadhar enquired to what extent the scheme would benefit the poor agriculturists. Mr. Hadow replying to the various points of criticism made it clear that the proposed institute was not intended to be the only one of its kind in India. There were more facilities available in the Punjab for the location of such a station than elsewhere. There appeared to be some misconception regarding the yield of profit. The figure was swelled by taking into account the land revenue also. As a matter of fact they got only 1·3% last year, though this year as a result of heavy economies they hoped to get 3%. In answer to a question as to why the Institute should not be in Bombay, Mr Hadow said that the Punjab had already an Institute and considerable ambitions ; the whole weight of Government was behind the scheme and there was a large variety of different kinds of irrigation whereas Sind had only one. There was no question of overlapping with Agriculture Department as they in the Irrigation Department did not propose to deal with crops but only on the effect of canal water on soils. Mr. Milne laid stress on the necessity for investigations on water-logging problems and stated that close collaboration between the Irrigation and Agriculture

* Not printed.

Departments was very necessary, but he did not consider that the best value would be got from the money proposed to be spent on this scheme with the proposed organisation. They had already experience of this. He had not intended to speak on this subject but as Mr. Hadow had told the Board what he thought the functions of the Agricultural Department were and another member had called attention to the overlapping of work between the Agricultural and Irrigation departments he would make a very brief statement. He said the Irrigation Department is a department of engineers whose main business is to bring the irrigation water to the field ; the application of water to the land is the business of the farmer and the Agriculture Department.

He would give to the Agricultural Department all soil work including soil surveys. He would give to the Irrigation Department. (a) Hydraulics ; including works on modules, meters, weirs, outlets, falls, sluices, etc. (b) all engineering works connected with water-logging. He would then have a Committee including the Director of Agriculture and Chief Engineer, Irrigation, to draw up a programme of the special work required to be done and to see that the work was properly carried out.

There would then be no overlapping and there would be no difficulty in getting the heartiest co-operation between the members of the special staff employed or between the Departments. His experience showed that such an organization was imperative to getting the best return for money spent on this scheme. At this stage Colonel Olver referred to the importance of prevention of water-logging from the point of view of controlling animal diseases. Dr. Hyder moved that the scheme be referred to a committee for detailed examination upon which Mr. Ramamurty withdrew his previous amendment as Dr. Hyder's motion was considered to be all-embracing. On the scheme being put to vote, it was decided to refer it to a committee to be appointed for the purpose : the selection of the personnel of the Committee was left to the Chairman.

3. *Application from the Government of Bihar and Orissa for a grant of Rs. 78,680 spread over a period of five years for a scheme of research on the economics of irrigation from tube wells. (Subject No. 10 of the Agenda). (Appendix XII).—* Mr. Sethi introducing the scheme explained how very important it was to ascertain—

- (a) the cost per unit of water ;
- (b) the prevention, as far as practicable, of wastage in distribution,
- (c) the optimum quantities of water to be allowed to different crops consistent with yield and profit ; and
- (d) the most profitable systems of farming that will fully utilise the available water.

He then went through the various items of recurring and non-recurring expenditure and pointed out that the Local Government were providing more than the usual 50% of the total expenditure and commended the scheme to the favourable consideration of the Board. Dr. Hyder stated that it would be much better to refer this scheme also to the Committee which would be appointed in due course to examine the Punjab scheme for scientific research

in Irrigation (Appendix XI). Mr. Allan pointed out that a great deal of the proposed work was already in progress in the United Provinces. Referring to paragraph 9 of the printed scheme (Appendix XII), he said that it would appear that the investigations were not restricted merely to tube-wells. He doubted whether the problem required a special station but favoured the suggestion for referring the scheme to the Committee. Dr. Hector was of opinion that a major part of the work proposed would be of value to Western Bengal and agreed with Dr. Hyder. Mr. Hadow thought that the present scheme had no connection whatever with the Punjab Irrigation research scheme. Mr. Milne approved the idea of referring the scheme to a committee. He, however, emphasised the importance of the scheme and incidentally observed that the Punjab Agricultural Engineer had invented a new strainer costing considerably less than those already on the market. Mr. Ramamurty said that Madras was interested in tube-well problems. Conditions of supply of water differed in the cases of tube-wells and canals. He recommended that the Bihar and Orissa scheme should be referred to a Committee and would personally prefer, if possible, that the Punjab water requirements of crops scheme, Punjab Irrigation Research scheme and the present scheme should all be examined together by the said Committee. Mr. Milne explained that as the water requirements scheme had already been examined by a special committee and recommended by the Board, there was no question of any further reference to a committee. Mr. Carpenter considered that the proposed investigations would be of very great value to the ordinary soil-agriculturists. The results already obtained in the United Provinces should be available to Bihar and Orissa. He preferred a reference to the committee. Mr. Sethi, in reply, pointed out that the Royal Commission on Agriculture had recommended that each province should carry out such work and that the principle of the scheme had already been accepted by the Board when it recommended the Punjab Water Requirements scheme, to which the present one was only a complement. He was not in favour of referring the matter to the Committee as proposed. The Board, however, decided by a majority of votes that the scheme should first be examined by a Committee to be appointed for the purpose.

4. *Investigation of the Traffic of Livestock through the province of Bihar and Orissa. (Subject No. 11 of the Agenda). (Appendix XIII).*—Mr. Sethi, in introducing the scheme, said that the original scheme, which involved a total expenditure of Rs. 31,720, was prepared by Mr. Henderson. The scheme had now been revised, as suggested by the Council Secretariat and the total expenditure had been reduced to Rs. 17,040 spread over a period of two years. He explained that there was a very large flow of cattle through Bihar and Orissa from West to East owing to fairs and markets. There was also believed to exist a good deal of export of animals bred or reared locally in the province. The main object of the scheme was to devise some means for the control of diseases imported into the province by these animals and for this purpose it was essential to collect data regarding the types or breeds, etc., of cattle that passed through the province. The proposed investigation would not only benefit Bihar and Orissa but other neighbouring provinces as well. Colonel Olver, in supporting the scheme, explained that owing to financial stringency

it was not possible for the Government of Bihar and Orissa to bear any portion of the expenditure. He said that the main value to be obtained from the original scheme, which would be of benefit to other provinces, was information regarding the movements of cattle which was a big factor in the control of disease. In the revised scheme, this aspect seemed to have been to some extent lost sight of and attention directed mainly to the breeding aspect which, though of undoubted value, had only been introduced to make the scheme more generally useful and to give more employment for the staff of stock-men which it was proposed to employ. Rao Bahadur Naik was of opinion that the scheme was not of an all-India importance, but it was purely a provincial question. Mr. Ware, in agreeing with Rao Bahadur Naik, said that the Local Government should undertake this investigation themselves. Major Riley, in supporting the principle of the scheme, said that the original scheme was discussed with him by Mr. Henderson, but the revised scheme appeared to him to be quite a different thing altogether. He was quite prepared to give every help to the Livestock Expert when he was appointed but he thought that it was essential that veterinary officers ought to be on the staff. Mr. Devadhar was also of opinion that the scheme was purely a provincial one and as such he thought that the Local Government should finance the scheme, if necessary by introducing legislation or by imposing some kind of new taxation. Mr. Sethi in replying to the various points raised during the discussion, said that in revising the scheme he had not changed the original idea of Mr. Henderson and that the scheme should be financed by the Council as the results obtained would be beneficial not only to Bihar and Orissa but also to other provinces. He explained that the Livestock Superintendent and the two Livestock Inspectors provided for in the scheme would be veterinary officers specially selected for their knowledge of livestock.

In the result the Board by a majority of votes recommended the scheme for sanction.

5. *A scheme for the continuance of investigations on different aspects of the cereal rust problem and the recommendation of the special Committee of Mycologists thereon. (Subject No. 18 of the Agenda). (Appendix XIV).*—The Chairman at the outset requested Mr. Main to let the Board know with reference to paragraph 10 of the Report of the Committee of Mycologists whether he intended to submit a revised estimate of expenditure on account of Dr. Uppal's scheme (Enclosure I to Appendix XIV). Mr. Main stated that he had since decided to accept and support Dr. Mehta's scheme. He would not press the Bombay scheme at present for financial reasons. Dr. Mehta's reports only confirmed what Dr. Uppal suggested a few years ago. It was now clear to him that no wheat breeders could claim to have discovered a strain or strains resistant to physiologic forms of rusts. He personally preferred an intensive survey in each province as against the random survey proposed by Dr. Mehta and was sorry that the Committee which met a few days ago did not drive this point home. Sooner or later, sooner rather than later, the Council would have to take up intensive work. Dr. Mehta dwelt at some length on the necessity of continuance of the work on which he was engaged and explained his future programme of work. There was wind-borne infection; and he was able to obtain spores several days before rusts actually appeared. He had devised

a simple and most inexpensive method of getting spores from air by kites. He proposed to expose aeroscope slides at 44 stations spread all over the wheat area in India. He had now evidence of over-summering of rusts in the Kumaun, Simla and other hills. There is evidence of over-summering in the South too, for example, in the Nilgiris. Over-summering is likely in the Palnis and possibly in the Western Ghats as well. He was satisfied as to the source of infection. The problem in India was quite unique and he contrasted it with the conditions prevailing, for example, in America. He considered that the problem in India was to breed resistant varieties for cultivation in the hills alone. He shortly expected to be able to prepare a map of India showing the distribution of rusts, all over the wheat area. He did not particularly select standard types of wheat for his tests, because that would not solve the problem of the poor cultivators most of whom used only the ordinary *desi* wheat. Random samples showed striking resemblances. He was not sure that the time had come for de-centralisation of work. Keeping in view the distribution of *Berberis* the number of forms of black rust in India is likely to be small. The area under wheat in the South of India was very small. It was therefore primarily a Northern India problem. The results of the preliminary tests were more than satisfactory and he now proposed to test some 130 to 150 single spore cultures keeping in view the requirements of each province. He also proposed to continue the study of weather conditions at different altitudes. The scope of his original scheme had now been extended so as to include dissemination and physiologic forms of rusts. In order to do justice to his duties to the Council and to the College, he desired that he should be relieved of a considerable part of his college duties. The Principal of the College had agreed to the proposal provided the Imperial Council met the expenditure involved. He summed up by saying that he had been trying his best to run his scheme as economically as possible consistent with efficiency. Mr. Milne congratulated Dr. Mehta on the work so far done. By means of aeroslides and other work Dr. Mehta had shown how the rusts spread and that over-summering took place in the hills. Proper place for work was therefore on the hills and personally he wanted more information on the subject before recommending further study in Southern India. He had every sympathy with Dr. Uppal to whom the credit for first raising the question of investigations on physiologic forms of rusts was due. Dr. McRae stressed on the excellence of work done by Dr. Mehta and stated that the only real point of difference was in regard to the time taken to get information on physiologic forms. In accordance with the desire of the Director of Agriculture, Bombay, not to press for an intensive survey of physiological forms, which would raise the cost of the scheme considerably, he thought it better policy at the present moment, as finance was scarce, to accept that part of the scheme as proposed by Dr. Mehta. He accordingly supported the scheme as recommended by the Committee.

The Board adopted the recommendation of the Special Committee of Mycologists.

CHARAN DAS,

The 19th July 1932.

Secretary.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD
AT SIMLA ON WEDNESDAY, THE 20TH JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman*.
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK.
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. P. H. CARPENTER.
7. Mr. G. K. DEVADHAR.
8. Mr. E. S. FARBROTHER.
9. Professor J. C. GHOSH.
10. Dr. G. P. HECTOR.
11. Dr. L. K. HYDER.
12. Mr. NIZAMUDDIN HYDER.
13. Mr. P. J. KERR.
14. Mr. T. F. MAIN.
15. Dr. W. McRAE.
16. Mr. D. MILNE.
17. Colonel A. OLVER.
18. Captain Nawab Rais JUNG BAHADUR.
19. Mr. S. V. RAMAMURTY.
20. Major P. B. RILEY.
21. Mr. P. T. SAUNDERS.
22. Mr. D. R. SETHI.
23. Mr. F. J. F. SHAW.
24. Mr. G. T. TAIT.
25. Mr. W. TAYLOR.
26. Mr. F. WARE.

¹Rai Sahib Malik CHARAN DAS, *Secretary*.

The following attended as visitors :—

1. Mr. Z. R. KOTHAWALA.
2. Dr. V. N. LIKHITE.
3. Mr. C. V. SANE.
4. Mr. W. SAYER.
5. Mr. C. P. G. WADE.

The meeting lasted from 10-30 A.M. to 1 P.M. and adjourned till 10-30 A.M. on the 21st July to allow the informal Committee on the question of holding the next meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry to meet in the afternoon.

2. The Chairman referred the Members to subject No. 37 of the Agenda regarding the election of two members from the Advisory Board to the Governing Body. He said that there were two vacancies *vice* Messrs. Hewlett and Carpenter. Mr. Carpenter, who ceased to be a member of the Council in May 1932 on the expiry of his three years term, had been re-elected to the Council by his constituency. Mr. Hewlett, the other member, resigned his membership on leaving India. Mr. Carpenter was eligible for re-nomination. He requested the members to send in by 1 o'clock on the 21st July 1932 two nominations from among the members of the Advisory Board, an up-to-date list of whom would be circulated to the members during the course of the day. On receipt of the nominations, ballot papers would be distributed to the members. Each member would then put a cross against the two names of his choice.

3. *Recommendations of the Indian Oil-Crushing Industry Committee, 2nd meeting, December 1931.*

Cultivation of Mahua and introduction of improved varieties of oilseeds and the question of improved storage. [Item No. 12 (a) of the Agenda]. (Appendix XV).—The Chairman drew attention to the four recommendations made by the Indian Oil Crushing Industry Committee under this head and stated that they might take them up one by one. Dr. McRae gave a synopsis of the information separately received (not printed) from the local governments. Mahua trees were found naturally grown in the forests generally in Bombay, United Provinces, Bihar and Orissa and the Central Provinces. No accurate statistical information was available regarding the extent of the cultivation in any province at the present day. As regards utility, Mahua fruit was rich in oil—about 40 to 50%. This oil found use all over India in the manufacture of soaps and candles by virtue of its high melting point. It was generally used also as an adulterant of and as a substitute for ghee, as lamp oil for burning and for culinary purposes. The oil cake contained about 2.5% of nitrogen but the nitrogen was neither ammonified nor nitrified to any appreciable extent. Hence it had little value as an organic manure. In the United Provinces the bulk of the cake was used as fuel in the mills crushing Mahua seed; while in Bombay it was used for feeding cattle in country parts and as a manure. Mahua flowers were mostly used in the manufacture of country liquor but in Bombay they were used to some extent for feeding purposes as well. Mr. Nizamuddin Hyder considered that there was a possibility of the extension of

Mahua but their Industries Department had not taken up the question as yet. Mr. Carpenter referred to the statement made by Mr. Burt that Mahua cake was a cheap manurial cake, and stated that that was not the case; it was, on the other hand, an expensive manurial cake as a large quantity had to be used on account of its low nitrogen content. Rao Bahadur Naik thoroughly agreed with the recommendations of the Committee and added that Mahua was not only useful as food for cattle and as manure but it was also used by poor people in Kaira and Panchmahal for example, as food. Perhaps the Excise Department might come in the way of its extension. The Board approved of the recommendation of the Committee in regard to the extension of the Mahua cultivation.

Dr. Shaw explained the work that had been so far done in Pusa on linseed. They had isolated 123 different types and selected two high yielding varieties which had a highly satisfactory oil content. They were working on sesamum and had isolated thirty different types having high oil percentage and yielding power. Regarding diseases they knew which of the types were resistant. Work on mustard was also in progress for the last three years. Mr. Ramamurty wanted emphasis to be laid on evolving high yielding strains particularly in castor and ground-nut. There was scope for cross-breeding. Rao Bahadur Naik agreed with Mr. Ramamurty but stated that the vital question was how far the grower was benefited. He thought that in every scheme the interest of the grower should be mainly looked into. Mr. Milne said that in the Punjab they had taken up work on *Toria Sarson*, ground-nuts and sesamum. They were distributing improved strains of *Toria* and *Sarson* to different farms. His definition of an improved crop had throughout been one that would give farmers more profit than the crop which they were already growing. On the question of diseases he stated that their entomological section was collaborating with their oil-seeds Botanist. Mr. Allan considered that the financial return obtained was really important. They had succeeded in getting higher-yielding and rust resistant varieties of linseed and castor in the United Provinces.

The recommendation of the Indian Oil Crushing Industry Committee on this subject was approved.

Mr. Milne spoke on the question of improved storage of oil-seeds and the damage caused by fermentation when seeds stored were damp but he was not sure as to what exactly the Committee wanted to be done. Professor Ghosh instanced the case of the Indian Turpentine and stated that the difficulty there was that in the course of transport the turpentine got oxidised and solidified. Mr. Duke, the Oil Expert in the United Provinces, might be asked to prepare a note on the subject. Dr. Shaw thought that all that was required was that they should be kept in a dry place. The Chairman summed up by saying that he would place the remarks made at the Board before the Committee for any further information that it might be able to furnish on the question. The Board agreed.

4. *Import duty on oil-mill machinery and spare parts.* [Subject No. 12 (b) of the Agenda]. (Appendix XVI).—The Chairman in introducing the subject stated that in view of the present financial situation it was hardly likely that

the Government of India would be inclined, just at present, to remove the existing duty on oil-mill machinery ; he therefore thought that nothing could be done immediately : but suggested that the position should be carefully watched with a view to taking action for removing the duty at the earliest possible moment. Dr. Hyder, and Mr. Devadhar supported the proposal. Rao Bahadur Naik stated that the Council should take up the matter at once. The Chairman stated that he would communicate the Board's recommendation to the Commerce Department of the Government of India with a statement to the effect that while the Board did not now wish to press the matter, the recommendation should be borne in mind at the time of revision. The Board agreed.

5. *Helping village presses and large scale oil factories.* [Subject No. 12 (c) of the Agenda]. (Appendix XVII).—Mr. Milne, who initiated the discussion on the subject, stated that, personally speaking, he would like to have the enquiry into the *Teli's* business before attempts were made by the Council to devise improved machinery, etc. The Chairman enquired whether a proposal that the Council should offer suitable prizes for all-India or for specific provinces in this connection would meet the purpose. Mr. Milne thought that the idea should be explored. Mr. Ramamurty said that their Industrial Engineer in Madras had devised some comparatively cheap presses. If only ground-nut oil could be deodorised there was more scope for the extension of its use in Madras. The Board generally approved of the recommendation of the Committee.

6. *Organisation and development of the manufacture of soaps, candles, lubricants and edible products, etc., such as Ghee and Vegetable Substitutes for which there is a demand; question of laying down standards for imported and indigenous soaps and candles and for edible oils; also steps to increase the demand for edible oil* [Subject No. 12 (d) of the Agenda]. (Appendix XVIII).—The Chairman opened the discussion on the question of laying down standards for soaps and candles. In answer to Rao Bahadur Naik, the Chairman said standards could be adopted by the prescription of certain minima of constituent elements. Professor Ghosh wanted something to be done in this direction. Mr. Ramamurty thought that it would be better not to lay down any definite standards at the present time when the soap industry in the country was in its infancy. He rather preferred to let things take care of themselves ; he believed that in due course the good article would drive out the bad. Dr. Hyder agreed with Mr. Ramamurty that it was still premature to attempt to set up any legal standards ; it was moreover difficult to enforce such standards in a vast sub-continent like India. Rao Bahadur Naik agreed with Dr. Hyder. It was decided that the views expressed by the Board should be communicated to the Oil Crushing Industry Committee for further consideration. Mr. Milne thought that the concensus of opinion in the Board was that standards were desirable, but that it was hardly practicable to enforce them just now. He personally thought that standards were an urgent necessity and that the practicability of applying standards should be thoroughly looked into as early as possible.

In regard to the recommendation on the subject of edible oil-products, Mr. Ramamurty observed that the importation of mineral oil with which such

products were adulterated should be prohibited and that he understood that this matter had already been referred by the Government of Madras to the Government of India. Colonel Olver thought that this was important from the point of view of nutrition and wanted a strong recommendation to be made. He stressed the fact that no real improvement in the position was possible without an organisation and improvement of the dairy industry. Mr. Kothawala thought that there was sufficient *ghee* available in the country, but people were not able to face the competition of adulterated *ghee*; any encouragement given to the production of "Vegetable" *ghee* will do further harm to the *ghee* industry in this country. Rao Bahadur Naik doubted whether there was shortage of *ghee*. *Ghee* was, however, dear. He wanted legislation preventing adulteration of genuine *ghee* with vegetable *ghee*. There was general agreement in the Board that it was desirable to introduce a separate name for 'vegetable *ghee*', which should not include the specific word '*ghee*'.

Dr. Hyder felt that there was genuine shortage of *ghee*. Mr. Milne said that, vegetable *ghee* has a definite food value and had its place among foods. There was need for correct labelling and correct description. Mr. Tait said that there were three and not two kinds of *ghee*, namely, genuine, vegetable and adulterated *ghee*. Mr. Carpenter said that the thing required was a knowledge of what constituted *ghee* and what constituted vegetable oil. Mr. Ware said that vegetable *ghee* had a food value but not the same food value as genuine *ghee*. Dr. Hyder said that the recommendation of the Committee did not solve the real problem. He agreed with Colonel Olver that only an extension of the dairy industry would solve that real problem. They require improvement of breeds of cows and their milk yield. The Board decided that the matter should be referred back to the Oil-Crushing Industry Committee for further consideration and report.

7. *Application from the Annamalai University for a grant to investigate the problems for the marketing of the groundnut crop of the South Arcot District (Subject No. 13 of the Agenda). (Appendix XIX).*—Mr. Ramamurty introduced the scheme. He explained that the scope of the work as originally outlined by the University had been curtailed by the Indian Oil-Crushing Industry Committee in order to confine it to a purely marketing investigation. South Arcot was one of the largest centres of groundnut cultivation in the Madras Presidency and was particularly suited for the enquiry and the co-operation of the Annamalai University would be very helpful. He referred to the bad marketing that was prevalent and was sure that the results of the proposed enquiry would throw considerable light on similar problems in other parts of India. Dr. Hyder supported the scheme. The Board recommended the scheme for sanction.

8. *Application from Professor J. C. Ghosh, D.Sc., Chemistry Department, Dacca University, Dacca, for a grant of Rs. 11,200 spread over a period of five years for the investigation of the organic constituents of Indian soils. (Subject No. 14 of the Agenda). (Appendix XX).*

Application from Dr. B. K. Singh, Professor of Chemistry, Ravenshaw College, Cuttack, for a grant of Rs. 8,260, spread over three years for research work on the nature of organic compounds present in the rice soils of India, and the

factors influencing their decomposition with special reference to Bihar and Orissa soils. (Subject No. 22 of the Agenda). (Appendix XXI).—Dr. Hector stated that subject No. 14 (Appendix XX) was not exactly a new scheme; it was part of the old scheme which the Council had already sanctioned and which had been in progress for the last two years. It was in fact the Advisory Board which, at its meeting held in December 1929, considered that the investigation of the organic constituents of the soils was more important than the estimation of the organic matter in soils. It was a modest scheme and he strongly recommended it to the favourable consideration of the Board. Mr. Carpenter was satisfied that the problem was of very great importance. Information was required as to the different substances that constituted organic matter. It was well worth investigation. He, however, wanted if possible, that the Board should consider the Dacca scheme along with the application of Dr. B. K. Singh for a grant for work on the nature of organic compounds present in the rice soils of India and the factors influencing their decomposition with special reference to Bihar and Orissa soils (subject No. 22 of the agenda) (Appendix XXI). Professor Ghosh explained in reply to Mr. Devadhar that the proposed investigation would not only cover Bengal soils but also soils from all parts of India. Soils of humid regions where organic matter was large would get first attention, while the soils of arid areas would come next. Mr. Milne agreed with Mr. Carpenter but had two points of criticism on details, namely, (i) that unless an experienced Research Assistant was taken, an initial pay of Rs. 120 instead of Rs. 150 would be sufficient for a fresh M. Sc. and (ii) that the University should be able to find money for the capital grant of Rs. 985 asked for laboratory apparatus and chemicals which included such small items as flasks, etc. (He thought Dr. Ghosh was a very capable man to take up the sort of work proposed. Professor Ghosh explained that they had a very experienced man in view and hence the pay proposed. As regards the capital grant, it was not possible for the University to find the money this year but it would be able to do so in the succeeding four years during which the scheme would be in progress. Mr. Sethi introduced the Bihar and Orissa scheme (No. 22 of the Agenda) (Appendix XXI) and pointed out that the Government of Bihar and Orissa had recommended the scheme only for a period of three years in the first instance with a possibility of extension for another two years if the results obtained justified it. He explained that a knowledge of the formation, nature and decomposition of the soil organic matter was the most important and most outstanding need of soil science to-day. Professor Ghosh, in answer to the Chairman's question as to which of the two schemes 14 and 22 should be preferred, stated that in his opinion schemes which were the natural growth of work already in progress should get preference over fresh schemes. In Bihar soils, so far as he was aware, organic matter never exceeded 6 or 7%. Mr. Carpenter was of the opinion that both Dr. Singh's scheme and Dr. Ghosh's scheme covered practically the same ground. He therefore recommended that Dr. Singh's scheme should lie over till such time as the results of Professor Ghosh's scheme were available and they were in a position to allot a definite portion of the main work to Dr. Singh. This view was accepted by the Board. The Chairman then put Professor Ghosh's scheme to vote and Board recommended the scheme, as framed, for sanction.

9. *Application from the Dacca University for a grant of Rs. 2,000 on account of apparatus, etc., for the year 1932-33 in connection with the scheme for agricultural research already sanctioned by the Council. (Subject No. 15 of the Agenda). (Appendix XXII).*—Dr. Hector explained that the grant asked for was in connection with the scheme which was already in progress. The only large item was the provision of Rs. 1,450 for the purchase of a Sharples Laboratory Super-centrifuge complete with electric motor; it was required in connection with the extensive study which had been undertaken on the colloidal behaviour of lateritic clays. Dr. Carpenter took exception to the provision of Rs. 300 for two platinum crucibles when cheaper silica crucibles were available. Professor Ghosh emphasised the need for Platinum as opposed to silica crucibles. In the result the Board recommended the entire grant of Rs. 2,000 on account of apparatus for the year 1932-33.

10. *Application from the Madras University for a grant of Rs. 25,830 spread over three years for a scheme of research in the cytological study of Indian crop plants (Subject No. 16 of the Agenda). (Appendix X III).*—Mr. Ramamurty, introducing the scheme, pointed out that the University of Madras proposed to carry out the comparative chromosome studies of different varieties of crop plants and related wild species with a view (a) to determining whether chromosome variations numerical or otherwise, could be correlated with varietal variations; (b) to gathering the necessary cytological data for providing a basis for genetic analysis of crop plants such as was in progress in the U. S. A., and (c) to studying linkage groups. He, however, suggested that the selection of crops for cytological study should be made with the approval of the Director of Agriculture, Madras, and also that the work should be conducted throughout at Coimbatore where he would give the necessary facilities. Dr. Shaw supported the scheme as cytology was of great importance. The programme of work was too wide as it covered the whole range of cytology: he would concentrate on some one crop which had been already a subject of close genetical analysis at Coimbatore, for example, the cytology of the cane and sorghum hybrids work on which was being done by the Imperial Sugarcane Expert. Mr. Ramamurty preferred intensive work on paddy but also work on some of the millets besides sugarcane. He would not like to limit the investigation to one crop. Dr. Hyder wanted concentration on one crop, sugarcane, at Coimbatore. Dr. Hector approved of the scheme but recommended concentration on two or three crops, in particular on rice. Dr. McRae uttered a word of caution against too diffuse an investigation. Professor Ghosh was of opinion that the actual cytological laboratory work could not be better done at Coimbatore than at Madras. Mr. Milne wanted the study confined to two crops of economical value on which Coimbatore had already done breeding work and pure strains of which were being grown. Dr. Shaw gave it as his personal opinion that no one man could possibly handle more than two crops. On a vote, the Board decided to recommend the scheme with discretion to work up to 4 crops in preference to limiting it to two crops.

11. *Recommendation of the Committee appointed to examine the Report on Hemp Marketing in India prepared by Mr. T. S. Sabnis (Subject No. 17 of the Agenda). (Appendix XXIV).*—Dr. McRae introduced the report of

the special committee appointed to examine the Report on Hemp Marketing in India prepared by Mr. T. S. Sabnis and moved that it be adopted. After Dr. Hyder had spoken in support, the report of the Committee was accepted.

12. *Application from the Government of Bombay for a grant of £500 (Rs. 6,667) on account of the deputation of Dr. B. N. Uppal, Plant Pathologist to Government to foreign countries to study virus diseases of plants (Subject No. 19 of the Agenda). (Appendix XXV).*—Mr. Main explained how after the Virus Research Scheme had been sanctioned by the Council, its inauguration had to be postponed at the suggestion of the Council Secretariat on account of financial stringency. After discussing the matter with Mr. Burt, he had come to the conclusion that advantage should be taken of the opportunity afforded by the postponement to depute abroad Dr. Uppal (who was to take charge of the scheme) to get himself acquainted with the latest additions to knowledge on the subject. Very little Virus work had been done in India and the proposed deputation would materially assist Dr. Uppal in the conduct of the main scheme. The cost was only about £500 and it included visits to England, U. S. A., and the continent. Mr. Devadhar wholeheartedly supported the application. Mr. Ware wanted to know whether Dr. Uppal had done any virus work himself. Mr. Main stated that some preliminary work had been done by Dr. Uppal. Dr. McRae strongly supported the proposal in view of the fact that virus disease was very common in India. Sugarcane and other crops suffered from that. It was most important that Dr. Uppal should be sent abroad on deputation to see what was being done in the laboratories in the countries specified. In the future, it was going to be a very widely developed subject.

The Board recommended the application for sanction.

13. *Question of compilation by the Imperial Council of Agricultural Research annually for circulation to all concerned, of a list of research work completed or under investigation in the Agricultural and Veterinary Departments or in the Universities in India (Subject No. 20 of the Agenda). (Appendix XXVI).*—The Chairman, in explaining the proposal, said that the publication of research programmes of the Imperial and Provincial Departments of Agriculture as a separate compilation was discontinued by the Government of India in 1922 on the recommendation of the late Agricultural Adviser. The Local Governments were, however, allowed a free hand in regard to the printing of their programmes of research in their Annual Reports of Agricultural and Veterinary Departments. As a result the Madras, Burma and Bihar and Orissa Departments of Agriculture were publishing their research programmes while others did not. The question was whether the Board wanted the revival of the previous practice. Dr. MacRae favoured the proposal and suggested that a paragraph might be added in the Provincial Reports giving the programmes. This was agreed to.

14. *Participation in the Congress of the Far Eastern Association of Tropical Medicine (Subject No. 21 of the Agenda). (Appendix XXVII).*—Colonel Olver, in opening the discussion on the subject, stated that this Congress would give an opportunity to the veterinary workers in this country to discuss with workers of other countries important veterinary problems. It

would not be practicable to organise a purely Veterinary Congress in the East and it would be of great advantage to this country if veterinary workers were encouraged to read papers at the Far Eastern Congress which had a veterinary section. Mr. Ware strongly supported the proposal and said that participation in this Congress was the only way to come in contact with workers in other countries. He himself attended the Congress held in 1927 in Calcutta and the veterinary subjects discussed therein were very interesting indeed. He suggested that the Council should communicate in this matter with the Veterinary Departments of other Governments in the Far East with a view to their supporting and joining the Association. The Board recommended the proposal for sanction.

15. *Application from the Government of Madras for a grant for research work on potatoes (Subject No. 23 on the Agenda). (Appendix XXVIII).*—Mr. Ramamurty pointed out that at its meeting held in May 1931 the Governing Body had rejected the Madras scheme for research work on potatoes for two reasons, namely, (i) that the scheme should be located at a central place like Pusa so as to serve the needs of all provinces or that in the alternative help should be given for such research not only in Madras but also in other provinces such as the United Provinces and Bihar and (ii) that the crop was not of primary importance to India. He stated that all that he wanted was that potato breeding should be done somewhere. As Mr. Burt had pointed out in his technical note (Enclosure V to Appendix XXVIII), Pusa was definitely *not* a suitable place either for breeding new varieties of potatoes or for the acclimatising and first testing of imported potatoes. The potato crop was the main crop in the Nilgiris and they, in Madras, were already doing some important work. He, therefore, expressed the hope that the Board would again recommend the scheme for sanction. Mr. Nizamuddin Hyder doubted whether varieties evolved in the hills would suit the plains. Some work on indigenous varieties suited for the plains was also needed. Mr. Milne explained the work done by him in the Punjab since 1909. Varieties imported from Scotland in 1909 and grown in the Simla Hills had given farmers consistently a profit of Rs. 100—150 per acre more than the indigenous breeds. He had in the Punjab a collection of the best Scotch varieties up-to-date and was also crossing indigenous varieties as well as indigenous and Scotch varieties in the attempt to get strains still more suitable for the Punjab. Work was at present being done near Simla but was being transferred to Kangra as it could be better supervised there. It was being done in close collaboration with Iyallpur. Hill varieties, he said, lost their stamina very soon when grown in the plains owing to, he thought, to the plains climate not being cold enough to ripen the tubers properly. As Madras had not as cold a climate as the Simla Hills he thought Madras could not give suitable potatoes for the Punjab. He thought it would be the other way round just as England goes to Scotland periodically for more vigorous strains. He saw no reason however why Madras should not have its own station although he was not satisfied with the site at present chosen. Mr. Sethi stated that the area under potatoes in Bihar and Orissa was 60,000 acres and not 30,000 as originally mentioned by him. He was of the opinion that the north of India should have its own potato research stations in due course. He, however, supported the Madras scheme.

Mr. Allan considered that the Madras scheme was entirely a provincial one: each province should do some research work on its own account. Mr. Birt explained the position in Assam where they had been obliged to give up all *desi* varieties and go in only for imported ones. Mr. Ramamurty stressed the fact that there was no reason why they should not evolve new varieties themselves instead of always depending on imported varieties. Mr. Carpenter did not see how he could support the scheme when it largely interested only Madras. It was therefore more or less provincial in character.

The Board did not recommend the scheme for sanction.

16. *Participation of India in the Fifth World Poultry Congress, Rome, 1933 (Subject No. 31 of the Agenda). (Appendix XXIX).*—Colonel Olver, in introducing the subject, said that the Poultry Industry in India was still in its infancy but it was extending rapidly and in certain provinces a good deal of work had been done and very valuable results obtained. Figures prepared by the Statistician to the Council showed that in other countries the import of eggs was a very big business and there was no reason why this country should not develop a big export business of eggs in the shell or of egg powder or liquid eggs. The eggs produced by *desi* fowls were considerably bigger than Chinese or Egyptian eggs but the first thing to be done was to produce eggs, even bigger and more even in size to be more attractive for the English market. A good deal had already been done in various provinces in this direction largely by the use of imported birds but there was no doubt that a great deal more should be done in grading up Indian poultry by selection. Mr. Milne said that in the Punjab they had had a Poultry Expert for the last 5 or 6 years. Their main object was to improve the *desi* fowl. They had collected the best fowls seen in villages in the province and by means of trap nesting lists had now *desi* fowls which were laying about double the number of eggs laid by the ordinary *desi* fowl. The work had shown that very great improvements could be made in *desi* fowls which were far better suited to the climate and other conditions of the country than most foreign breeds. There was a tendency to pay attention to foreign breeds in preference to Indian breeds as the former were more paying than the latter for certain purposes, in certain conditions but in his opinion the main work of Government as regards poultry should be the improvement of the *desi* fowl. Due to financial stringency the work in the Punjab was threatened with extinction. Fowls benefited the small farmer and the poorer classes in general and he favoured the idea of pushing this industry as quickly as possible. In reply to Mr. Devadhar, Colonel Olver said that it had been proposed to start a Central Poultry Institute, but the proposal was in abeyance for the present. Mr. Ware supported the proposal and stated that in considering the composition of the delegation those who had experienced of poultry diseases should be preferred. In answer to Major Riley, the Chairman said that the cost of the delegation, if one was to be sent, had not been estimated. Ordinarily, those who were on leave in Europe at the time of the Congress would be selected and in that case the cost would be very small. Mr. Sethi remarked that the poultry industry in India was not yet in an advanced condition, and it would be more appropriate to spend money on the improvement of poultry to begin with rather than on any delegation to participate in an International

Conference. Mr. Ramamurty agreed with Mr. Sethi. Colonel Olver explained that it was intended to send a student to study poultry in England and he would benefit by attending the Conference.

In the result the Board by a majority of votes recommended the proposal for sanction.

SIMLA,

The 20th July 1932.

CHARAN DAS,

Secretary.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH,
HELD AT SIMLA ON THURSDAY, THE 21st JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman.*
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK,
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. P. H. CARPENTER.
7. Mr. G. K. DEVADHAR.
8. Mr. E. S. FARBROTHER.
9. Professor J. C. GHOSH.
10. Dr. G. P. HECTOR.
11. Dr. L. K. HYDER.
12. Mr. NIZAMUDDIN HYDER.
13. Mr. P. J. KERR.
14. Mr. T. F. MAIN.
15. Dr. W. McRAE.
16. Mr. D. MILNE.
17. Colonel A. OLVER.
18. Captain Nawab RAIS JUNG BAHADUR.
19. Mr. S. V. RAMAMURTY.
20. Major P. B. RILEY.
21. Lieutenant-Colonel A. J. H. RUSSELL.
22. Mr. P. T. SAUNDERS.
23. Mr. D. R. SETHI.
24. Mr. F. J. F. SHAW.
25. Mr. G. T. TAIT.
26. Mr. W. TAYLOR.
27. Mr. F. WARE.
28. Brigadier A. J. WILLIAMS.

Rai Sahib Malik CHARAN DAS, *Secretary.*

The following attended as visitors.

1. Dr. G. S. CHEEMA.
2. Lieutenant-Colonel R. N. CHOPRA.
3. Mr. Z. R. KOTHAWALA.
4. Dr. V. N. LIKHITE.
5. Mr. C. V. SANE.
6. Mr. R. C. SRIVASTAVA.
7. Mr. W. SAYER.
8. Mr. C. P. G. WADE.

The meeting lasted from 10-30 A.M. to 1 P.M. and adjourned till 10-30 A.M. on the 22nd July to allow the Sub-Committee appointed to examine the progress reports on the schemes sanctioned by the Council to meet in the afternoon.

2. *The Punjab Veterinary Department scheme for investigation into the most suitable and economic methods of combating different types of parasitic infection in ruminants in the field, concurrently with experiments to determine whether certain mineral deficiencies tend to lower animal resistance to parasitic infection. (Subject No. 24 of the Agenda). (Appendix XXX).*—Mr. Taylor, in introducing the subject stressed the importance of the investigation on parasitics and animal nutrition, as the economic loss from these was probably greater than from animal diseases. He said that the scheme was self-explanatory and that the only thing he wanted to add was that the work would be done by a team of workers. Colonel Olver supported the scheme and said that parasitic infection was causing economic loss and the degeneration in stock and that Veterinary Departments had not been able, up to the present, to check this infection. Messrs. Ware and Saunders, in supporting the scheme, said that the two scientific questions involved in the investigation i.e., parasitic infection and animal nutrition, were of equal importance and the scheme put forward was very modest as compared with the results expected from it. Mr. Kerr also supported the scheme very strongly and remarked that Bengal being a wet Province any investigation in these directions would be welcome.

In the result, the Board unanimously recommended the scheme for sanction.

3. *Scheme for research on sugarcane in the Madras Presidency. (Subject No. 25 of the Agenda). (Appendix XXXI).*—Mr. Ramamurty stated that the Sugar Committee had already examined the scheme at its meeting held in December last but that it wanted certain technical details to be completed. The scheme had been revised after discussion with Mr. Burt and was now for the Board's approval. Until two or three years ago Madras did not devote enough attention to sugarcane; opinion had now changed and they had come to the conclusion that there was need to some extent to displace paddy by commercial crops. Work on the *sorghum* hybrids and medium canes had been in progress for some time and promised good results. The trouble in Madras was the comparatively high cost of cultivation of sugarcane, Rs. 400

per acre as against a return of, say, Rs. 600. They were therefore trying new varieties and also finding out means of cutting down the cost of cultivation. He wanted the position to be made clear that the Council should sanction the grant asked for, namely, Rs. 1,50,100 spread over a period of five years subject to the actual receipts from the two stations being made over to the Council. The amount of the receipts would be credited to the Council after the close of the year. Mr. Srivastava supported the scheme. Apart from the importance of sugarcane cultivation there was a great deal of interest now evinced in the Madras Presidency in production of sugar and in *gur* manufacture. The acreage in Madras was not large as yet; but it deserved every help that could be given as there were immense potentialities there.

The Board recommended the scheme for sanction.

4. (A) *Scheme for the establishment of a sugarcane research station in the Punjab.*

(B) *Application from the Government of the United Provinces for a grant for investigation into various problems of sugar industry in the United Provinces.*

(C) *Scheme for a Research and Testing station for the indigenous system of gur and sugar manufacture, drawn up by the Sugar Technologist, Imperial Council of Agricultural Research (Subject No. 26 of the Agenda).—(Appendix XXXII).* Mr. Milne introduced the Punjab Scheme for a sugarcane research station. He explained the various items of the proposed programme of work and said that on the question of site he was personally more than satisfied that Jullundur would not be suitable for the purpose. There was, first and foremost, the question of inadequate water supply. They might not therefore be able to do full justice to the work if it was to be carried on at Jullundur. Secondly, more money would be required for the construction of the necessary buildings and laboratories. Thirdly, it would be rather difficult to exercise proper supervision over the work of the young assistants who, as could be seen from the estimates of pay proposed, were to be graduates of little experience of research. Lyallpur District had more acreage under cane and Risalewala farm had a better water supply than Jullundur Farm. Proper supervision could also be assured as, at Lyallpur, they had entomological, mycological and other technical officers necessary for the purpose. Mr. Milne then went through the various items of expenditure recommended for omission by the Sugar Committee and pleaded for the acceptance of the scheme, as originally submitted by the Government of the Punjab. In particular, he stated that the provision of Rs. 10,000 per annum made for 'Machinery and equipment to be developed or purchased (manufacturing)' was very necessary as *gur* was selling at a very low price and an important part of the scheme was to show the farmer how to convert his cane into a commodity of more value, if the Board were inclined to agree with him in this respect, then, it naturally followed that the posts of Technical Chemist and one Chemical Assistant which were considered unnecessary by the Sugar Committee should also be allowed to remain. Mr. Wynne Sayer wanted to know whether the acreage under cane at Lyallpur went up simply as a result of the drop in the price of cotton; or, was it due to the fact that the Coimbatore canes were more paying? He also enquired whether if the price of cotton rose at any time, the acreage under cane would go down.

Mr. Milne, in reply, stated that the rise in the acreage was probably due to the combination of circumstances mentioned by Mr. Sayer. Coimbatore canes had certainly made the sugarcane crop in the Punjab a paying concern. He said there were economic reasons why the Punjab peasants did not grow thick canes and he was not prepared to admit that they were ignorant of the existence, or the utility of thick canes. The thin grassy canes grew well in certain places where there was not enough water supply and made excellent fodder when there was fodder scarcity: thick canes required more water and manure to grow good quality canes, were less resistant to disease and their megassi did not provide sufficient fuel for the old type of furnace to boil the juice etc., etc., etc. Mr. Sayer thereupon asked whether it was not after all a question of irrigation for the purposes of growing canes. Mr. Devadhar asked (i) whether cotton was grown in water-logged areas; (ii) to what extent had Coimbatore canes replaced the indigenous varieties in the Punjab and the extent of the profit; and (iii) whether the cultivation of sugarcane, as was being carried on at present, was remunerative. Professor Ghosh said that the Punjab was next only to the United Provinces in the matter of cane acreage in India, but stood fifth in the production of *gur*. He would like to be informed whether this had anything to do with climatic conditions in the Punjab. Mr. Milne said that cotton could not stand water-logging; that Coimbatore canes had replaced the indigenous varieties in about 100,000 acres and that the former was comparatively more remunerative. He quoted figures of profits from canes grown on the Risalewala Farm. Answering Professor Ghosh, Mr. Milne said that the output of *gur* per acre for the whole province averaged about a ton; but in certain places as, for example, at the Lyallpur Farm, yields had been even as high as 120 maunds to the acre and 70 to 80 maunds of *gur* per acre was now the average yield; therefore there was nothing wrong with the climate of Lyallpur as far as cane growing was concerned. More attention must be paid to the cultivation of cane; Punjab farmers required improvement in the methods of cultivation and improvement of varieties. In the opinion of Dr. Hyder the broad problems of work in the Punjab and the United Provinces schemes were the testing of Coimbatore canes and water-requirements etc. It was very necessary to avoid duplication of work, unless there were any differential agricultural factors. So far as he could see the soil was not very different; the cane plants were the same: and there were no special environmental features; no difference in season or in the method of irrigation. In the circumstances was there any need for this duplication of work? Mr. Srivastava said that the problem was to find out what response certain cultural methods gave in various places. The need for the local testing was as great as the need for the many experimental farms which existed within the same province. There was no overlapping in the two schemes. The revised United Provinces scheme provided for definite work at Meerut, Grahampur and Shahjahanpur. Mr. Milne said that they in the Punjab found Co. 205 very popular in certain localities, but it did not mean that it would prove to be the best everywhere. He stated that other varieties had already been found more suitable in certain localities and that from experience with canes and other crops the crying need was for more stations than they could afford. Mr. Allan did not like to be tied down to one station. Mr. Main said that there was a provision of Rs. 10,000 per annum or a total of

Rs. 50,000 over five years for machinery and equipment to be developed or purchased. This was practically, a scheme within a scheme ; but there was no provision for an Engineer. Mr. Srivastava pointed out that this particular item had not been recommended by the Sugar Committee ; rather, it had been reduced to Rs. 2,000 per year. In answer Mr. Milne stated that the Rs. 10,000 was for the provision of vacuum-pans etc., that they had a well qualified Engineer and well equipped Workshop at Lyallpur and that the proposed machinery would be installed at Lyallpur. He said that it was proposed to devise an improved method of manufacturing sugar something beyond the open-pan method with the help of Professor Carter Speers of the Technical Department of the Foreman Christian College, Lahore. He drew attention to the fact that the grant of Rs. 8,800 for machinery and implements had been reduced by the Sugar Committee to Rs. 2,000 which was a sum required for agricultural implements, therefore provision for installing the open pan system with centrifugals had also been cut out and thus the scheme had been crippled in that very important direction. Mr. Ramamurty asked whether the work proposed in the Punjab would be original research or whether it would only be an extension of Mr. Srivastava's work. Mr. Srivastava pointed out that the Rs. 2,000 per year recommended by the Sugar Committee was not for original research ; it was only intended to make provision for some machinery to convert the crop into a saleable product. Some tests on crushers would also be made by the way. Professor Ghosh wanted the provision of Rs. 10,000 per annum to stand as also the post of Technical Chemist ; otherwise the proposed Punjab Station could not be up to the mark. Mr. Carpenter considered that the proposed machinery was not for the purpose of research ; but for demonstration. He therefore did not see why the Council should be asked to finance this item. The Chairman then put each individual recommendation of the Sugar Committee to vote and in the result the Punjab scheme, as modified by the Sugar Committee, was recommended for sanction.

As regards the question of the site of the proposed station the Board left it to the discretion of the Chairman to settle in consultation with the Punjab Government.

At this stage the Chairman announced that in order to suit the conveniences of Colonels Chopra and Russell he proposed to take up subject No. 35 of the agenda.

5. *Application from Lieutenant-Colonel R. N. Chopra of the School of Tropical Medicine, Calcutta, for a grant for research in systematic cultivation of medicinal plants and study of food poisons in India (Subject No. 35 of the Agenda). (Appendix XXXIII).*—Colonel Chopra, in introducing the scheme, said that the object of his scheme was firstly to investigate the food poisons and allied conditions. It was well known that there were a number of food poisons, affecting both man and animal in this country about which very little was known. He proposed to work out some of the allied groups of cereal poisons and allergic conditions produced in men and animals by pollens of grasses and plants. Poisoning of the nature of ergotism had frequently been reported from different parts of India by consumption of such food-stuffs as barley, oats, wheat. The investigation of the conditions which affected both men and animals was a field incompletely explored in this country and deserved the

attention of those responsible for the direction of medical, agricultural and veterinary research. The second part of his scheme was concerned with the investigation of medicinal plants growing in India and the encouragement of their cultivation. On account of the variety of climatic conditions every drug could be grown in India. In spite of this India imported not only large quantities of prepared medicines, but also crude drugs. Drugs which could be easily grown in India were not grown because it was not known where many of them could be advantageously grown and which particular drug could be profitably grown. At present, persons interested in drugs had no means of getting their products tested to know if they were up to standard and effective. Colonel Chopra pointed out that if his scheme were sanctioned it would establish the nucleus of an advisory organisation which would be able to help people interested in drug culture with advice. In addition to the one chemist asked for by him, he had a large team of trained chemists now working in the School and the new man would be able to cope for the time being with the extra work that would fall on the existing organisation. The third part of his scheme was to carry out a systematic study of the present distribution of medicinal plants which were natives of India and of exotics which had become naturalised. He also wanted to make it clear that it was never his intention to carry out a general survey of medicinal plants in India; he thought that such a survey was not necessary. What he proposed to do was to bring the information regarding the distribution of medicinal plants up-to-date and rectify inaccuracies which had been detected. Many facts in connection with the distribution etc., of plants like Ephedra, Artemesia, Digitalis, needed investigation and his main difficulty with the indigenous drugs and food poison work was on the botanical side which he hoped to overcome with the assistance of a whole-time Botanist who was to be appointed for the purpose. The work, when completed, would be published in the form of an up-to-date glossary of Indian medicinal plants giving information regarding their habits, distribution, uses, active principles and references to all the latest work. In conclusion, he assured the Board that if his scheme were sanctioned and he had a whole-time Botanist, the work on the indigenous drugs would be considerably facilitated and accelerated, and the Board would be getting advantage of collaboration of a large and efficient organisation at present working in the School of Tropical Medicine. Colonel Russell was definite that Colonel Chopra was the best man to undertake the proposed work. He however, would like the scheme to be referred to a small Committee representative of the different interests involved to secure proper co-ordination and collaboration between the Agricultural, Veterinary, Medical and Forest Departments. Mr. Allan said that some work had been done in the United Provinces. A committee including agricultural, university and medical representatives, was to meet in July and devise a scheme for intended work in the examination of indigenous drugs and their cultivation under plain and hill conditions, which would be put before the Board. Mr. Kerr promised the support of the Veterinary Department in Bengal. In answer to Rao Bahadur Naik, Colonel Chopra said that no systematic attempts had so far been made to grow indigenous plants in India though the Forest and the Agricultural Departments were doing some work in that direction. In Kashmir they were growing digitalis on a fairly large scale. There was no advisory body to help the people.

Mr. Devadhar, in supporting the scheme, stated that it was necessary to stop the drain of about 70 lakhs of rupees at present being spent on foreign drugs. Colonel Chopra was the best man for the proposed investigation and his Institute was the most suitable. Mr. Sehti promised all facilities in the plains of Bihar and Orissa. Mr. Ramamurty referred to the work carried out in Madras and assured Colonel Chopra of his co-operation. Mr. Saunders supported the scheme and favoured the idea of referring the scheme to a Committee. Mr. Milne referred to the work done in the Punjab in order to extend the trade in indigenous drugs and referred to a Himalayan Institute in Kulu run by Professor Roerich a Russian American. He wanted Colonel Chopra, if possible, to get into touch with that institution as Professor Roerich was also working on drugs. Mr. Blaschek welcomed the scheme as he thought that it would increase the forest resources of India. The chief difficulty was botanical identification. He preferred to have a systematic Botanist with an Indian and European reputation. He wanted the scheme to go before a Committee. Rao Bahadur Naik supported the scheme. Brigadier Williams wanted the work to be done in close collaboration with the Madras Toxicology scheme. Mr. Ware and Colonel Olver wanted a Committee to go into the whole question, to secure the necessary co-ordination and to reduce the scheme to proper proportions with a view to avoid needless waste of efforts. After Colonel Chopra's reply, the Board decided to refer the scheme to a Committee, in order to devise means of co-ordination and co-operation between the Agricultural, Veterinary, Medical and Forest Departments in the working of the scheme. The personnel was left to the Chairman to decide. On Dr. Hyder's suggestion, which was seconded by Mr. Devadhar, it was also decided that the Committee should meet as soon as possible and report to the Board before the present session came to a close.

CHARAN DAS,

Secretary.

Simla, the 21st July 1932.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD
AT SIMLA ON FRIDAY, THE 22ND JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman.*
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK.
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. P. H. CARPENTER.
7. Mr. G. K. DEVADHAR.
8. Mr. E. S. FARBROTHER.
9. Professor J. C. GHOSH.
10. Dr. G. P. HECTOR.
11. Dr. L. K. HYDER.
12. Mr. NIZAMUDDIN HYDER.
13. Mr. P. J. KERR.
14. Mr. T. F. MAIN.
15. Dr. W. McRAE.
16. Mr. D. MILNE.
17. Colonel A. OLVER.
18. Captain Nawab Rais JUNG BHAHADUR.
19. Mr. S. V. RAMAMURTY.
20. Major P. B. RILEY.
21. Mr. P. T. SAUNDERS.
22. Mr. D. R. SETHI.
23. Mr. F. J. F. SHAW.
24. Mr. G. T. TAIT.
25. Mr. W. TAYLOR.
26. Mr. F. WARE.

Rai Sahib Malik CHARAN DAS, *Secretary.*

The following attended as visitors—

1. Dr. G. S. CHEEMA.
2. Lieutenant-Colonel R. N. CHOPRA.
3. Mr. Z. R. KOTHAWALA.
4. Dr. V. N. LIKHITE.
5. Mr. C. V. SANE.
6. Mr. R. C. SRIVASTAVA.
7. Mr. W. SAYER.
8. Mr. C. P. G. WADE.

The meeting lasted from 10-30 A.M. to 1 P.M. and adjourned till 10-30 A.M. on the 23rd July to allow the Special General Meeting of the whole Council to be held in the afternoon.

2. Before the regular business on the Agenda was taken up, Mr. Milne referred to an application from the Government of the Punjab for an additional grant of Rs. 5,000 for conducting experiments on designing a small power sugarcane crushing mill which had been submitted to the Council's Secretariat and requested that, in view of the urgency of the question, it might be brought forward for consideration at the present meeting of the Advisory Board. The Chairman, in reply, said that he would try his best to have the papers distributed to the members of the Board in the course of the day so that the subject might be discussed at the meeting of the Board on Saturday, the 23rd July.

3. The Ballot papers (not printed) for the election of two representatives of the Advisory Board to serve on the Governing Body of the Council (Subject No. 37 of the Agenda) were then distributed and the Chairman requested the members to return the same, duly filled in, to the Secretary before the meeting terminated.

4. *Application from the Government of the United Provinces for a grant for investigation into various problems of sugar industry in the United Provinces [Subject No. 26 (b) of the Agenda]. (Appendix XXXII).*—Mr. Allan introduced the scheme. So far as he could see there appeared first and foremost to be a latent feeling in the Board, when it discussed the original scheme in January last, that the United Provinces Government were endeavouring to divest themselves of their responsibility for encouraging research. It was not the fact at all. There had been no reduction and there never was any intention of reducing the staff at Shahjahanpur. The staff asked for from the Council was in addition to that already maintained by the local Government, for purpose of research and not in substitution of any member of the existing staff. Secondly, the original scheme did not probably meet with the approval of the Board because it did not coincide with Mr. Clarke's earlier proposals. According to the present revised scheme, all chemical work had been concentrated at Shahjahanpur, all entomological work at Meerut and all mycological work at Gorakhpur. He then went through the various items of the proposed programme of work. In his opinion the physiological work was better done at

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Shahjahanpur as they had the necessary laboratory facilities there. The technical programme was quite a simple one. The cost was trivial as the Local Government had to purchase it after a year or two for 75 per cent. of the original cost. The Economic side of the scheme was withdrawn as the Imperial Council had already taken up the question in connection with the economic enquiry into the cost of production of crops. Mr. Sethi was against the Gorakhpur station as the results obtained at the Muzaffarpore sugarcane station in North Bihar would be equally applicable to Gorakhpur. Conditions in South Bihar were entirely different and a sub-station there would be more fruitful than one at Gorakhpur. The only additional work that was proposed to be done at Gorakhpur was the mosaic work but this was already being done at Pusa. The Mycologist, if necessary, might be stationed at Shahjahanpur. The technical programme was purely demonstration work and the Local Government should be able to find money for it. Mr. Ramamurty considered that two stations would be quite sufficient for the purpose of the proposed programme of work. Regarding the technical portion of the scheme he remarked that the work to be done under this head was the same that the Punjab Government proposed to do. He wanted to know whether receipts would be credited to the Council and in this connection instanced the case of Madras, Bihar and Orissa and the Punjab who had promised to give all receipts from sugar stations to the Council or a lump sum in lieu thereof. Mr. Wynne Sayer said that while work done at Pusa on canes had benefited the United Provinces, the work done at Shahjahanpur had benefited only the Shahjahanpur area. The greatest enemy to sugar cane in India was the Borer and he wished that the Sugar Committee had considered this question. Some method of control of the Borer was required. He thought that there was no need or an enquiry as to how a larger, a bigger or a better cane could be produced; the inquiry should be directed to the production of a cheaper cane suitable for factory requirements. He recommended the omission of the Gorakhpur station, if the Board wanted a further station it should be in South Bihar. Professor Ghosh thought that there was some apparent difference of opinion between the Sugar Committee and the United Provinces Government which needed to be reconciled. The Committee emphasised the need for a detailed study of the variations in the composition of sugar cane juice from July to March under different manurial conditions; the Local Government on the other hand, considered it not so important. Mr. Srivastava in supporting the scheme laid stress on the importance of the technical portion of the scheme. The cultivator of cane did not get adequate profit now. As cheap hydro-electric power was available in several districts in the United Provinces its use for *gur* and sugar manufacture should be encouraged. After Mr. Allan had replied to the various points of criticism levelled against certain aspects of the proposed scheme, the Board accepted the general principle of the scheme but voted against (1) the proposed sub-station at Gorakhpur, and (2) the technological portion of the scheme. The 'Economic' side of the scheme had already been withdrawn. Mr. Allan pressed that an Assistant Surgarcane Expert and a Research Assistant should be added to the staff provided in the scheme for the Meerut Station as there

was now to be no station at Gorakhpur. Mr. Carpenter asked whether the officer was not previously required at Meerut and why no provision was made. Mr. Sayer would only add the Assistant Sugar Cane Expert but not the Research Assistant. The Board recommended the additional provision of an Assistant Sugarcane Expert to the Meerut Station. The revised United Provinces scheme, as amended, was then put to vote and carried. As regards the question of handing over receipts from the proposed stations to the Council, the Board decided that the matter should be left to the Chairman to decide in consultation with the United Provinces Government.

5. *Scheme for a Research and Testing Station for the indigenous system of gur and sugar manufacture, drawn up by the Sugar Technologist, Imperial Council of Agricultural Research. [Subject No. 26 (c) of the Agenda]. Appendix XXXII*.—Mr. Srivastava explained that his scheme aimed at providing an experimental station, properly staffed and equipped, and located in a suitable centre, for the purpose of testing existing processes and machinery used in manufacturing *gur*, *rab* and sugar by the indigenous systems, for conducting trials of new plant and processes, and for undertaking research work for introducing improvements. At the last meeting of the Board the scheme was practically supported by all the speakers, but it had to be referred back because it was bracketted with the Punjab and the United Provinces schemes. He also answered certain comments made by Khan Bahadur Hadi on his scheme. In reply to a query from Mr. Devadhar, Mr. Srivastava mentioned that the instances of failure of the plant enumerated by Khan Bahadur Hadi were not due to the fact that they were worked by the Co-operative Department, they were rather due to insufficient grasp of the subject. Professor Ghosh, in supporting the scheme, wanted more stress to be laid on devising new processes and better plant as no case had been made out for the testing of the existing plants, etc., in one Central Station. Mr. Allan felt that the right place for the proposed station was Meerut. Messrs. Ramamurty and Milne supported the scheme. Mr. Wynne Sayer enquired how the indigenous method of manufacturing sugar would stand in relation to white sugar manufacture. Mr. Srivastava in reply to the criticisms stated that in every respect the Rohilkhand Bel was more efficient than Hadi's. As regards the location of the station we said that Meerut was as good a station as any and that the station would be selected with the Council's approval. 24 white sugar factories were under construction this year: but, still, the indigenous method had its own advantages and would continue to exist for a generation though in the end it was bound to disappear and be replaced by the factory. Cost of production of sugar by the indigenous method was cheap compared to that of the factories. Average cost of cultivation of cane was also in the vicinity of annas 4 a maund.

The Board recommended the scheme for sanction subject to financial details being scrutinised by the Chairman.

6. *Application from the Government of Assam for a grant of Rs. 48,000 spread over five years for the proposed extension of sugarcane work at the Jorhat Experiment Station, Assam. (Subject No. 27 of the Agenda). (Appendix XXXIV)*.—Mr. Birt introduced the scheme. Two years ago the Government

of Assam put up a scheme which was comparatively ambitious; the scheme, as now revised, was quite modest, costing Rs. 48,000 spread over a period of five years. The question of the Local Government, taking over buildings on the termination of the scheme would require very serious consideration. In regard to Chaudhuri Mukhtar Singh's suggestion, Mr. Birt stated that the Government of Assam were not in a position to spend any new money at the present moment. The importance of sugarcane work in Assam could not be measured solely with reference to the present acreage. There was need to have a second crop, for example, in the Nowgong district to replace jute. He commended the scheme to the favourable consideration of the Board. Mr. Sethi referred to specific items of expenditure provided in the scheme and thought that there was clear over-estimation. Rs. 5,500 for fencing, Rs. 3,000 for a cattle shed, Rs. 2,500 for a godown when there ought to have been one already in the Station; either they should not be given or, if given, should be considerably reduced. The Chemical Assistant, and the Farm Manager could not be fit for research work when the scale of pay proposed was so low. Mr. Carpenter said that the scheme should be viewed not so much from the point of view of existing acreage in Assam as from its future possibilities. The idea of introducing a second crop was very sound. Assam differed from the other parts of India in regard to climatic and rainfall conditions; it was therefore necessary to have a separate scheme. As regards the criticisms about under-payment for the staff and over-payment for fencing godown and buildings, Mr. Carpenter's laboratory adjoining the Assam Government's laboratory, he knew the existing staff and they were quite capable of directing the work of the new assistants. The amount provided for fencing, etc., was reasonable. Mr. Wynne Sayer wondered whether tea planters would view the development of sugarcane kindly. He supported the scheme. Dr. Hyder also supported the scheme on the principle that help should be given where it was most needed. Assam was a poor and backward province. Dr. McRae considered chemical testing necessary and that the staff suggested was sufficient for the work required to be done. Mr. Ramamurty wanted, if possible, that better staff should be provided. Mr. Birt said that the scheme was only for the extension of the existing farm at Jorhat: they had already the senior staff required. The buildings, etc., were necessary as the present accommodation was not adequate. Dealing with the objection, regarding the high cost of fencing, he said that there was a good deal of trouble due to jackals and that in order to overcome this trouble they wanted to put up high and strong fencing. Mr. Srivastava wanted the scheme to be referred to the Sugar Committee for detailed consideration. The scheme had not been properly drafted. Dr. Hyder in a powerful speech pleaded for an immediate recommendation of the scheme. Messrs. Devadhar and Carpenter supported this proposal.

The Board rejected the motion to refer the scheme to the Sugar Committee and recommended the scheme for sanction subject to financial details being settled by the Vice-Chairman in consultation with the Government of Assam.

7. *Application from Mr. A. R. Sirinivasa Rao for a grant for conducting certain experiments in Sugarcane. (Subject No. 28 of the Agenda). (Appendix*

dia XXXV).—Mr. Ramamurty said that while the scheme did not aim at what might be called fundamental research, it still proposed to carry out certain experiments which would be of advantage to the general body of cultivators. This was the first scheme, where a cultivator who had spent a large sum of money on the work, came to the Council for financial assistance: the sum asked for was only Rs. 7,500 spread over a period of five years. He recommended that the Board should view the scheme sympathetically. Mr. Nizam-ud-Din Hyder opposed the scheme. Mr. Wynne Sayer thought that it was a very deserving case: but if sanctioned, would prove to be an embarrassing precedent, a view with which Mr. Milne thought it was *not* a deserving case and that it would be an awkward precedent if sanctioned thoroughly agreed. Mr. Allan also opposed the scheme. The Board rejected the scheme by a very large majority.

8. *Tractor operating costings. Forms prepared by the Burmah-Shell Oil Storage and Distributing Company of India, Ltd., Bombay (Subject No. 29 of the Agenda). (Appendix XXXVI)*.—The Board adopted the report of the Special *ad hoc* Committee appointed to go into the question.

9. *Report of the results of Tractor work conducted during the last season (1931-32) by the Burmah-Shell Oil Storage and Distributing Company of India, Limited, Bombay*. [Subject No. 29 (a) of the Agenda]. (*Appendix XXXVII*).—Mr. Wade first gave expression to the grateful appreciation of the Burmah-Shell Oil Storage and Distributing Company of India, Limited, for the invitation to send a representative to attend the Board's Meeting. He pointed out that his Company's work last season was devoted chiefly to deep ploughing for weed eradication as recommended by the 1930 Meeting of the Advisory Board. His Company's chief object in carrying out this agricultural work was to collect data regarding the cost of work with various types of tractors and implements under varying conditions, to determine the practicability and suitability of certain types of tractors and implements for this work and to carry out propaganda with a view to interesting both individual landlords in tractors and also firms and individuals in commercial contract ploughing. Mr. Wade said that his Company realised generally that it was not economical for tractors to be employed for deep ploughing only but that it was necessary to carry out all farm operations, and he referred to his Company's proposed co-operation with Mr. Ramamurty in connection with a rural re-construction scheme near Madura.

The question of ploughs was next discussed by Mr. Wade, and he expressed the appreciation of the help and co-operation promised by Mr. Wynne Sayer. In conclusion Mr. Wade said he would like to know whether the Board considered his Company were working on the right lines and whether the work they were doing was of value and utility. He also asked for suggestions and said he would be pleased to consider proposals from other areas. Mr. Wynne Sayer said that they were under an obligation to the Burmah-Shell. He wanted the economics of the subject to be further worked out. It was a work altogether neglected in the past. Work was required to be done in every Province in India owing to different soil conditions that prevailed. He stressed the need for special ploughs to be prepared

for purposes of deep ploughing. Mr. Main endorsed the view of Mr. Sayer. Mr. Nizam-ud-Din Hyder stated that their own departmental work, the year before last, on tractors in Hyderabad had not been satisfactory. It cost Rs. 38 per acre. Last year, the Burmah-Shell undertook the work and did very well. The cost was Rs. 12 to Rs. 13 per acre. Their thanks were due to Burmah-Shell and Mr. Wade. The Board decided that a copy of the discussions should be communicated to the Burmah-Shell.

SIMLA,

CHARAN DAS,

The 22nd July 1932.

Secretary.

PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF
THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH
HELD AT SIMLA, ON SATURDAY, THE 23RD JULY 1932.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman*.
2. Mr. R. G. ALLAN.
3. Rao Bahadur BHIMBHAI R. NAIK.
4. Mr. A. G. BIRT.
5. Mr. A. D. BLASCHECK.
6. Mr. P. H. CARPENTER.
7. Mr. G. K. DEVADHAR.
8. Mr. E. S. FARBROTHER.
9. Professor J. C. GHOSH.
10. Dr. L. K. HYDER.
11. Mr. NIZAMUDDIN HYDER.
12. Mr. P. J. KERR.
13. Mr. T. F. MAIN.
14. Dr. W. McRAE.
15. Mr. D. MILNE.
16. Colonel A. OLVER.
17. Captain Nawab Rais JUNG BAHADUR.
18. Mr. S. V. RAMAMURTY.
19. Major P. B. RILEY.
20. Mr. P. T. SAUNDERS.
21. Mr. D. R. SETHI.
22. Dr. F. J. F. SHAW.
23. Mr. G. T. TAIT.
24. Mr. W. TAYLOR.
25. Mr. F. WARE.

Rai Sahib Malik CHARAN DAS, *Secretary*.

The following attended as Visitors :—

1. Dr. G. S. CHEEMA.
2. Lieutenant-Colonel R. N. CHOPRA.
3. Mr. M. S. A. HYDARI.
4. Mr. Z. R. KOTHAWALA.
5. Dr. V. N. LIKHITE.
6. Mr. C. V. SANE.
7. Mr. R. C. SRIVASTAVA.
8. Mr. W. SAYER.
9. Mr. C. P. G. WADE.

The meeting lasted from 10-30 A.M. to 1-30 P.M. when it dispersed having completed all the items on the Agenda.

2. The Chairman at the outset announced that, as a result of the ballot held on the previous day, Messrs. Carpenter and Kerr, who secured the highest number of votes, were elected as representatives of the Advisory Board to the Governing Body.

3. *Application from the Government of the Punjab, for a grant of Rs. 33,000 spread over a period of five years for a scheme for the Improvement of the tea industry in the Punjab (Subject No. 32 of the Agenda). (Appendix XXXVIII).—* Mr. Milne said that in the Punjab, they had an area round about 9,000 to 10,000 acres under Tea. They had had the expert advice of Mr. Carpenter in accordance with whose recommendations the scheme had been prepared. The programme of work was definite and the cost in so far as the Council was concerned was only Rs. 38,800 spread over five years. The Local Government would provide the land costing about Rs. 50,000 and also make available the services of an Assistant whose training had cost the Punjab Government, say, Rs. 3,000. Professor Ghosh wanted to know whether the scheme would continue beyond the period of five years and, if so, who would meet the cost. Mr. Milne stated that the Board would only commit itself to the 5 years scheme under consideration. Mr. Ramamurty considered that the scheme was entirely provincial; the Council was not justified in rendering it any financial assistance. The area in the Punjab was insignificant compared to the total area under tea in the whole of India and in the present state of the tea market, an extension of tea cultivation in tracts which offered no natural facilities was not desirable or economical. Mr. Carpenter spoke in support of the scheme. The soil of Kangra was different from the soil of Assam and Bengal. Price of tea had gone down and as good tea and cheap tea was needed in North and Central India far from Calcutta and as definite results could be got in the five-year period, and as the sum asked for was not much, he hoped that the scheme would be accepted. In answer to Rao Bahadur Naik, Mr. Milne said that it was possible that, as a result of the proposed work, there might be some extension of tea cultivation but most of the tea exported went to Russia, Afghanistan and does not compete with Indian tea. Dr. McRae also supported the scheme. Dr. Hyder said that tea was not an industry, strictly so called, in the Punjab as yet; private enterprise should first take up the question. On the scheme being put to vote, it resulted in a tie, ten voting for and ten against the scheme. On the well-known principle of maintaining the *status quo*, the Chairman gave his casting vote against the scheme which was therefore rejected.

4. *Report of the Fruits Sub-Committee. (Subject No. 33 of the Agenda). (Appendix XXXIX).—* Mr. Allan, first, introduced the United Provinces Hills scheme. (Annexure II to Enclosure VI). He enlarged on the suitability of the Government orchard at Chaubattia for a research station and explained the various items of work proposed to be carried out. Mr. Ramamurty supported the scheme but wanted that the receipts from the station should be credited to the Council. Mr. Allan explained that as he stated before the Sub-Committee, it was on the whole advantageous to the Council if this point was not pressed. Professor Ghosh warned against sanction of funds for this scheme as the Chaubattia station had been a failure for the last 70 years. The climate of Kumaun Hills was not probably suitable for the purpose. After Mr. Allan's reply the scheme, as amended by the Sub-Committee, was recommended for sanction.

Mr. Sethi next introduced the Bihar and Orissa scheme. (Enclosure VII to Appendix XXXIX). He pointed out that the Committee had recommended

that the scientific part of the United Provinces plains (Annexure VI to Enclosure VI to Appendix XXXIX), and the Bihar and Orissa schemes should be combined and that the work should be carried out in the latter province. By adopting this course unnecessary duplication would be avoided and a fairly large financial saving effected. The Government of Bihar and Orissa would provide the laboratory and chemical facilities and irrigation water free. The Board accepted the Committee's recommendation.

Mr. Main introduced the Bombay Cold Storage scheme (Enclosure III to Appendix XXXIX) and emphasized the importance of the overseas fresh fruit market. He also referred to the work that had been done in the Bombay Presidency in the matter of organisation of fruit growers and also in regard to the improvement of marketing. Rao Bahadur Naik supported the scheme but asked why Poona had been selected in preference to Bombay for locating the proposed plant, etc. He also laid stress on the need for a reduction of the railway freight on fruits intended for export. Perhaps it was also necessary that a Canning Factory should be set up. Mr. Main replied that the question of location was gone into thoroughly by himself, Dr. Cheema and Mr. Burt and it was decided that Poona was the better location chiefly because Dr. Cheema and the Agricultural Engineer were on the spot and accordingly the work would be carried on better and with more certainty at Ganeshkind than at Bombay. The scheme as amended by the Committee was recommended, subject to financial details being scrutinised by the Chairman.

The Board agreed that, as recommended by the Committee, the Assam scheme (Enclosure VIII to Appendix XXXIX) should be referred back to the local Government with the request that a revised scheme might be put up.

The Board then formally adopted the Report of the Fruits Sub-Committee.

5. *Marketing of Agricultural Produce (Subject No. 34 of the Agenda). (Appendix XL.)*—The Chairman explained that this was only for information at this stage, the subject would come up again before the Board in due course. The Board agreed.

6. *Application from Lt.-Colonel R. N. Chopra of the School of Tropical Medicine, Calcutta, for a grant for research in systematic cultivation of medicinal plants and study of food poisons in India (Subject No. 35 of the Agenda). (Appendix XXXIII.)*—The report (Appendix XLI) of the Sub-Committee which was appointed by the Chairman in accordance with the Board's recommendation on the previous day was adopted and the scheme was recommended for sanction.

7. *Assistance to be given by the Indian Railway Central Publicity Bureau in the promotion of agricultural and veterinary development (Subject No. 38 of the Agenda). (Appendix XLII.)*—Mr. Tait recommended that consideration of the question of Demonstration Trains—all-India and Provincial—should be postponed to the next meeting of the Board by which time they might also have the views of the Indian Railway Conference Association who were examining the subject at their meeting in Bangalore just now. On account of retrenchment his film department had been entirely closed down; he would, however, be quite prepared to assist Agricultural Departments in whatever way possible with the films he already had with him. He proposed that there should be a conference between him and the provincial Directors of Agriculture and such

other members of the Board as might like to attend at the time of the next meeting of the Advisory Board to consider the whole matter. Mr. Milne did not favour the idea of all-India Demonstration Trains and gave his reasons. As regards films, where the railways could help was by making local films which the Agricultural Departments could either buy or hire. He thanked Mr. Tait for the assistance recently rendered by him in connection with the grant of Railway concession fares to farmers visiting Government farms during farmers weeks arranged for by the Punjab Agricultural Department. Messrs. Kerr and Main associated themselves with Mr. Milne's remarks and thanked the Railway Publicity Department. Mr. Main said that in Bombay Agricultural Officers were on the Railway Advisory Boards there. Mr. Ramamurty supported the idea of a conference of Directors of Agriculture with Mr. Tait. In the end it was decided that a sub-committee consisting of all Directors of Agriculture and others interested in the subject should meet at the time of the next Advisory Board meeting and discuss the subject.

8. *Scheme for carrying on research work in the Anand Creamery in the manufacture of products and by-products of milk (Subject No. 39 of the Agenda). (Appendix XLIII).*—Colonel Oliver, in introducing the scheme, said that the proper development of the dairying industry in India, to enable it to compete with imported products, was a matter of considerable economic importance and great urgency. The scheme had to be prepared in a great hurry as it was considered that the present opportunity of making use on favourable terms of the plant and facilities provided by the Anand Creamery should not be missed. There was also a risk of the plant and buildings deteriorating considerably, were this scheme to be delayed. Mr. Main said that he was very interested in the scheme which aimed at solving the important problem of city milk supply. There was, however, one difficulty on the administrative side of the scheme. The only person whose name appeared in the papers regarding the scheme and who was responsible for the scheme was Mr. Kothawala. The Government of India had also taken a very cold attitude. If Mr. Kothawala was going to work on the scheme it was important to remember that he was not a servant of the Council and the Council had no direct control over him. In that case if the post of Mr. Kothawala was abolished, as a measure of retrenchment, then who would take up the scheme? He therefore suggested that the Government of India should be pressed to accept responsibility for the scheme. Dr. Shaw said that this scheme was unique and differed from all the other schemes that had come before this meeting in that the scheme was the Council's own scheme and not that of the Imperial Department of Agriculture. He agreed that there was only one man, Mr. Kothawala, who had to work on this scheme, but he did not think that his post would be abolished. The only difficulty that he found on the administration side of the scheme was that of Mr. Kothawala's travelling allowance. Mr. Devadhar and Rao Bahadur Naik supported the scheme. In answer to Dr. McRae, Colonel Oliver said that the proposal was that the scheme should be worked by Mr. Kothawala through the Director of Pusa, though the latter was not responsible for the scheme. With regard to the item "transfer of machinery" Dr. McRae pointed out that when Anand Creamery had been closed last March this machinery had been transferred from Anand to Karnal because it was absolutely necessary for tracting the dairy students. He wished

to be assured that 500 rupees in item T. A. was enough and that the sum of 500 rupees in the item upkeep of buildings was sufficient to meet the condition laid down in Enclosure I to Appendix XLIII that the plant and buildings will be kept in proper repair by the I. C. A. R. Mr. Kothawala said that the machinery had arrived very late at Karnal, so that there was no chance of the students getting advantage from its use. The present batch of students would not have the opportunity of using this machinery at all. But this difficulty could be overcome by arranging the training of the students at Anand. Regarding his travelling allowance, he said that he did not think there would be any practical difficulty about that. He also said that from past experience 500 rupees was enough for repair of buildings and plant. At this stage the Chairman told the members of the Board that if the administrative difficulties should prove insuperable the scheme would, doubtless, have to be stopped; but he hoped and felt sure that the difficulties could be overcome. The Board then recommended the scheme subject to the condition that the administrative difficulties were adjusted by the Chairman in consultation with the Education, Health and Lands Department. ●

9. *Improvement of the standard of education in the existing Veterinary Colleges in India (Subject No. 40 of the Agenda). (Appendix XLIV.)*

Colonel Olver, in introducing the subject, explained that the Royal Commission on Agriculture had recommended that the framing of a suitable curriculum for the training of Assistant Veterinary Surgeons should be referred to a Body of Experts. The question was discussed at an informal meeting of veterinary officers held at Simla in June 1931 and they suggested certain principles, e.g. the raising of the entrance qualification in the Veterinary Colleges to F. Sc.—Medical Group—Punjab or any equivalent standard and that the course of instruction should be of three years duration, English being the medium of instruction. The Government of India ascertained the views of the local Governments in regard to these principles and most of the local Governments had generally approved of them. The Government of India had now asked for the advice of the Council. The matter was discussed at an informal meeting of Veterinary Members of the Board and they suggested that, as recommended by the Royal Commission, the curriculum should now be drafted by a Committee of Experts. Mr. Saunders suggested that the recommendations of the Informal Committee of Veterinary Members of the Board be adopted. He said that the Committee of Experts would be composed of Colonel Olver, Mr. Ware and the Principals of the Veterinary Colleges in India. Though there was no Director of the Civil Veterinary Department on the Committee, he hoped that Mr. Ware, in whom all the Directors had full confidence, would look to their interests.

The Board then adopted the recommendation of the Informal Committee.

10. *Progress Reports on Research Schemes.—*

- (a) Scheme for research into properties of colloid soil constituents by Dr. J. N. Mukherjee, Khaira Professor of Chemistry, University of Calcutta.
- (b) Scheme for statistical investigations on experimental errors in field trials, by Mr. P. C. Mahalanobis, Professor, Presidency College, Calcutta.

- (c) Report for the year 1931-32 on the 'Effect of Ions on the Growth of Plants' by Dr. S. S. Bhatnagar.
- (d) Report for the period 1st July 1931 to 31st March 1932, in respect of the scheme for investigation of the 'Wither Tip' of Citrus trees by Dr. H. C. Chowdhury (Appendix XIV).
- (e) Report on the work done in the Agricultural Research Section of the Department of Chemistry, Dacca University, Dacca, during 1930-31 and 1931-32, in connection with the scheme for agricultural research sanctioned by the Imperial Council of Agricultural Research.
- (f) Report of the investigations carried out by Dr. A. N. Puri, on the standardization of Physico-Chemical Single Value Measurements most suitable for Indian soils.

(Subject No. 30 of the Agenda). [Items (a), (b), (c), (e) and (f) Appendix XLV.]—The report of the Committees* that examined the various Progress Reports was adopted.

11. *Application from the Government of the Punjab for an additional grant of Rs. 5,000 for conducting experiments on designing a small power sugarcane crushing mill (Subject No. 41 of the Agenda). (Appendix XLVII.)*

With the permission of the Chairman Mr. Milne explained the subject. He dwelt at length on the work that had been done and the need for further work on the design, construction and testing of mills. It was important that delay in continuing the work should be avoided. Mr. Sethi asked whether the Punjab Government were in order in spending money on the purchase of existing mills while the object of the grant was designing a new mill. Mr. Srivastava said that no new mill could be designed unless the existing ones were first tested. He testified to the good work already done in the Punjab. After Mr. Milne's reply the Board decided to recommend the grant now applied for.

12. *Classification of Research Schemes (Subject No. 36 of the Agenda). (Appendix XLVIII).**—The Chairman, in opening the subject for discussion, asked for the views of the Board on the classification suggested by the Council's Secretariat. Mr. Ramamurty suggested that the Fruit and other Horticultural schemes should be given preference to the schemes connected with the water requirements of crops. Dr. Hyder suggested that in sanctioning schemes the Board should have some rough working formulæ, namely, (1) some sort of limit to the annual charge, and (2) the duration of time which should not ordinarily exceed five years. The Chairman explained that the time limit was already observed, in that no scheme was sanctioned for more than five years; the question of limiting the annual charge was, however, for discussion. Mr. Milne stated that the vital problem before the Government of India and the local Governments at the present moment was the restoration of prosperity to the farmer. If the farmer could not pay his revenue, no Government could exist. He, therefore, suggested that, in classifying research schemes, the main principle should be to give preference to schemes which would give the earliest and most valuable results to practical farmers. Sugar schemes should be treated separately and urgently. Dry farming and fruit schemes should also

* For item (d) see Appendix XIV, para. 11 and Appendix XLVI.

stand in the forefront. In conclusion, he said that the subject of classification was a complicated one and to this end he suggested that a small committee of persons, who have no scheme under consideration, should be formed to go into the whole question. Mr. Allan endorsed the views of Mr. Milne. Mr. Carpenter agreed with Dr. Hyder that there should be some money limit while sanctioning schemes. As for classification of schemes, he agreed with Mr. Milne to some extent and said that the schemes should be divided into two main heads, *i.e.*, schemes of primary importance and schemes of secondary importance. In his opinion schemes pertaining to cattle, rice, sugar and the schemes coming from Universities were the schemes of primary importance. Regarding the secondary schemes, he thought that dry farming and fruit schemes were not of the same importance as rice, sugar, etc., and therefore belonged to the second category. To this statement Mr. Main objected. Mr. Devadhar and Rao Bahadur Naik agreed to the principle suggested by Mr. Milne in classifying schemes. Rao Bahadur Naik emphasised the immediate necessity of sanctioning the Bombay Cold Storage Scheme. Professor Ghosh said that the schemes already in progress should not be stopped and that schemes of cold storage ought to receive the immediate attention of the Council. Colonel Olver stressed the importance of the scheme for carrying on research work at the Anand Creamery (Subject No. 39 of the Agenda) (Appendix XLIII) for the reason that the machinery was lying idle and there was risk of its deteriorating if allowed to stand longer. Mr. Kerr supported Mr. Carpenter and said that there should be a Committee to go into the whole question of classification. Major Riley suggested that Dr. Hyder should be on such a Committee.

In the result the Board, by a majority of votes, agreed—

- (1) that preference should be given to schemes which would give the earliest and most valuable results to the practical farmer ; and
- (2) that till the prevailing financial stringency was over, each grant should be limited to a maximum of Rs. 1,25,000 spread over a period of five years.

The Board decided that as the above two principles were easy of application, the classification could be made by the V. C. with the help of the Council's Secretariat subject to the decision of the Governing Body. No sub-committee was necessary.

13. The Chairman then called upon Mr. Carpenter to move his resolution (Subject No. 42 of the Agenda) of which he had given notice on the previous day. Mr. Carpenter thereupon moved the following resolution :—

“ That in view of the increasing interest manifested by Provincial Governments, Universities and private research workers in agricultural research, and in view of the steadily increasing number of useful schemes that are coming up to the Council, this Board presses on the Government of India the need not only for making the annual grant of five lakhs to the Council in 1933-34 but also for restoring the grant temporarily taken away in the current year ”.

Mr. Devadhar seconded the resolution. Mr. Milne, in supporting the resolution, read, with approval, the following from page 189 of the Appendices

to the Summary of Proceedings of the Imperial Conference, 1930 :—

“ It is important that investigations, once begun, should not be subject to unreasonable interruptions because of financial stringency. There is a real danger in times of financial stress that Governments may be tempted to economise in expenditure on scientific services on the ground that the need for them is less urgent than for other forms of expenditure, and that research can well be put on one side until prosperous conditions return. In the opinion of the Committee, the need for the conduct of scientific enquiries, and the application of the knowledge gained thereby, is more urgent when industries are depressed than when they are flourishing. Research cannot be expected to yield fruitful results if it is pursued in fits and starts. The Committee have embodied these views in the following resolution :—

The Research Committee of the Imperial Conference, being convinced that progress will in the future be dependent to an increasing extent upon the growth and application of scientific knowledge, desire to direct the attention of the various Governments of the British Commonwealth of Nations to the importance of making adequate provision from State funds for the steady pursuit of scientific research into the various problems affecting the material well-being of mankind. They also desire strongly to urge their view that the severe economic depression from which the British Empire in common with the rest of the world, is now suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utilisation of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones ”.

Continuing, Mr. Milne, said that the coming competition would be keener than had already been the case and it was impossible for any one country to stand out of this battle. India must enter into the battle if she wanted to keep her place amongst Nations. Mr. Ramamurty said that there was a strong feeling in the Board that the Government of India should restore the grant temporarily taken away for the current year. The Council of Research was one of the most beneficent activities of the Government of India and it had, during the last two or three years of its existence, helped the Provincial Governments to a great extent in furthering the cause of agricultural improvement in the country. Messrs. Main and Kerr, Rao Bahadur Naik, Dr. Hyder, Major Riley, and Captain Rais Jung and almost every member of the Board spoke in support of the resolution which was then carried unanimously.

14. After the Chairman had thanked all the members for the trouble they had taken in coming all the way to Simla and for helping in the successful conduct of the proceedings of the Board, Mr. Devadhar proposed a vote of thanks to the Chairman which was carried unanimously. The meeting of the Board then terminated.

CHARAN DAS,
Secretary.

SIMLA :
The 25th July 1932.

APPENDIX I.**SUBJECT No. 1.****DECISIONS OF THE GOVERNING BODY ON THE RECOMMENDATIONS OF THE
ADVISORY BOARD IN JANUARY 1932.**

(1) *Scheme for an economic enquiry into the cost of sugarcane production in the United Provinces, North Bihar, Bombay, the Punjab and Madras. Revised proposals for the carrying out of an enquiry into the cost of production of sugarcane, cotton and rotation crops.*

Chief Economist to draw up a detailed scheme, sanctioned for one year in the first instance.

(2) *Extension of the Locust research scheme—Report of the 3rd meeting of the Locust Committee.—Sanctioned.*

(3) *Experimental consignments of mangoes to England—Proposal from the Bombay Department of Agriculture.—Sanctioned.*

(4) *Appointment of Mr. K. P. Kartha for a period of six months to compile statistics showing the comparative efficiency of the different feeding scales adopted in the military dairies and of the effects of disease and other necessary factors on dairying efficiency.—Sanctioned.*

(The remaining recommendations are under consideration.)

CHARAN DAS,
Secretary.

The 7th July 1932.

APPENDIX II.

SUBJECT No. 2.

APPOINTMENT OF COMMITTEES.

The Chairman of the Advisory Board considers that it would be best to have the Tractor Operating Costings—Forms prepared by the Burmah-Shell Oil Storage and Distributing Co. of India, Ltd., Bombay examined in detail by an *ad hoc* Committee. He has accordingly appointed the undermentioned committee for the purpose :—

Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman (ex-officio)*.

Dr. W. McRAE.

Mr. T. F. MAIN.

Mr. D. MILNE.

Mr. R. G. ALLAN.

Mr. D. R. SETHI.

Mr. WYNNE SAYER (*Imperial Agriculturist, Pusa*).

Mr. C. P. G. WADE (*Burmah-Shell Oil Co.*).

Rai Sahib Malik CHARAN DAS, *Secretary (ex-officio)*.

The Committee will meet at 3 P.M. at Rock House (office of the Imperial Council of Agricultural Research), on Monday, the 18th July 1932.

2. *Fruits Committee*.—In accordance with the principle already accepted the fruit schemes received from the United Provinces, Bihar and Orissa, and Assam will first be examined by the undermentioned Committee :—

Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman (ex-officio)*.

Dr. W. McRAE.

Director of Agriculture—

Madras.

Bombay.

Bengal.

United Provinces.

Central Provinces.

Assam.

Rai Sahib Malik CHARAN DAS, *Secretary (ex-officio)*.

This Committee will meet at Rock House at 3 P.M. on Tuesday, the 19th July 1932.

3. *Committee to examine Progress Reports*.—As it is considered desirable that all progress reports on the schemes sanctioned by the Imperial Council of Agricultural Research should as far as possible be first examined in detail by a Technical Committee the Chairman of the Board has appointed the undermentioned Committee to examine :—

(i) the Dacca University Scheme.

(ii) Dr. Bhatnagar's Scheme.

(iii) Prof. Mahalanobis' Scheme.

(iv) Dr. Puri's investigations :—

Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman (ex-officio)*.

Dr. W. McRAE.

Mr. T. F. MAIN.

Dr. G. P. HECTOR.

Mr. D. MILNE.

Mr. D. R. SETHI.

Mr. A. G. BIET.

Mr. P. H. CARPENTER.

Dr. F. J. SHAW.

Prof. J. C. GHOSH.

Rai Sahib Malik CHARAN DAS, *Secretary (ex-officio)*.

This Committee will meet at Rock House, at 3 P.M. on Thursday the 21st July 1932.

4. As regards the Committees mentioned in items (iv)—(vi), it is proposed to hold an informal meeting of the Veterinary members of the Board at 3 P.M. on Monday, the 18th July in Col. Oliver's room in Rock House, Simla. The three Committees in question will consist of all the veterinary members attending the meeting of the Board and will meet to discuss item (iv) on Tuesday the 19th, item (v) on Wednesday the 20th and item (vi) on Thursday the 21st July 1932 at 3 P.M. in Rock House.

CHARAN DAS,
Secretary.

The 7th July 1932.

APPENDIX III.

SUBJECT No. 3.

APPLICATION FROM DR. SAM HIGGINBOTTOM, PRINCIPAL, AGRICULTURAL INSTITUTE, ALLAHABAD, FOR A GRANT OF RS. 8,600 SPREAD OVER A PERIOD OF 2 YEARS FOR RESEARCH ON THE "COMPOSITION OF MILK".

Attention is invited to the attached application from the Principal, Agricultural Institute, Allahabad, for a grant of Rs. 8,600 spread over a period of two years. The application which has been recommended by the Provincial Research Committee and supported by the United Provinces Government is submitted for the consideration of the Advisory Board.

2. It has been suggested to the Allahabad Agricultural Institute (Enclosure) that the breeding policy now adopted at the Institute should be simplified so as to ensure the maintenance on the farm of a sufficient number of cows of pure Indian milch breeds to be tested and that the cross-breeding should be confined to one European breed for the same reason. The reply from the Institute will be circulated to the members of the Advisory Board as soon as it is received.

CHARAN DAS,
Secretary.

SIMLA,
The 6th July 1932.

COPY OF LETTER FROM THE SECRETARY TO GOVERNMENT, UNITED PROVINCES, AGRICULTURE DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, No. 322-A./XII-A-183, DATED THE 10TH JUNE 1932.

I am directed to forward herewith the application of the Principal, Allahabad Agricultural Institute, Naini (Allahabad) for a grant of Rs. 8,600 spread over a period of two years for research on composition of milk.

2. The scheme was considered by the Provincial Agricultural Research Committee at its meeting held on May 3, 1932, and has been revised according to its recommendations. The Governor acting with his Ministers accordingly supports the application for the grant of Rs. 8,600 (aggregate).

3. One hundred spare copies of the scheme are being sent separately.

AN APPLICATION FROM DR. SAM HIGGINBOTTOM, PRINCIPAL, AGRICULTURAL INSTITUTE, ALLAHABAD, FOR A GRANT FROM THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, OF RS. 8,600-0-0 SPREAD OVER A PERIOD OF 2 YEARS FOR RESEARCH ON THE "COMPOSITION OF MILK."

Introduction.

In order to get competent outside opinion on the proposed application, the scheme was submitted for criticism and suggestions, to the following authorities:—

- (1) Director, Imperial Institute of Agricultural Research, Pusa.
- (2) Imperial Dairy Expert, Bangalore.
- (3) Director of Agriculture, Bengal.
- (4) Director of Agriculture, Punjab.
- (5) Principal, Agricultural College, Coimbatore.
- (6) Deputy Director, In-Charge of Agriculture, Chepauk.

Copies of their replies are appended herewith for your information.

In view of the criticism and suggestions received it has been deemed worthwhile to modify and amend the original proposed scheme so as to make it more comprehensive and of greater value.

In support of the proposed scheme the Director, Imperial Institute of Agricultural Research, says :—"Accurate information regarding the composition of milk of Indian breeds of cattle is really needed as it is at present meagre". The note of the Officiating Imperial Agricultural Chemist submitted by the Director also calls attention to the complexities of the situation and states that further work would be welcome. The suggestions of the Director have been incorporated in the proposed scheme.

The Imperial Dairy Expert writes :—"I entirely agree with you that any authoritative information regarding the composition of milk of the Indian breeds of cattle is very meagre and I am of the opinion that a scheme on the lines outlined by you will yield very important and useful information".

The Live-stock Expert to the Government of Bengal, through the Director of Agriculture, says, "Mr. Worth has been doing butter-fat and solids not-fat but has not done work of the nature proposed". In a conversation, the Live-stock Expert voiced his support of the proposed research scheme.

The Director of Agriculture in reply to our enquiry advised us that money is scarce and that he did not think that the scheme would be approved in its original form.

The Principal, Agricultural College, Coimbatore, says, regarding the scheme, "A detailed study of the composition of Milk of Indian breeds of cows and buffaloes is of very great importance with a view to educate the breeder and the consumer of milk, if not also the gowala. He further says that the attempt in making researches is laudable and the scheme, which is the first instalment, deserves some support.

The Deputy Director of Agriculture, In-charge, Chepauk, points out that a certain amount of data has been obtained, though more are welcome. He also points out that the estimated cost of the original scheme is high. The scheme has been revised in this respect and should now meet with general approval.

* "Many analysis of milk from various countries are reported in the literature of the composition of milk. In a large number of cases only milk-fat and solids not-fat have been determined and reported but numerous complete analysis are given.

Unfortunately a study of these data frequently fails to disclose the nature of samples analyzed whether from single milkings of individual cows. Composite samples from several milkings of individual cows, or from the mixed milk from a herd or from several herds of cows. In many cases, also no attempt is made to differentiate between samples from the milk of the different breeds of dairy cows. Also, it is often impossible to determine whether the samples analyzed were representative and were of known purity."

The nature of the research project.

It is proposed to secure data regarding the composition of milk from the following pure breeds of Indian cows and buffaloes. Scindi, Harriana, Kankrej, and Murrah. Sufficient animals are available in each group to make the study comprehensive, inasmuch as the Allahabad Agricultural Institute herd comprises the following numbers of pure-bred animals : Scindi (25), Harriana (10), Murrah (13).

It is further proposed that the scope of the investigation shall supply data regarding the composition of milk of these breeds from the following points of view :—

1. The collection and classification of accumulated data regarding the composition of milk from existing laboratories such as the Public Health Department, the Chemist to Government, laboratories of Municipalities, Agricultural Colleges, Military Dairies, etc.

2. The composition of herd milk of the Scindi, Harriana, Kankrej and Murrah breeds of milch animals.

*O. R. Overman, Bulletin No. 325, University of Illinois, Agricultural Experiment Station, U. S. A.

3. The composition of milk of single animals of the Scindi, Harriana, Kankrej and Murrah breeds of milch animals, for complete lactation periods.

- (a) Milch animals on one time milking a day.
- (b) " " two " " "
- (c) " " three " " "
- (d) " " four " " "
- (e) " " composite test once daily.

4. The composition of milk within the breed as affected by age, interval between milkings, environments, period of oestrus, stage of lactation, season of the year, humidity, water consumption, concentrates and fodders, etc. To be done in conjunction with the whole project.

5. The composition of milk from each quarter of the udder of at least ten milch animals.

6. The composition of fore milk, middle milk, and strippings, for complete lactations of the Scindi, Harriana, Kankrej and Murrah breeds of milch animals, of a total of at least ten animals.

7. The statistical analysis of data.

The method of conducting the research.

In order to summarize the method of conducting the research, the proposed investigation may be said to fall into three main parts :—

- (1) the survey of existing data,
- (2) the scope and method of the proposed research,
- (3) the statistical analysis of data and conclusions.

It is proposed to collect all available data from the literature already published and available regarding the composition of milk of Indian breeds of milch animals by a thorough library study. It is further proposed to collect all available accumulated, but unpublished data from all existing organizations including Public Health laboratories, the Department of the Chemist to Governments, Agricultural Colleges in India, Military Dairies, etc. It is also proposed to encourage existing organizations to investigate the subject independently so that recent and more up-to-date data may become available for publication. This section of the investigation may be called "The survey of existing data".

The tests to determine the composition of the herd milk will involve 8 composite samples daily. The tests of the milk of single animals will involve (approximately) 58 composite samples daily. The testing of the milk from each quarter of the udder will involve at least 40 samples daily. The tests on the composition of the fore-middle and stripping will involve at least 30 composite samples daily.

The testing of the milk on one to four time milk in a day, with a minimum of three milch animals in each group, will involve 30 samples a day.

"What the Agricultural Institute, Allahabad, U. P. will contribute towards this scheme :—

- (1) All samples of milk to be analysed. Estimated minimum cost Re. 1,000 annually.
- (2) All laboratory equipment required for the analysis as outlined.
- (3) Two Ph. D. part time workers on parts of the research scheme as outlined.
- (4) All our present facilities for giving effect to this scheme".

The methods of analysis.

In order to secure adequate samples of milk to allow for all determinations, with checks, on half-pound samples of milk in ground glass stoppered bottles will be necessary.

The official methods of chemical analysis will be used. The following determinations will be made as far as practicable :—

- (a) fat,
- (b) solids not-fat,
- (c) protein,
- (d) lactose,
- (e) ash,
- (f) specific gravity,
- (g) freezing point (very important).

Estimated recurring expenditure.

	1st Year.			2nd Year.		
	Rs.	A.	P.	Rs.	A.	P.
(1) Tabulator at Rs. 60 per mensem	720	0	0	840	0	0
Chemicals (acids, etc.) bottles, labels, record books, etc.	1,000	0	0	1,000	0	0
(2) Laboratory Research Assistants at Rs. 100 per mensem.	2,400	0	0	2,400	0	0
Total	4,120	0	0	4,480	0	0

Total recurring expenditure estimated for the 2 years period Rs. 8,600.

Respectfully submitted,

W. J. HANSEN, B.S.A., M.Sc.,
Prof., Dairying and Animal Husbandry,
for Principal.

No. 1623 OF 1932.

IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

From

W. McRAE, Esq., M.A., D.Sc.,
Director, Imperial Institute of Agricultural Research,
Allahabad.

To

THE PROFESSOR OF DAIRYING AND ANIMAL HUSBANDRY,
Allahabad Agricultural Institute, Allahabad.

Dated Pusa, the 12th March, 1932.

SUBJECT.—*Proposed application to the Imperial Council of Agricultural Research for a grant to conduct research on the composition of milk of Indian breeds of cattle.*

SIR,

With reference to your letter No. 2470, dated the 25th November 1931, regarding the subject mentioned above, I have the honour to enclose a note by the Imperial Agricultural Chemist embodying his views on the proposed scheme.

2. Accurate information regarding the composition of milk of Indian breeds of cattle is really needed as it is at present meagre.

I would like to suggest for consideration that if the work in the proposed scheme is confined to cattle of pure Indian breeds, more useful and important information would accrue than in the case of a more extensive scheme embracing cross-breeds.

I have the honour to be,

SIR,

Your most obedient servant,

(Sd.) W. McRAE,
Director.

Fairly full notes on some work done on the milk of Indian cows and buffaloes are appended herewith. It is therefore here necessary only to refer to the salient points observed during the courses of those investigations.

Leather (1901) has pointed out that the Indian samples of cow's milk are similar to the European samples in certain essentials but that there are certain dissimilarities too. He has also studied the composition of the buffaloes milk.

Meggitt and Mann's work (1911-1912) has brought out the important fact that there exists a great variation in the milk of animals both cows and buffaloes, of one breed. This dominance of the individuality of the animal is noticeable in the herds of even the recognised milking breeds and is to be attributed to there having been no selection for many generations.

Leather and Dobbs (1914) have estimated the errors of experiment in recording the yield and quality of milk, and drew some interesting conclusions on the amount and richness of the milk secretions from the different parts of the udder.

Annett and Sen (1919) have drawn attention to certain indications that weather conditions influence the composition of the butter-fat.

Plymen and Aiyer (1921) have found that determinations of the usual physical and chemical constants cannot differentiate between the butter-fat produced by cows or buffaloes. A useful record of previous work done on the subject will be found at page 187 of their first memoir.

In the Annual Reports of our Institute (from 1922-23 onwards) there will be found records of analysis of Pusa milk samples which has been carried out for a long series of years. This work has demonstrated that each cow tends to keep up an individual character in giving milk similar fat content in her different lactations.

I would now beg to make a few remarks on certain observations in the draft of the proposed application from the Allahabad Agricultural Institute for a grant from the Imperial Council of Agricultural Research. While agreeing with them on the necessity for further work on this important subject, I may be permitted to point out that there do exist some useful records of work "as to the composition of the milk of Indian cows and buffaloes and the normal variations due to age, period of lactation, etc." a knowledge of which "is prerequisite in order to determine the purity or extent of adulteration, and to formulate standards for milk ordinance regulations". Taking as an example the relationship between the progress of lactation and the composition of the milk, the well known fact that the fat content shows a gradual rise with the period of lactation, has been confirmed by the works of Meggitt and Mann at Poona, of Annett and Sen at Cawnpore and of this laboratory during a continuous period of the last many years. Again, on the question of formulation of standards for milk ordinance regulations, it should be remembered that in many of the Municipal, Public Health and other Laboratories in India there exists a most important collection of data, some of which is yet unpublished. It is the existence of these records which enable the local authorities to judge of the quality of the samples submitted for examination. I am personally aware that this is the case with the laboratory of the Calcutta Municipal Corporation, which has selected certain figures of analytical data as allowable limits for genuine samples, and that based on these, the Government of Bengal have fixed upon legal standards of analysis—(*vide* Notification Nos. 735-738 P. H., dated the 20th March, 1928).

What I have written above is meant to draw attention to an example of the complexities of the situation. As has been already stated above, I am of opinion that further work

on this subject would be welcome, and the idea of co-operation between the Scientific Department of University of Allahabad and Dairy Department of the Allahabad Agricultural Institute seems to be worthy of support.

As they have asked for suggestions on the proposal I beg to note the following points :—

- (1) The composition of local samples of milk and butter differs and it has therefore occurred that different countries have fixed different limits of standards, India is a vast country and the milch cattle as well as the environments in which they are placed are widely different in the different localities. The ideal procedure would therefore be to experiment with such animals as may be taken to represent the milch cattle prevailing in the locality rather than with any animals which are included in the study simply because they are handy.
- (2) It is incumbent to collect all local data. For this purpose likely laboratories such as those of the Public Health Department of the Chemical Examiner to the Government, of Municipalities, etc., may be consulted.
- (3) It is important to include both single animals and herds in the investigation. The question of single animals is of significance because of two considerations. In the first place this would enable one to find out individual variations and Meggitt and Mann's work as well as the Pusa investigations have proved how this aspect is of special significance in the case of Indian cattle. Secondly it would be remembered that here a large portion of the milk and butter consumed represents products obtained from single animals.
- (4) It is advisable to include cows and buffaloes in the study as dairy products from both these animals are used. Moreover, although Plymen and Aiyer's experience were to the contrary, the composition of both the butter and the milk has been generally found to be different in these cases, and the Government of Bengal had to fix different legal standards.
- (5) Very often judgment about the adulteration or otherwise of a milk sample is guided by a consideration of its fat content. Fat is easily and quickly determined. Moreover fat is about the most valuable of all the constituents of milk. Unfortunately the amount of fat varies widely even in genuine samples. Moreover arguments have been at times advanced on behalf of dealers supplying milk of presumable poor quality that the cow has foreign blood in her and that a lower standards should therefore apply to her. In this connection the determination of lactose is of importance. The proposal of the Allahabad Agricultural Institute, to include other items besides the fat, seems to desirable.
- (6) The study should cover a number of lactations and the suggested period of five years seems to be good.

(Sd.) J. SEN,

Officiating Imperial Agricultural Chemist.

No. 138/2838 of 1931.

IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

FROM

ZEL R. KOTHAVALA, Esq., B. Ag., B. Sc., N. D. D.,

Offg. Imperial Dairy Expert, Bangalore.

TO

W. J. HANSEN, Esq., B. S. A., M. Sc.,

Prof., Dairying and Animal Husbandry,

Agricultural Institute A. P. Mission, Allahabad.

Dated Bangalore, the 13th December 1931.

DEAR SIR,

I regret the delay in replying to your letter of the 25th ultimo, which was accompanied by your scheme.

I entirely agree with you that any authoritative information regarding the composition of milk of the Indian breeds of cattle is very meagre and I am of opinion that a scheme on the lines outlined by you will yield very important and useful information.

This section received several inquiries on the subject in the past and as there was definite information required about the milk of cows and buffaloes by the Secretary of the Shri-Govardhan Sanstha, Gorakshan of Poona, in last September, this section was prompted to take up the work, and a comprehensive scheme on the lines indicated in your paper was drawn up, but it had to be deferred due to the existing financial stringency. For the same reason I am afraid it will not be possible for you to get any financial help from the Imperial Council of Agricultural Research, at present. I shall, however, be very pleased to co-operate with you in the matter in whatever way I can.

Yours faithfully,
(Sd.) ZEL R. KOTHAVALA,
Offg. Imperial Dairy Expert.

No. 20669-A.

GOVERNMENT OF BENGAL.

OFFICE OF THE DIRECTOR OF AGRICULTURE, BENGAL.

FROM

THE DIRECTOR OF AGRICULTURE, BENGAL.

TO

W. J. HANSEN, Esq., B. S. A., M. Sc.,
Prof., Dairying and Animal Husbandry,
Allahabad Agricultural Institute, Allahabad.

Dated the 23rd December, 1931.

SIR,

With reference to your letter No. 2668 of the 25th ultimo, enclosing a draft of a proposed application for a grant from the Imperial Council of Agricultural Research, I have the honour to forward herewith the remarks made thereon by the Live-Stock Expert, Bengal, for your information and necessary action.

I have the honour to be,

SIR,

Your most obedient servant,

(Sd.)

for Director of Agriculture, Bengal.

Dated 22nd December.

Remarks made by the Live-Stock Expert, Bengal, on the application for a grant from the Imperial Council of Agricultural Research.

Mr. Warth has been doing Butter-pit and solids not-fat but has not done work of the nature proposed. I will discuss this with Mr. Hansen and Dr. Higginbottom at Allahabad and report later.

D.-O. No. 22165.
DEPARTMENT OF AGRICULTURE, PUNJAB.

Lahore, 5th December 1931.

DEAR SIR,

Regarding your letter No. 2447, dated 25th November, 1931, I wish to say that money is very scarce with the Imperial Council of Agricultural Research at the moment and that I do not think that that body would be likely to approve of this scheme in its present form.

Yours sincerely,

(Sd.) D. MILUK.

W. J. HANSEN, ESQR., B. S. A., M. Sc.,

PROFESSOR OF DAIRYING AND ANIMAL HUSBANDRY,

Allahabad Agricultural Institute, American Presbyterian Mission,

Allahabad.

Note of the Principal, Agricultural College, Coimbatore, on the application for a grant from the Imperial Council of Agricultural Research project on the composition of milk.

A detailed study of the composition of milk of Indian breeds of cows and buffaloes is of very great importance with a view to educate the Breeder and consumer of milk, if not also the Gowala.

2. The question however of investigating this problem with the view, as is suggested in the draft, to determine the purity of extent of adulteration and to formulate standards for milk ordinance regulation is like putting the cart before the horse.

3. The pre-requisite to such a study is the evolution and maintenance of pure milk breeds, chemical analysis being taken up at the same time as breeding starts and extended through a whole period of, say, ten to 15 years by which time a breed may fairly become established. This should for a long time to come, be solely with a view to effect improvements in breeding and to help it, rather than devising and fixing standards for the benefit of the consumer or the inquisitorial subordinate.

4. The results of chemical analysis undertaken when pure breeds and types have not been evolved, are likely to be divergent, conflicting, at best inconclusive.

5. Work of this nature can therefore be taken up only in institutions where breeding of animals forms a regular feature of the programme and where facilities exist for conducting analysis, the requisite chemical staff and laboratory equipment.

6. These conditions are to a very large extent satisfied in Agricultural Colleges in India whether affiliated to Universities or not, as Animal Husbandry and consequently Dairying forms a part of and an integral part of the course of training for student in such Institutions.

7. Possibly more than one typical breed can be found maintained in these institutions and sub-breeds are mostly representative of the breeds in the province.

8. In these Institutions cows and buffaloes are maintained under normal conditions of health and care. Their history is known and records of their performance are kept with a fair amount of accuracy and can be relied upon, especially when tackling the question of variations due to age, lactations, differences in feed.

9. Further analysis of—

(a) samples from single milkings, or

(b) composite samples from several milkings of individual cows will be in complete without the mixed milk from pure or typical breed or herd being also analysed at about the same time and to that extent render conclusions drawn less acceptable or definite.

10. Present holders of University degrees in Agriculture in India are trained for such analysis an investigation and with some practice should be competent by themselves to conduct enquiries into this and allied subjects of composition of milk, far more satisfactory the science men who have no agricultural training and on that account need the assistance of Agricultural men. At the Coimbatore Agricultural College analysis which students make of milk is directed towards ascertaining fat, solids-not-fat, protein, lactose, sahspecific gravity moisture.

11. In these circumstances it is considered advisable, if not also economical, that research into this subject is carried on in such Agricultural Colleges as are provided with a trained staff and equipment in the shape of cattlebreeds and wherever these two conditions do not exist, the co-operation of Science Departments of Universities and of the Local Agricultural Departments may be secured.

12. There is one point in the scheme which may need alteration as experience is gained but which does not affect the merits of the scheme as propounded. This is the suggestion that studies be made of individual cows for a complete lactation period.

13. Adoption of suggestion that analysis of milk of individual cows and for a complete lactation period to three for a cow, as within five years, the period fixed for the grant, under ordinary conditions obtaining in India, the average number of calvings would be three and very rarely four.

14. In any event the attempt made by Professor Dhar and Dr. Sam Higginbottom in making researches is laudable, and their scheme which is the first instalment deserves some support.

15. The grant proposed in the scheme however is in my opinion rather high.

(Sd.)

Principal.

AGRICULTURAL DEPARTMENT.

FROM

M. R. RY, RAO BAHADUR D. ANANDA RAO, GARU, B. Sc.,
Headquarters Deputy Director of Agriculture-in-charge, Cherpauk.

TO

W. J. HANSEN Esq., B. S. A., M. Sc.,
Prof. Dairying and Animal Husbandry,
Allahabad Agricultural Institute, Allahabad.
No. 1960-31, dated 4th January 1932.

SIR,

Your letter reference No. 2467, dated the 25th November 1931.

Messrs. Leather and Dobbs investigated the yield and composition of Montgomery herd at Pusa and the errors that occur in carrying out milk tests. The yield and composition of the milk of the two breeds "Gir" and "Sind" in the Bombay Presidency were carried out by Messrs. Meggits and Mann. A large number of analysis of milk from individual Ongole and Kangayam cows were carried out in this Presidency as also the buffalo milk. These investigations especially those of Meggit and Mann cover the following points:—

1. How the yield and composition of milk from a herd and from individual cows are related to one another.
2. How the yield and composition of milk are influenced by—
 - (a) Season.
 - (b) Weather conditions.
 - (c) The period of lactation reached by an animal.

(d) The food which an animal was receiving.

(e) The age of the animal wherever possible.

3. A certain amount of data has been obtained, though many more are welcome. But in my opinion this need not be obtained at such a high cost as Rs. 25,000 as proposed in the scheme.

I have the honour to be,

SIR,

Your most obedient servant,

(Sd.)

for *Head Quarters Deputy*
Director of Agriculture.

ENCLOSURE.

COPY OF LETTER FROM THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO DR. SAM HIGGINBOTTOM, PRINCIPAL, AGRICULTURAL INSTITUTE, ALLAHABAD, No. 256/VET., DATED THE 6TH JULY 1932.

I am directed to say that your application for a grant of Rs. 8,600 spread over two years for research on the composition of milk has been received through the Government of the United Provinces and will be placed before the Advisory Board of the Council for consideration at its next meeting to be held from the 18th to 22nd July 1932. It however appears that the breeding programme now being carried on at the Allahabad Agricultural Institute is a complicated one and it is suggested that it should be simplified, so that sufficient numbers of cows, of the pure Indian milch breeds to be tested, would always be maintained in the herd. For the same reason the cross-breeding should be confined to one European breed. It is anticipated that unless the breeding system is simplified the results obtained from such research as is proposed in the scheme would be too unreliable to form a sound basis for arriving at definite conclusions, as the cattle now bred in the Institute are of a great variety. I am therefore to request you kindly to furnish this Department with information on the following points:—

- (1) Whether the breeding policy of the Institute can be simplified;
- (2) What numbers and exactly what breeds of cows it is proposed to use for this investigation and if the same number of animals of each breed will be available throughout the experimental period.

As the information on the above points is required for circulation to the members of the Advisory Board, I am to request that your reply may kindly be sent as soon as possible, so as to reach this Department not later than the 18th July 1932 when the Board meets.

SUBJECT No. 3.

APPLICATION FROM DR. SAM HIGGINBOTTOM, PRINCIPAL, AGRICULTURAL INSTITUTE, ALLAHABAD, FOR A GRANT OF Rs. 8,600 SPREAD OVER A PERIOD OF 2 YEARS FOR RESEARCH ON THE COMPOSITION OF MILK.

In continuation of the note already circulated on the subject mentioned above, the attached letters of 9th and 11th July 1932 from the Principal, Allahabad Agricultural Institute, are circulated to the members of the Advisory Board.

CHARAN DAS,

Secretary.

The 15th July, 1932.

COPY OF A D.-O. LETTER FROM PRINCIPAL, ALLAHABAD AGRICULTURAL INSTITUTE, ALLAHABAD, TO RAI SAHIB MALIK CHARAN DAS, SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, S. W., No. 3308, DATED THE 9TH JULY 1932.

Reference your esteemed favour of the 6th, No. 256/Vet.

There is no need to fear that the complexity of the cattle breeding programme of the A. A. I. will interfere with the proper fulfilment of the scheme to come before the Advisory Board on the 18th.

We have on hand 25 Scindi (Purebred) cows, 8 Harriana, 10 Kankrej and 13 Murrah Buffaloes, for the purpose of the proposed research on the "Composition of milk". We are further making a purchase of 16 additional Scindi cows in the very near future. No crossbred cows of any description will come under the purview of this research. The above herds represent our "foundation stock" in connection with which we have a definite "breeding up" Policy. Our foundation herds will be fully maintained up to strength and greatly strengthened by the large number of Scindi, Harriana and Kankrej heifers now growing up here.

We are in receipt of Colonel Oliver's esteemed favour reviewing the statement of our *Cattle Breeding Operations*, which we placed before him. As you have done, he stressed the importance of a simplified cattle breeding scheme. The same is receiving our best consideration and we hope at a later date to be able to submit such changes as we may propose to make. However, let me emphasize the fact, that our *crossbreeding* policy does not in itself detract from the value of the research or interfere with it, on the composition of milk of the Indian Breeds here, that we propose to make.

In conclusion, and in direct reply to your two points, I am pleased to say:—

- (1) That the breeding policy of the Institute can be simplified in the near future, but that the question is quite a separate one and not "really" related to the project under consideration.
- (2) We definitely propose to use the following breeds and numbers of cows for our investigation on the composition of milk—

Scindi Breed	..	...	..	..	..	..	25
Harriana Breed	..	..	..	..	..	..	8
Kankrej	..	..	..	..	..	..	10
Murrah Buffaloes	..	..	..	..	..	..	13

In addition to these animals on hand we propose to add 16 to the Scindi group. These additional 16 cows are to be purchased in the near future.

We also can definitely say that at least the same number of animals will be available throughout the experimental period, as are available now, providing we do not have any unexpected losses due to epidemics, etc., and even in that case we would replace the animals so lost from our foundation herds.

We further wish to assure you that the grant for which we are applying is only for a part of the total cost of the scheme, and that we definitely propose carrying on the scheme after the 2-year grant will have lapsed. Further that every precaution will be taken to ensure that the results will be thoroughly reliable and a sound basis for arriving at conclusions.

Respectfully submitted.

COPY OF A D.-O. LETTER FROM PRINCIPAL, ALLAHABAD AGRICULTURAL INSTITUTE, ALLAHABAD, TO COL. A. OLVER, C.B., C.M.G., F.R.C.V.S., ANIMAL HUSBANDRY EXPERT, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, S. W., No. 3320, DATED THE 11TH JULY 1932.

With further reference to No. 256/Vet., the application for a grant of Rs. 8,600 spread over two years, for research in the composition of Milk, and our conversation of even date.

I am pleased to confirm my oral statements and state as follows :—

1. That the Dairy and Animal Husbandry Division of the Allahabad Agricultural Institute, definitely commits itself to a policy of maintaining and developing the possibilities of one and only one indigenous breed of Indian cattle namely, the Scindi breed, by all the methods and resources available by us.
2. That we intend scrapping at the earliest possible date our cattle breeding (Work) with the Harriana, and Kankrej breeds of Indian cattle and that from date these breeds will not be used for crossbreeding while on this farm and until the time of their disposal.
3. That from date, we cease crossbreeding with our Holstein and Jersey imported bulls and that we subjugate our crossbreeding work and concentrate on the breeding up of the Scindi herd here.
4. That from date, we propose using Brown Swiss imported bulls on inferior Scindi stock, from time to time, and do not propose to use any other breed of foreign bulls.
5. That we will be engaged from July 15th 1932, upon "the investigation of the effect of Napier Grass on the yield and composition of milk". This subject is covered by the scope of the proposed research as set out in paragraph 4 under the heading of "the nature of the research project."
6. That we are summarizing accumulated milk production data, and making an economic study as to the cost of milk production—some of the preliminary graphs of which you saw for publication.

The foregoing changes in our cattlebreeding scheme are being made in order to more adequately stress to our students and the public the importance and the benefits of a policy of "breeding up" the indigenous breeds of Indian cattle.

At present we have 23 Scindi cows and 8 Scindi heifers on hand, 13 Scindi cows are in milk. During this month we are purchasing an additional 16 Scindi cows that will give us a total of 29 Scindi cows in milk and 10 dry Scindi cows. This size of a herd is quite large enough in order to secure significant results with a low amount of experimental error.

We trust that the application will be accepted with these amendments.

Respectfully submitted.

APPENDIX IV.

SUBJECT No. 4(a).

APPLICATION FROM THE GOVERNMENT OF MADRAS FOR A GRANT OF RS. 1,39,510 SPREAD OVER A PERIOD OF FIVE YEARS FOR A DRY FARMING SCHEME FOR THE CEDED DISTRICTS OF THE MADRAS PRESIDENCY.

Attention is invited to the attached letter from the Government of Madras, No. 909-III/32-6, dated the 25th April 1932 (Annexure) forwarding a dry farming scheme for the Ceded Districts of the Madras Presidency. The scheme involves a non-recurring expenditure of Rs. 42,750 on account of buildings and equipment and Rs. 5,760 on account of scholarship for an assistant who has worked on Sorghum at the station for two years to study such work in America in the third year, and a recurring expenditure over five years of Rs. 91,000. It is anticipated that the annual receipts of the agricultural station amount to Rs. 4,300. The net amount therefore which has been asked for from the Imperial Council is Rs. 1,18,010 spread over a period of five years. This amount will be further reduced if the Government of Madras agree to provide the Temporary quarters for staff (estimated cost, Rs. 9,000).

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 14th June 1932.

ANNEXURE.

LETTER FROM S. H. SLATER, Esq., C.M.G., C.I.E., I.C.S., M.L.C., SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA, No. 909-III/32-6, DATED STONEHOUSE HILL, THE NILGIRIS, THE 25TH APRIL 1932.

With reference to Sir Vijayaraghavacharya's letter No. 50-Agri., dated the 8th January 1932 (not printed), I am directed to enclose 100 copies of a revised scheme (enclosure) for dry farming in the Ceded districts of the Madras Presidency. The scheme was placed before the recently constituted Provincial Research Committee on 1st April 1932. The Committee has decided to forward the scheme to the Imperial Council of Agricultural Research for financial support, emphasizing the importance of its co-ordination with the Manjiri scheme in the Bombay Presidency.

2. I am to explain that the Assistants for Millets while being under the administrative control of the Deputy Director of the circle will be under the technical guidance of the Millets Specialist. Special attention is paid in the scheme to millets as that crop is most widespread and most in need of intensive study in the Ceded districts. It is more affected by drought than cotton. Its failure means a famine as it is the food crop. Cotton comes next in importance.

3. It will be recognised that a gazetted Superintendent who will be the Chief Investigating Officer of the station is indispensable if research work of any value is to be done, and the present financial situation in this Presidency makes it useless to expect that such an appointment will be possible for some time if we are to depend on Provincial funds. There are at present only 5 gazetted Superintendents in the Province and not nine as surmised by Sir Vijayaraghavacharya. An officer with adequate botanical qualifications will be appointed to the post and both he and the Physiological Assistant will be specially trained in Plant Physiology under Dr. T. Ekambaram, M.A., L.T., Ph.D., Professor of Botany, Presidency College, Madras and Honorary Director of the University Botanical Laboratory.

4. The special qualifications of the Soil Physicist, Dr. Seshadri, are now specified under item (2), Para. 10 of the scheme. He was specially selected for the post by the Madras Services Commission. He has already had more than a year's training under Mr. B. Viswanath, Agricultural Chemist, Coimbatore. The Deputy Director at present in charge of the circle Mr. K. Gopalakrishna Raju, has had sufficient practical experience

of dry farming in Tinnevely and Coimbatore, and recently acquainted himself with what is being done at Manjiri and elsewhere in the Bombay Presidency. The Director of Agriculture considers him very well qualified to manage the scheme. The local Government will see that either the present Deputy Director or another equally qualified officer is placed in charge of the scheme throughout the period.

5. The Hagari scheme has the same objectives as the Manjiri scheme in Bombay which has been agreed to by the Advisory Board of the Imperial Council of Agricultural Research and awaits the sanction of the Governing Body. But as the conditions of soil and crop are different in the two areas, the two schemes may properly be regarded as complementary to each other, and as parts of a general plan for the development of dry farming—a line of great importance in many parts of India which has not hitherto received adequate attention.

ENCLOSURE.

DRY FARMING SCHEME FOR THE CEDED DISTRICTS OF THE MADRAS PRESIDENCY.

The Central and Southern table-land of the Madras Presidency, comprising ten of the largest districts, receives, with exceptions, only a moderate, and in a few cases, low and precarious rainfall. The major portion of the Ceded districts (Cuddapah, Kurnool, Bellary and Anantapur) and portions of the adjoining state of Mysore lie in this latter region. In this area the rainfall is not only low but most capricious both in amount and distribution, and frequently prolonged and destructive intervals occur between rains, or premature cessations at critical seasons, while much of the precipitation is too light to be profitably utilized for an irrigation scheme. The average rainfall for this tract ranges from 20 to 30 inches, while in portions of Bellary and in some parts of the adjoining state of Mysore it is still less. (Statement of rainfall appended.) To the hostility of the climate must be added considerable inferiority of the soil and the absence of reliable irrigation sources.

2. The list of famines which have affected South India shows that this tract has suffered more frequently than any other. In the century 1800—1900, at the beginning of which these four districts came under British possession, there have been five scarcities, and six famines, besides numerous bad seasons. As a consequence “the unfortunate ryot has hardly emerged from one famine before he is submerged under another.”

3. The average ryot in this tract is poor. Agriculture is the chief occupation and the main source of food. Hence the periodical famines produced by the uncertain climate can be averted whenever possible, only by the intelligent application of scientific methods of agriculture. For successful farming in this tract the main problem is to determine the best means of utilizing the scanty and uncertain rainfall.

4. The Royal Commission on Agriculture in India, in their report, conclude on this problem as follows:—

“The problems of cultivation in such tracts in which crops are entirely dependent upon rainfall are, in our opinion deserving of far closer attention than they have received from the Agricultural departments. It happens, moreover, that those crops that have received least attention from the departments of Agriculture, such as the millets, are amongst the typical crops in most unirrigated districts. Thus the cultivator in dry areas, may, we think, reasonably complain that, neither as regards those problems of cultivation peculiar to the conditions in which he farms, nor as to the crops, with the exception of cotton and groundnut which are of special importance to him, has he received a fair share of the time and attention of the Agricultural departments.”

5. This region is broadly divisible into black-soil and red-soil tracts. In the red-soils there are possibilities for wells in many places and as such it is largely a question of economics rather than of agronomy. The black-soils are fairly large in extent and wells are well nigh impossible in many places. The recent boring operations in the Bellary district confirm this fact. Proper and careful conservation and utilization of rain water is the

only method which can help in the improvement of the agricultural condition of this tract. It is therefore considered desirable to concentrate on this problem of dry farming in the heavy black-soils of this famine zone.

6. The average annual rainfall of this tract is about 20 inches which is roughly equivalent to 4,530,000 pounds of water per acre. If all this water were available for crop production, it should be capable of producing 9,000 pounds of total dry matter, on the rough basis that for every pound of dry matter produced, 500 pounds of water would be necessary. But the average production of grain and straw together amounts to only 2,000 pounds, which means that the cropping value is only about a fourth of what it should be on the theoretical considerations. The same is probably the case with cotton. A large quantity of water is lost by surface flow and evaporation. It should be possible to increase crop yields to an appreciable extent if the loss of moisture from the soil could be minimized. An increase of even one per cent. of available moisture in the soil will bring about an increase of 40 pounds in the yield of dry matter.

7. About twenty years of experimental work at the Hagari Agricultural Research Station has shown that the supply of moisture is the limiting factor in crop production in the dry tract. Since 1924, the Deputy Director of Agriculture and the Government Agricultural Chemist have been trying to obtain adequate facilities for the study of the factors that govern the retention and supply of moisture by the soil to the crop. But the requisite staff and accommodation could not be had. Nevertheless, in view of the urgency and importance of the problem, a series of preliminary experiments were laid down at the Hagari Agricultural Research Station in the year 1927 after a preliminary testing of the land in the previous year. These experiments have for their object the study of the effect of different cultural treatments on the better retention and supply of moisture to the soil as measured by crop growth. The importance of fundamental studies on the movement of water in the soil, the moisture relationships between the soil and the plant and the effect of different cultural practices thereon has not been overlooked. For want of facilities by way of men, money and accommodation this could not be done at Hagari but these are being investigated on a smaller scale at Coimbatore from the year 1929. The experiments at Hagari and Coimbatore are carried out by Mr. T. Lakshman Rao, B.A., D.I.C. (London), Assistant Agricultural Chemist, under the direction of the Government Agricultural Chemist. The result so far obtained, though of a preliminary nature, show that—

- (i) the movements of moisture in the soil occur in a very limited depth range and very directly with the mean daily rainfall and inversely with the evaporation from the surface of the soil;
- (ii) surface mulching does not appear to exercise a protective influence on the evaporation of moisture from the soil;
- (iii) deep ploughing appears to economize water but if too frequently is detrimental to crop yield;
- (iv) bunding 9 inches high (12 inches at bottom and 9 inches on the top) is very effective both in the retention of moisture and crop yield.

8. The laboratory studies at Coimbatore are on a soil about two and a half feet deep and cannot therefore be strictly the basis in interpreting the field results at the Hagari Experiment Station where the soil is about ten feet deep or more. We must have precise information on the physical composition of the soils at Hagari and the movements of moisture therein, before we are in a position to formulate schemes of dry farming practice for the benefit of the ryot. The Government of Madras, recognizing the importance and urgency of the work, have strengthened the staff of the Government Agricultural Chemist by the appointment of a Soil Physicist to his section in November 1930 and this officer is intended to carry out the work at Hagari. But he is unable to commence work owing to the lack of necessary laboratory and technical facilities at Hagari and which the Madras Government being unable to provide desire to secure through this scheme.

9. Location.—This tract is at present served by the two existing agricultural research stations at Nandyal (Kurnool district) and Hagari (Bellary district). The Nandyal station, located in the Nandyal valley, is more favourably situated from the point of view of rainfall. The Hagari station, situated on the bank of the river Hagari with its rainfall of about

17 inches, is a suitable locality for carrying out work in this problem. A small area of 25 acres can be leased out contiguous to the existing station and the proposed research can be carried out both in the new and old areas. The proximity to a permanent station thus eliminates the need for a larger area to meet the various needs of the comprehensive scheme. It provides a permanent area on which buildings and other structures may be put up. The existing equipment, staff, and facilities of the present station will be available and make the scheme less costly than it would otherwise be. The disabilities of choosing a new area in proximity to a town to save investment on residential buildings are set off by considerably greater advantages incidental to work carried on as an extension to an existing station. The present station lacks residential facilities, and being about 9 miles away from the nearest town (Bellary), the question of dispensing with residential quarters is not a practical proposition. It is, however, proposed to erect only six katcha buildings at a minimum cost, having taken into full consideration the number of buildings already available at the agricultural research station. The types of residences provided are far below the usual accommodation provided for such officers. The investment on non-residential buildings has been kept as low as possible.

10. The total contribution of the Madras Government to the scheme amounts to Rs. 1,23,722 and is as follows :—

(1) The Hagari Agricultural Station with a cultivated area of about 150 acres has an equipment of six pairs of cattle, a cattle-shed, a store house and five permanent residential quarters for the staff. The staff consists of four farm managers, one cotton assistant, one fieldman, two laboratory attenders, one clerk, one store-keeper and two peons. Exclusive of initial capital outlay on land and buildings, live and dead stock, the working expenses for five years come to Rs. 49,250, the average per annum being a little over Rs. 9,850. The pay of the establishment amounts to Rs. 48,588. Therefore, the total comes to Rs. 98,838.

(2) Dr. T. R. Seshadri, the Soil Physicist, with a staff of one assistant and one peon will be transferred to Hagari. Their contribution in the way of salaries for the five years amounts to Rs. 25,884. Dr. Seshadri is an M.A. of the University of Madras and Ph.D. of Manchester. He has a good basic instruction in Physics and has the additional advantage of guidance of Rao Bahadur B. Viswanath, the Agricultural Chemist, who, in addition to his local knowledge, has special experience with soil problems of Iraq.

11. To augment this existing staff the following additions are proposed to cope with the full scheme :—

One Superintendent (Rs. 250—25—750).

Three assistants (Rs. 120—10—170) starting on Rs. 120.

(Soil Physics—One.)

(Millet—Two.)

One assistant for Physiology (Rs. 150, 160, 170—200—200).

Four fieldmen (Rs. 35—1½—50) starting on Rs. 35.

(Soil Physics—One.)

(Millet—Two.)

(Physiology—One.)

One peon (Rs. 12—18) starting on Rs. 12.

One typist-clerk (Rs. 35—1½—50).

At present the agricultural station is supervised by a farm manager working under the immediate guidance of the Deputy Director of Agriculture. If the proposed scheme is initiated, there is going to be a substantial increase in research work, and if as proposed in paragraph 13 under organization the whole scheme is to be under the administrative control of the Deputy Director of Agriculture, it is absolutely necessary that the latter officer be relieved of a mass of routine work to enable him to co-ordinate the researches in

plant breeding, soil physics and agronomy. Hence the necessity for a Superintendent in the gasetted rank.

12. *Research proposed*.—The problems proposed to be included in the scheme are three-fold—

- (1) The study of the relation of soil moisture to crop growth and the methods of increasing its availability.
- (2) The study of the important crops of the tract, namely, sorghum, setaria and cotton with special reference to their water relationships.
- (3) Agronomic studies—
 - (1) *Soil moisture*.—This may be divided into two categories: Field work and Laboratory work.

Field work—

- (i) The field experiments, that are now in progress at Hagari to be elaborated and intensified.
- (ii) *In situ* studies of the rate of percolation and rise of water.

Laboratory work—

- (i) Study of the movement of moisture in the soil.
- (ii) Determination of the mechanical composition of the soil at various periods.
- (iii) The determination of the maximum, minimum, and hygroscopic water affinities of the soil under different treatments.

(2) *The study of the crop—*

- (i) Physiological life history of the crop.
- (ii) The water requirements of crops.
- (iii) The root system of crops.
- (iv) An intensive study of the millets including the determination of the characteristics of drought resistant strains.
- (v) Isolation of superior strains as regards yield, duration and drought resistance.

(3) *Study of general agronomy—*

- (i) Field experiments on the aspects of seed rate, spacing, time of sowing, depth of sowing, etc.
- (ii) Trials of implements best suited to serve the cultural needs of dry farming.
- (iii) The study of the economics of the improved methods.

- (4) Study of meteorological factors including sunlight, temperature, humidity, and wind and their influence on the growth and development of crops.

It will be noticed that research indicated in items (1) and (2) above dealing with soil moisture and crop studies are fundamental in character and deal with problems affecting all tracts of country with deficient rainfall. The main problem that is proposed to be tackled is the better utilization of the small rainfall received in tracts of similar nature which exist all over India. It is obvious that fundamental research of Dr. Keen at Rothamsted has profoundly modified the older theories on the relationship between the soil and its moisture.

13. *Organization*.—The Millet Specialist and the Agricultural Chemist who will have their assistants stationed at Hagari will periodically supervise and guide research entrusted to them but for administrative purposes, it is proposed, that the whole scheme be under the general control of a thoroughly competent Deputy Director of Agriculture, stationed at Bellary, who will control all the officers provided for in the scheme.

Little work has been done in India on the water requirements of crops and their root systems. The only place where such work has been done to any degree of depth (under conditions approximating ours) is in America, in the arid tracts of Nebraska,

Arizona, etc., by Briggs and Shantz and their collaborators. It is proposed to send an assistant who has worked on Sorghum at the station for two years to study such work in America in the third year.

14. *Laboratory and equipment.*—An old engine shed now being used by the Cotton Assistants is the only laboratory facility at present available at Hagari. The minimum facilities in this direction are provided for by the construction of a laboratory with fittings. A pot culture house and an additional threshing and drying floor are the major extra provisions made. It may be added that in the heavy black soils of Hagari, the amounts budgeted represent considerably lesser accommodation than they would give in red-soil areas.

15. The cost of the scheme (*exclusive* of the contribution of the Madras Government in land, equipment, men and money) to be met by the Imperial Council of Agricultural Research comes to Rs. 1,39,519. The annual receipts of the agricultural station amount to about Rs. 4,300.

The budget details are appended.

16. The Advisory Board of the Imperial Council of Agricultural Research while approving a scheme of dry farming research at Manjiri put up by the Bombay Government, definitely stated that "it should be left open to territories outside the limits of the Bombay Presidency to come up with schemes which would fall in line with this one." The scheme proposed for Hagari is one such. While Hagari and Manjiri are similar in regard to rainfall and climate, they differ in their soils. Hagari soils are much deeper and less slopy than those of Manjiri, and problems, and their line of attack are different. Hagari is concerned with sorghum, cotton and setaria, whereas Manjiri is mainly concerned with the first. Bombay proposes to do its research on problems connected with soil-plant-manure. Madras has been doing and proposes to do the same in a more intensive way. While both the schemes have a similar objective, owing to differences in soil, regional and crop conditions, one is supplemental to the other. If the Bombay scheme is of all-India importance, that of Madras is as much so. The two schemes form part of a co-ordinated whole.

The 9th March 1933.

S. V. RAMAMURTI,
Director of Agriculture.

Detailed Estimates.

Non-recurring.

	Rs.
I. Buildings—	
1. Temporary quarters for six of the staff at Rs. 1,500 each	9,000
2. Laboratory	12,000
3. Pot Culture House, Lysimeters, etc.	7,000
4. Drying and Threshing floors	2,000
Buildings—Total ..	30,000
II. Equipment—	
1. Fencing and lay out of 25 acres	750
2. Furniture for laboratory	2,500
3. Fittings and apparatus and materials for laboratory	7,500
4. Implements	1,000
5. Reference books	1,000
Equipment—Total ..	12,750

Scholarship for Foreign training.

	Ra.
Passage—up—II Class—	
First six months, beginning—	
Coimbatore to Nebraska (via Bombay, Marseilles and New York) ..	1,400
Second six months, end—	
Nebraska to Arizona	100
First year end—down—II Class—	
Arizona to Coimbatore (via Colombo—Eastern route)	1,200
	2,700
	2,700
	Ra.
Stay and study—1 year—	
Cost of living	250
Fees, etc.	100
Maintenance for family	75
	} Based on recent I.C.C. } Research Scholarship to } Cambridge.
	425
Less	170
	} Probable pay of incumbent.
	255
	} Per month.
	255 × 12.. ..
	3,060
	Grand Total .. 5,760

Recurring.

	First year. Ra.	Second year. Ra.	Third year. Ra.	Fourth year. Ra.	Fifth year. Ra.
I. Pay of Officers—					
Superintendent (Ra. 250—25—750) ..	3,000	3,300	3,600	3,900	4,200
Total for five years ..	18,000				
II. Pay of Establishment—					
Two assistants (Ra. 120—10—170) for millets	2,880	3,120	3,360	3,600	3,840
One assistant (Ra. 120—10—170) to the soil physicist	1,440	1,560	1,680	1,800	1,920
One assistant (Ra. 150, 160, 170 200, 200) for five years for physiological work	1,800	1,920	2,040	2,400	2,400
Four fieldmen (Ra. 35—1½—50) ..	1,680	1,752	1,824	1,896	1,968
Millets	2				
Soil physics	1				
Physiology	1				
One peon (Ra. 12—18)	144	150	156	162	168
One typist clerk (Ra. 35—1½—50) ..	420	438	456	474	492
	8,364	8,940	9,516	10,332	10,788
Total for five years ..	47,940				

III. Allowances—							
Travelling allowance	..	..	1,000	1,000	1,000	1,000	1,000
Total for five years		..	5,000				
IV. Contingencies—							
Rent on 25 acres of land	..	..	250	250	250	250	250
Extra working expenses	..	..	1,000	1,000	1,000	1,000	1,000
Apparatus and materials for laboratory			2,500	2,500	2,500	2,500	2,000
Office expenses—							
Postage, repairs to furniture, etc.	..	..	200	210	300	300	300
Pay of Menials	..	..	100	100	100	100	100
			4,050	4,060	4,150	4,150	3,650
Total for five years		..	20,060				
Total, Recurring		..	91,000				

Abstract Estimates.

Non-recurring.

							Rs.
Buildings	..	..	..	..	..	..	30,000
Equipment	..	..	..	..	..	..	12,750
Scholarship..	..	..	..	..	..	..	5,760
Non-recurring—Total							48,510

Recurring:

For five years—							
Pay of Officers	..	..	..	..	..	..	18,000
Pay of Establishment	..	..	..	..	..	..	47,940
Allowances	..	..	..	..	..	..	5,000
Contingencies	..	..	..	..	..	..	20,060
Recurring—Total							91,000

Total cost, Rs. 1,39,510.

RAINFALL STATEMENT.

No.	Station.	No. of years recorded.	Average annual rainfall.	No.	Station.	No. of years recorded.	Average annual rainfall.
				INCHES.			
CUDDAPAH DISTRICT.							
1.	Pulivendla ..	..	51 21.98	6.	Badvel ..	..	51 27.60
2.	Jammalamadugu ..	..	51 22.44	7.	Siddhout ..	..	51 33.16
3.	Proddatur ..	..	51 25.17	8.	Chitvel ..	..	35 34.63
4.	Kamalapuram ..	..	35 25.43	9.	Rajampet ..	..	51 34.20
5.	Cuddapah ..	..	51 31.61	10.	Rayachoti ..	..	51 25.71
KURNOOL DISTRICT.							
1.	Markapur ..	..	51 24.36	9.	Nandikotkur ..	..	51 27.00
2.	Cumbum ..	..	15 26.19	10.	Kurnool ..	..	51 25.92
3.	Giddalore ..	..	32 25.72	11.	Dhone ..	..	16 24.28
4.	Allagadda ..	..	26 27.33	12.	Pyapalli ..	..	40 24.58
5.	Nandyal ..	..	51 31.72	13.	Pattikonda ..	..	51 23.99
6.	Owk ..	..	40 19.84	14.	Gudur ..	..	16 23.95
7.	Koilkuntla ..	..	51 24.31	15.	Ramallakota ..	..	31 26.78
8.	Atmakur ..	..	40 30.57	16.	Kalwa ..	..	37 23.04
BELLARY DISTRICT.							
1.	Yemmiganur ..	..	41 23.19	7.	Kampli ..	..	41 21.50
2.	Adoni ..	..	51 26.35	8.	Hoepet ..	..	51 26.32
3.	Alur ..	..	51 23.19	9.	Hadagalli ..	..	51 22.03
4.	Siruguppa ..	..	41 24.33	10.	Harpanahalli ..	..	51 23.90
5.	Bellary ..	..	51 19.83	11.	Kudligi ..	..	51 24.58
6.	Rayadrug ..	..	51 19.50				
ANANTAPUR DISTRICT.							
1.	Madakasira ..	..	51 23.51	8.	Uravakonda ..	..	41 21.89
2.	Hindupur ..	..	51 23.26	9.	Gooty ..	..	51 23.19
3.	Penukonda ..	..	51 24.09	10.	Yadiki ..	..	41 22.27
4.	Bukkapatnam ..	..	41 25.75	11.	Tadpatri ..	..	51 23.11
5.	Dharmavaram ..	..	51 21.21	12.	Kadiri ..	..	51 25.59
6.	Kalyandrug ..	..	40 20.30	13.	Tanakal ..	..	7 20.09
7.	Anantapur ..	..	51 21.31				

APPENDIX V.

SUBJECT No. 4 (b).

APPLICATION FROM THE GOVERNMENT OF THE PUNJAB FOR A GRANT OF Rs. 1,65,430 SPREAD OVER A PERIOD OF 5 YEARS FOR A DRY FARMING RESEARCH SCHEME FOR THE SOUTH-EAST PUNJAB.

Attention is invited to the attached letter from the Government of the Punjab, No. 1511-D., dated the 29th April 1932 (Annexure) in regard to a dry farming research scheme for the south-east Punjab. The scheme involves, in so far as the Council is concerned a non-recurring expenditure of Rs. 11,700 and a recurring expenditure of Rs. 30,746 per annum or a total expenditure of Rs. 1,65,430 spread over a period of five years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 26th May 1932.

ANNEXURE.

COPY OF A LETTER FROM THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA, S. W., NO. 1511-D., DATED THE 29TH APRIL 1932.

SUBJECT. :—*Dry Farming Research Scheme for the south-east Punjab.*

I am directed by the Punjab Government (Ministry of Agriculture) to forward for consideration by the Council at its next meeting a Dry Farming Research Scheme (Enclosure) for the south-east Punjab which has obtained the approval of the Punjab Council of Research. Details of the scheme are contained in the attached note, 100 copies of which are being forwarded to you under separate cover.

2. It will be observed that the proposal is to utilize the entire area of the Rohtak District Farm for five years which, with the existing equipment, is valued at Rs. 75,000. The Punjab Government agrees to this as its contribution towards the scheme. Furthermore, the Punjab Government agrees to give to this scheme an annual sum equivalent to the income that it receives from this scheme, as in the case of other schemes submitted to the Council. Hence the grant for which the assistance of the Imperial Council of Agricultural Research is asked is Rs. 11,700 non-recurring and Rs. 30,746 recurring annually over a period of 5 years.

3. The scales of pay proposed for the staff are existing rates in the various Provincial services. There will be some small saving on the pay of this establishment which will be subject to such cuts as are imposed by Government on the salaries of its servants.

ENCLOSURE.

Dry Farming Research Scheme for the South-East Punjab.

At its meetings in January and June 1931 the Advisory Board of the Imperial Council of Agricultural Research had under consideration an application for a grant for Dry Farming Research in the Bombay Presidency, and at the latter meeting recommended that a grant of Rs. 3,53,059 during a period of five years be made. During the consideration of this scheme, both by the special Sub-Committee appointed to examine it and by the Advisory Board, a general feeling existed that other Dry Farming Stations were required, not only in areas immediately adjoining the Bombay Presidency, but in other parts in India. The view was expressed that while approving of the proposal to have these stations within the limits of the Bombay Presidency it should be left open to territories outside to submit schemes which would fall in line with this one. It was unanimously agreed, however, that conditions in the Punjab, and the territories immediately adjoining it, are so different in character from those in Bombay that a Northern India Scheme could not be linked up with the the Bombay Scheme, and that a separate scheme should not be put up to suit conditions in that part of India.

Whilst a large area in the Punjab is secure against famine, by irrigation from perennial canals or from wells, a still greater area is less fortunately situated. In parts of the South-East Punjab the failure of the harvest is a common feature, and the provision of famine works has become an almost annual necessity. The extent to which the agriculture of this part of the Province depends on rainfall may be judged from the following figures for the year ending 30th June, 1931 :—

District.				Total area of crops.	Area of crops grown by rainfall.
				Acres.	Acres.
Hissar	..	..	..	25,31,897	22,27,944
Rohtak	..	..	..	12,06,771	8,24,606
Gurgaon	..	..	..	10,87,590	8,94,220
Karnal	--	--	--	11,00,256	6,73,513
Ambala	..	..	..	8,39,597	7,87,593
Total	..	..	..	67,46,111	54,07,876

In the adjoining districts of the United Provinces the problem of dry farming is of equal importance, whilst in the State territories to the west there are also large areas where the chances of maturing barani crops are precarious. The results obtained at the proposed Dry Farming Station should, therefore, be of great utility to territories outside the Punjab also.

At Sirsa in the Hissar district an Agricultural Station has been in existence for the past three years. The experience gained on the barani area of this farm during these few years shows that with its very uncertain and unevenly distributed rainfall Sirsa is unsuited for Dry Farming research, and the chances of maturing a crop are always doubtful. Within the last 15 years the annual rainfall has been as low as 2·4 and as high as 37·7 inches, with an average of about 11·5 inches. The main part of this rainfall is received in July, August and September.

When examining the Bombay Scheme the Sub-Committee, already referred to, considered that in order to secure the best results during the period over which the scheme is spread, the site chosen should be located at a place having not less than 20 inches rainfall per annum. It is proposed that the Punjab Scheme should be located at Rohtak where the average annual rainfall is also about 20 inches of which the greater part falls in July August and September. As is shown by the figures already referred to, Dry Farming constitutes two-thirds of the total cultivation in this district which lies in the South-Eastern Punjab dry farming tract.

It is proposed that the District Farm at present under the Agricultural Department should be used for the purpose of this research scheme. This farm has an area of 100 acres, of which 52 acres are irrigated by perennial canal and the remainder is barani. An advantage of this farm is the fact that whilst the whole area can be used for barani cultivation canal irrigation supply is at hand, and can, if required, be utilized to repeat as near as possible the rainfall of a previous year, for the collection of data connected with particular experiments. The land of the farm is of average quality and representative of the tract. The farm is fully equipped with the necessary buildings, implements and live-stock, the utilization of which would considerably decrease the cost of a Dry-Farming Scheme. The buildings provide the necessary accommodation for a temporary field laboratory, office, the storing of farm produce and dead-stock, the housing of live-stock and of labourers, some Mukaddams and the Manager. The farm land has been acquired and the buildings erected at a cost to the Punjab Government of Rs. 72,051. The present live-stock on the farm was provided at a cost of about Rs. 1,600 whilst the cost of the implements and machinery was about Rs. 1,700. The total cost to Government of providing and equipping the farm, as it stands now, was not less than Rs. 75,000.

Research proposed.—The investigations to be carried out may be divided under the heads—

- (1) the soil,
- (2) the plant,
- (3) the field.

Under the first of these heads problems demanding an intensive study include—

- (a) soil classification ;
- (b) properties of the soil and its behaviour under different treatments with special reference to—
 - (i) the penetration of rain water on cropped and fallow lands ;
 - (ii) evaporation of soil moisture under similar conditions ;
 - (iii) water-holding capacity ; porosity, hygroscopicity, capillarity and wilting co-efficients.

In the Plant Section the investigations would include a study of—

- (a) the water requirements of the various crop plants grown in the tract with special reference to transpiration and the quantity of water required to produce a unit of dry matter ;
- (b) the root systems of various crop plants ;
- (c) the reaction of these plants to meteorological conditions of wind, temperature, humidity and sunshine.

In the Field Section problems to be solved are—

- (a) the influence of deep and shallow cultivation on the absorption of rain water by the soil ;
- (b) the effect of surface cultivation after each fall of rain on the water content of the soil ;
- (c) the value of inter-cultivation of crops from the same aspect ;
- (d) the growing of crops in ridged land as opposed to flat ;
- (e) the value of *bunds* for controlling rain water ;
- (f) the study of implements best suited for effecting the maximum conservation of soil moisture ;
- (g) the best treatment for different crops grown under dry farming conditions with reference to seed rates, manures and rotations ;
- (h) the effect of " cover crops " on the conservation of soil moisture ;
- (i) the adjustment of the ideal dry farming methods suggested by the work done in the Soil and Plant Sections to practical farming conditions and to the economics of the farm.

*Staff required.	Average per annum.
	Rs.
One Agriculturist (P. A. S. II Grade Rs. 200—250/25—750)	4,200
One Physiologist (P. A. S. II Grade Rs. 200—250/25—750)	3,600
One Soil Physicist (P. A. S. II Grade Rs. 200—250/25—750)	3,600
Two Agricultural Assistants (Grade Rs. 100—10—200/10—300)	3,360
Four Mukaddams (Grade Rs. 20—1—30/2—50)	1,056
One Laboratory Attendant on Rs. 18	216
One Accountant (Rs. 75—5—125)	960
One Junior Clerk (Rs. 40—2—80/2—90)	528
Three peons on Rs. 14 per mensem each	504
Total	18,024

*The scales of pay proposed for the staff are existing rates in the various Provincial Services. If these rates are reduced by Government, the proposed rates would be amended similarly.

Buildings.—The existing buildings are sufficient for all purposes other than the housing of the senior staff who can find the necessary accommodation in the town of Rohtak nearby.

Equipment.—The farm is equipped with four pairs of working bullocks and the usual dead-stock. It will be necessary to add to the number of bullocks, and implements required for experimental purposes, to provide lysimeters, a small pot culture house, books, etc., and to fit up the office rooms for laboratory purposes.

It is proposed that the scheme should be for a period of five years, and the funds which the Imperial Council of Agricultural Research is requested to provide amount to—

Rs.
11,700 (non-recurring),
1,55,000 (recurring).

as detailed below :—

	Non-recurring.	Recurring.
	Rs.	Rs.
1. Staff .. .. .	..	18,024
2. Labour, 16 beldars at Rs. 16 each ..	..	3,072
3. Variable labour .. .. .	..	1,000
4. Purchase and maintenance of bullocks	1,200	1,350
5. Machinery and implements	500	300
6. Laboratory equipment and pot culture house	10,000	1,000
7. Supplies and Services and Contingencies	..	5,000
8. Travelling allowance .. .. .	..	1,000
	<hr/>	<hr/>
	11,700	30,748
	<hr/>	<hr/>
	Say Rs.	31,000

APPENDIX VI.

SUBJECT No. 4 (c).

APPLICATION FROM THE GOVERNMENT OF HIS EXALTED HIGHNESS THE NIZAM FOR A GRANT OF Rs. 59,383 SPREAD OVER A PERIOD OF FIVE YEARS FOR A DRY FARMING RESEARCH SCHEME.

Attention is invited to the attached letter from the Government of His Exalted Highness the Nizam, No. 410-P., dated the 7th July 1932 (Annexure), forwarding a dry farming research scheme. The scheme involves a non-recurring expenditure of Rs. 12,662 and a recurring expenditure of Rs. 59,740 or a total of Rs. 72,402 spread over a period of five years. The Hyderabad Agricultural Department is prepared to contribute Rs. 6,437 and Rs. 6,582 on account of non-recurring and recurring expenditure respectively. The amount required from the Council is thus Rs. 6,225 non-recurring and Rs. 53,158 recurring or Rs. 59,383 in all spread over five years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 14th July 1932.

ANNEXURE.

COPY OF LETTER No. 4010/P., DATED THE 7TH JULY 1932, FROM B. A. COLLINS, Esq., C.I.E. I.C.S., DIRECTOR-GENERAL AND SECRETARY TO GOVERNMENT, DEPARTMENT OF COMMERCE AND INDUSTRY, HIS EXALTED HIGHNESS THE NIZAM'S GOVERNMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

In accordance with my telegram of to-day's date of which I enclose a copy (not printed) I forward herewith a scheme (enclosure) for a sub-station for Dry Farming Research to be worked in co-operation with the Bombay Dry Farming Research Scheme, as suggested in the report of the committee on the Bombay Dry Farming Research scheme, of which a copy was forwarded to the Hyderabad Government. The total cost of the scheme over a period of five years will be Rs. 72,402 of which the Hyderabad Government would be willing to contribute Rs. 13,019 as shown in the scheme. I request that this scheme may be laid before the Advisory Board, when the Director of Agriculture, who will be present, will be able to explain any points which are not clear.

ENCLOSURE.

DRY FARMING RESEARCH SCHEME FOR THE HYDERABAD STATE.

At the meeting of the Advisory Board of this Council held last year at Simla, the Dry Farming Research Scheme submitted by the Bombay Department of Agriculture was considered and approved. It was also recognised in principle that the adjoining provinces, including the Hyderabad State, had also a large area for improvement of which Dry Farming Research was needed. The general opinion in the meeting of the Board held in Delhi in January 1931, where the Bombay scheme was first introduced, was that because other provinces were also interested in the Dry Farming Research proposed by the Bombay Agricultural Department, a committee representing all the neighbouring interested provinces should be formed to co-operate in designing the lines of work and in examining the results obtained at all the research stations. It was also decided in the Simla meeting of last year that other provinces interested in the subject should submit their scheme later if they wished to carry on similar work themselves. The scheme submitted by the Hyderabad Agricultural Department is in accordance with the same decisions.

Conditions in the districts of Raichur, Gulburga, Osmanabad and Bhir on the western frontier of the Hyderabad State are similar to the conditions in the adjoining districts of the Bombay Presidency and they fall in the same famine zone. The causes of drought in these districts of the State are also the same.

The Hyderabad Agricultural Department has been in the process of re-organization and equipment since the past few years. It has been and is spending a considerable

amount of money on that account. It is for this reason and on account of shortage of staff that they have not been able to take up any research in dry farming. Still, they have taken one practical step recently. Four agricultural graduates have recently been employed for 'bundling' work in the Karnatak Division. These officers have been specially trained for us by the Bombay Agricultural Department, to whom we are thankful. The work has been started this year and it will be carried on on the same lines as in the Dharwar district. But bundling alone cannot save the country from famine, unless suitable dry farming methods also are introduced into the routine practice of the farmer. Research is needed to find out these suitable methods.

The problems of a fundamental nature will be studied at the central station in the Bombay Presidency, which has already been approved by the Board. The research station proposed by the Hyderabad Agricultural Department will tackle problems of a practical and local nature.

The Hyderabad State has this year started a new main experimental farm for the Karnatak Division at Raichur, which is the headquarters of the Deputy Director of Agriculture for that division. It is proposed to carry on dry farming research at this farm. Raichur district is situated between the Bijapur and Dharwar districts of the Bombay Presidency and the Bellary District of the Madras Presidency. All these three districts are liable to frequent famines. It is for this reason that it is proposed to start the work in Raichur, apart from the fact that there are more facilities, because of the existence of a main farm there.

The estimates submitted with the scheme have been drawn up on lines similar to those which have been approved by the Board for the sub-stations in the Bombay Presidency. Only a few alterations have been made to suit local requirements. The total cost of the scheme comes to Rs. 12,662 non-recurring and Rs. 59,740 recurring for five years. The Hyderabad Agricultural Department can make a contribution to this amount of Rs. 6,437 non-recurring and Rs. 6,582 recurring, i.e., Rs. 13,019 out of the total cost of Rs. 72,402. The Research Council is requested to provide a grant of Rs. 6,225 non-recurring and Rs. 53,158 recurring spread over five years.

(Sd.) N. HYDER,
Offg. Director of Agriculture,
H. E. H. the Nizam's Dominions.

Estimates.

The scheme will cost as follows :—

	Ra.
Non-recurring—	
(a) Buildings	5,925
(b) Equipment	6,737
Total ..	12,662
Recurring for five years.—	
(a) Salaries	35,230
(b) Allowances	6,360
(c) Contingencies	18,150
Total ..	59,740

Thus the total amount required is Rs. 72,402 for a period of five years. The contribution which the Hyderabad Department of Agriculture can make to this expenditure is Rs. 13,019 made up as follows:—

Item.	Total amount in 5 years. Rs.
Buildings, cattle shed, store, implement shed, manure pit and rain gauge	1,900
Equipment: Cattle, implements, weighing machine, fencing and land improvement	4,537
Salary of one junior assistant (Rs. 7,200 H.S.)	6,102
Rent of land	480
Total ..	13,019

BUDGET ESTIMATE.

NON-RECURRING EXPENDITURE.

(a) Buildings.

1. Residential (Kutchha quality):—

Type of staff.	Number of persons.	Square feet required.	Rate per square feet in Rs.	Cost in Rs.	Rs.
Graduate	1	553	1.50	830	
Non-Graduate	1	450	1.50	675	
Coolies	3	480	1.50	720	
					2,225

2. Laboratory and office (temporary quality) 600 square feet at Rs. 3 per square feet

1,800

3. Miscellaneous (kutchha quality):—

Type or building.	Square feet required.	Rate per square feet in Rs.	Cost in Rs.	Rs.
Cattle shed (2 pairs)	400	1.75	700	
Store	600	1.25	750	
Implement shed	200	1.25	250	
Manure pit and rain gauge			200	
				1,900
				Total ..
				5,925

(b) Equipment.

	Rs.	Cost in Rs.
1. Laboratory fittings		1,000
2. Livestock and deadstock—		
(a) 2 pairs of cattle	700	
(b) Implements	600	
(c) Weighing machine	300	
		1,600
3. Fencing 5,740 feet at Rs. 1,900 per mile		2,137
4. Land improvement 40 acres at Rs. 20 per acre		800
5. Lysimeters and shed		500
6. Office furniture		400
7. Reference books		300
		Total ..
		6,737

RECURRING EXPENDITURE.

(a) Salaries.

Name of head.	1st year.	2nd year.	3rd year.	Budget 4th year.	Estimates 5th year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<i>Pay of officer.</i>						
One class II officer at Rs. 250—15—400 p.m.	3,000	3,180	3,360	3,540	3,720	16,800
<i>Pay of establishment.</i>						
One Senior Assistant of subordinate Agricultural service at Rs. 150—10—250 p.m. . .	1,800	1,920	2,040	2,160	2,280	10,200
One Junior Assistant of subordinate Agricultural service at Rs. 110—5—150 p.m. . .	1,320	1,380	1,440	1,500	1,560	7,200
One Kamgar at Rs. 30—2—60 p.m.	360	362	364	366	368	1,820
One clerk accountant at Rs. 80—3—125 p.m. . .	960	963	966	969	972	4,830
One peon at Rs. 12 p.m. . .	144	144	144	144	144	720
Total Rs. H. S.	7,584	7,949	8,314	8,679	9,044	41,570
B. G. @ 18%	6,428	6,737	7,045	7,355	7,665	35,230
<i>(b) Allowances.</i>						
Travelling allowance	600	600	600	600	600	3,000
Conveyance allowance as under—						
(a) One class II officer at Rs. 50 p.m.	600	600	600	600	600	3,000
(b) One graduate assistant at Rs. 15 p.m.	180	180	180	180	180	900
(c) One clerk at Rs. 10 p.m.	120	120	120	120	120	600
Total Rs. H. S.	1,500	1,500	1,500	1,500	1,500	7,500
B. G. at 18%	1,272	1,272	1,272	1,272	1,272	6,360

(c) Contingencies.

Serial No.	Item.	Average annual cost Rupees.
1	Rent of land 40 acres at Rs. 12 per acre	480
2	Field operations	2,000
3	Laboratory expenses and requisites	800
4	Office incidental expenditure	100
5	Annual repairs to buildings	250
	Total for one year	3,630
	Total for five years	18,150

APPENDIX VII.

SUBJECT No. 5.

PROPOSAL BY THE BOMBAY GOVERNMENT FOR THE IMPORTATION OF CERTAIN INSECTS FROM AUSTRALIA FOR THE DESTRUCTION OF PRICKLY PEAR.

Attention is invited to the attached endorsement from the Government of India in the Department of Education, Health and Lands, No. F. 155-A./32, dated the 15th June 1932 forwarding a copy of their letter to the Government of Bombay on the question of the importation of certain insects from Australia for the destruction of Prickly Pear.

The subject is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 20th June 1932.

LETTER FROM M. S. A. HYDARI, ESQUIRE, I.C.S., OFFICIATING DEPUTY SECRETARY TO THE GOVERNMENT OF INDIA, TO THE CHIEF SECRETARY TO THE GOVERNMENT OF BOMBAY, REVENUE DEPARTMENT, No. F. 155-A./32, DATED SIMLA, THE 15TH JUNE 1932.

With reference to your letter No. 8097-A./28, dated the 26th February, 1932 (Enclosure I), I am directed to say that the Government of India consider that before permission is granted for the importation into India of insects known to be destructive to Prickly Pear it would be advisable to ascertain definitely from the Provinces and Indian States concerned whether they desire the elimination of this cactus from their territories. The Government of India, therefore, consider that this question should be referred to the Imperial Council of Agricultural Research for discussion at the next meeting of the Advisory Board of the Council.

The Secretary, Imperial Council of Agricultural Research, will in due course address the Government of Bombay and other local Governments and Indian States concerned on the subject. In the circumstances I am to express the hope that the local Government will agree to defer the question of sanction till the views of the Advisory Board of the Council have been obtained.

No. F. 155-A./32.

Copy of correspondence, together with a copy of a note dated the 16th March, 1932 (Enclosure III), by Mr. Bainbrigg Fletcher, Imperial Entomologist (on leave) forwarded to the Secretary, Imperial Council of Agricultural Research, for necessary action.

By order,

M. S. A. HYDARI,
Officiating Deputy Secretary.

ENCLOSURE I.

COPY OF A LETTER FROM THE GOVERNMENT OF BOMBAY, No. 8097-A./28, DATED THE 26TH FEBRUARY 1932.

I am directed by the Government of Bombay (Transferred Departments) to state that the Commonwealth Prickly-Pear Board, Sherwood, Brisbane, has successfully used an insect (*Cactoblastis cactorum*) for destroying pricklypear in Australia. The question of using an insect to control prickly pear has attracted interest in this Presidency and the military authorities at Poona are anxious to know whether the insect can be utilised in India because in some of their cantonments prickly pear is a serious pest. The Assistant Professor of Entomology, Poona Agricultural College, therefore, approached the Commonwealth Prickly-Pear Board with a view to obtaining a supply of the insect for experimental purposes. Before making a reference he had assured himself that it would not be dangerous to introduce this insect into India. The Board has expressed a willingness to assist

in the control of the prickly pear in this Presidency by forwarding supplies of *Cactoblastis cactorum* and other prickly pear insects, but it is unable to accede to such requests from colleges, institutions or individuals. The Board has promised to entertain the request only when it has received the official sanction of the Government of India. Under rule 3 of the rules under the Destructive Insects and Pests Act, 1914, such parasites may be imported without fumigation if they are accompanied by a special certificate from the Imperial Entomologist to the Government of India but it would appear from the letter from the Officer-in-Charge, Prickly Pear Investigations (Enclosure II), that the Board will not forward the insect without the official sanction of the Government of India. I am, therefore, to request that the Government of India may be moved to accord the requisite sanction.

ENCLOSURE II.

COPY OF A LETTER FROM THE OFFICER-IN-CHARGE, PRICKLY-PEAR INVESTIGATIONS, TO PROFESSOR T. N. JHAVERI, COLLEGE OF AGRICULTURE, POONA, No. A.P.D./H.A.H., DATED THE 11TH SEPTEMBER 1931.

The Secretary of the Queensland Prickly Pear Land Commission has supplied me with copies of recent correspondence with you, including a copy of your letter of April 15th (not printed) addressed to the Scientific Controller, the Prickly Pear Board, Biology Department, University of Queensland. The original of this letter has not been received at this office.

2. Although my Board would without doubt be willing to assist in the control of *Opuntia elatior* in the Bombay Presidency by forwarding supplies of *Cactoblastis cactorum* and other prickly pear insects, it is unable to accede to requests of this nature from colleges, institutions or individuals. The introduction of insects into India must be a matter for your Government to determine, and however anxious my Board might be to assist in the project, it can entertain such requests only when they have received the official sanction of the Indian Government.

ENCLOSURE III.

NOTE BY MR. BAINBRIGGE, FLETCHER IMPERIAL ENTOMOLOGIST, DATED THE 16TH MARCH 1932.

Cactoblastis cactorum is a Pyralid moth introduced from South America into Australia, where it has been very successful in destroying Prickly-Pear (*Opuntia inermis*, *O. stricta* and *O. aurantiaca*). Whether it would attack Indian species of *Opuntia* in the same way is not known. In any case it lives solely (so far as known) on species of *Opuntia* and, from a purely entomological viewpoint, there would be no objection to its introduction into India, as it would be most unlikely to develop a capability of living on any plants other than Prickly Pears.

I would, however, point out that the proviso to the Notification under the Pest Act only permits the importation without fumigation of plants infested with *parasitized* insects with the object of introducing such parasites into India.

I venture to submit, however, that the question of introduction of such insects to destroy Prickly Pear is a much wider one than appears at first sight. Once introduced and well established, it would be impossible to eradicate such insects or to prevent their spread into areas where possibly their activities as destroyers of Prickly Pear are not required.

The conditions in Australia and in India are very different. In Australia there are very large areas, scantily populated and used for grazing purposes, which have been overrun with Prickly Pear, and in such areas the destruction of Prickly Pear by its natural enemies is advantageous. In India there are practically no such areas and Prickly Pear is in many districts looked on as a valuable hedge-plant and as a fodder-reserve for cattle in times of drought.

Over ten years ago I discussed this matter with the Directors of Agriculture of Madras and Bombay, in connection with the possibility of importing Prickly Pear insects into India, and both these officers were of opinion that on the whole Prickly Pear was useful

as a hedge-plant and fodder-reserve and that it would be bad policy to destroy it and I concurred in their opinion on this matter.

Within the last few years a Scale-insect has been spread extensively in Madras with the object of destroying Prickly Pear and I understand that considerable destruction of Prickly Pear has resulted in some districts. There is, however, considerable difference of opinion as to whether such destruction is advisable, and within the last week I have received a complaint from the Guntur District regarding the destruction by this Scale-insect of a Prickly Pear hedge two miles long.

I would, therefore, suggest that before any permission is granted for the importation of further Prickly Pear insects into India, it would be as well to get a definite opinion from the various Governments concerned (*e.g.*, Madras, Bombay, Mysore, Hyderabad, Central Provinces, etc.), as to whether they desire the destruction of Prickly Pear within their areas, for insects of this sort are no respecters of political boundaries and, as already pointed out, once they were introduced and well-established, their spread could not be checked.

APPENDIX VIII

SUBJECT No. 6.

APPLICATION FROM PROFESSOR J. B. SETH, M.A., T.E.S., PROFESSOR OF PHYSICS, GOVERNMENT COLLEGE, LAHORE, FOR A GRANT OF RS. 1,800 PER ANNUM FOR A PERIOD OF TWO YEARS FOR INVESTIGATING AN ELECTRIC METHOD OF HYGROMETRY.

Attention is invited to the attached letter from the Government of the Punjab, No. 1509-D., dated the 29th April 1932 forwarding an application from Professor J. B. Seth for a grant of Rs. 1,800 per annum for a period of 2 years for investigating an electric method of Hygrometry. The scheme involves a total expenditure of Rs. 3,600 spread over a period of 2 years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 26th May 1932.

COPY OF A LETTER FROM THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA S. W., No. 1509-D., DATED THE 29TH APRIL 1932.

SUBJECT:—*Professor J. B. Seth's scheme for investigating an electric method of Hygrometry—Grant of Rs. 1,800 per annum for a period of two years.*

I am directed to forward herewith a copy of a letter No. 41/92-366, dated the 15th April 1932 (Enclosure I), and enclosures (Enclosures II and III), from the Secretary, Punjab Council of Research, regarding Professor J. B. Seth's scheme for investigating an electric method of Hygrometry, and to state that the Punjab Government (Ministry of Agriculture) recommends the scheme for a grant from the Imperial Council of Agricultural Research.

2. One hundred printed copies of Mr. Seth's scheme are being forwarded under separate cover.

ENCLOSURE I.

COPY OF A LETTER FROM THE SECRETARY, PUNJAB COUNCIL OF RESEARCH, TO THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, LAHORE, No. 41/92-366, DATED THE 15TH APRIL 1932.

SUBJECT:—*Professor J. B. Seth's scheme for investigating an electric method of Hygrometry.*

I have the honour to say that Professor J. B. Seth, M.A., T.E.S., Professor of Physics, Government College, Lahore, applied for a grant from the Imperial Council of Agricultural Research of Rs. 1,800 per annum for a period of two years to enable him to employ an M.Sc., graduate in Physics at Rs. 150 per mensem to investigate an electric method of Hygrometry. Professor Seth's application was considered at a meeting of the Punjab Council of Research on 2nd April 1932. The Council recorded its general approval to such a scheme but decided that the scheme as submitted, required elaboration by Professor Seth to bring out more clearly its application to agriculture. Professor Seth was, accordingly, asked to revise his scheme.

2. The Council also decided that on receipt of the revised scheme the opinion of members, as to whether the scheme was then in a suitable form for recommendation to the Imperial Council of Agricultural Research, should be obtained in circulation. This has now been done and of the 10 replies received from members, 9 are in favour of recommending the scheme to the Imperial Council of Agricultural Research, and one considers that the scheme is still too vague.

3. A copy of the scheme (Enclosure II) is now submitted with the request that, if it is approved, it may be forwarded to the Imperial Council of Agricultural Research in time for consideration at the next meeting of the Advisory Board which will probably be held in the first week in June.

4. A copy of the relevant extract from the proceedings of the meeting of the Punjab Council of Research (Enclosure III), which considered the scheme, is also enclosed for information.

ENCLOSURE II.

PHYSICS LABORATORY,
GOVERNMENT COLLEGE, LAHORE.

Dated 6th April 1932.

FROM

J. B. SETH, M.A. (CANTAB.), I.E.S.,
Professor of Physics,

TO

THE SECRETARY, PUNJAB RESEARCH COUNCIL, LAHORE.

SIR,

May I apply for a grant from the Research Council to this laboratory of Rs. 1,800 per year for two years? My object in applying for it is to enable me to appoint an M.Sc. (in Physics) for the two years at Rs. 150 per mensem to investigate an electrical method of hygrometry.

A few years ago it was discovered in this laboratory that the electrical resistance of a carbon (pencil) line drawn on a suitable surface changes with the humidity to which it is subjected. We have so far published two papers on the subject, namely,—

- (1) The effect of Moist Air on the resistance of Pencil Lines in the Proceedings of the Physical Society of London, Volume 41, December 15th, 1928, pages 29-34; and
- (2) Some Experiments with Carbon Lines Resistances, in the Philosophical Magazine of London, March, 1930, pages 415-422.

Besides the above a communication from me appertaining to it has also appeared in the *Nature* (of the 10th October 1931). From the correspondence which this communication to the *Nature* has evoked it has been brought home to me that this form of hygrometry if developed on appropriate lines will prove especially suitable in agricultural and entomological research. Thus Mr. W. H. Smith, Cold Storage Research Officer in the Department of Horticulture, Ontario Agricultural College, Guelph, Canada, writes to say that "such a method would be particularly useful in obtaining standard conditions for cold storage work on fruit, and the advent of an electrical hygrometer will be very welcome". I have also had exchange of papers on the subject with Mr. P. A. Buxton of the London School of Hygiene and Tropical Medicine and Mr. W. H. J. Vernon of the Chemical Research Laboratory, Teddington, Middlesex.

A great desideratum of some of the Research Workers in the field of Agriculture and Entomology appears to be some method of finding the humidity on a surface or in a very limited space and a means of controlling this humidity. The electrical method of hygrometry we are developing in this laboratory which is based, as mentioned above, on the change in resistance of a pencil line drawn on a surface, would appear to be the type of method which these research workers have been in search of, and it also seems that once the electrical hygrometer has been properly developed it can be used also as a humidity controller, which will be again of the exact type required by these workers. Such a humidity controller will also, I am told, be useful in fruit and food preservation work, and in short be of use to agriculturists in general.

It would thus be evident that this electrical method of hygrometry will prove to be of special benefit in agricultural and entomological research, and it is hoped the Council will make the small grant for which I am applying. If the grant is sanctioned, the man selected will work under me in the Physics Laboratory of the Government College, Lahore, which will supply him all the materials and apparatus required for the research.

I have, etc.,

J. B. SETH, M.A. (CANTAB.), I.E.S.,
*Professor of Physics, Government College,
 Lahore.*

ENCLOSURE III.

EXTRACT FROM PROCEEDINGS OF THE SIXTH MEETING OF THE PUNJAB COUNCIL OF RESEARCH HELD IN THE OFFICE OF THE FINANCIAL COMMISSIONER (DEVELOPMENT) PUNJAB, ON SATURDAY, THE 2ND APRIL 1932, AT 11-0 A.M.

* * * * *

Item No. 2.

The Vice-President asked Professor Seth to explain how his method can be of use to agriculture.

Professor Seth said that the electrical method of Hygrometry to be investigated would be of indirect benefit to agriculture.

Dr. Bhatnagar asked whether the method would be important in determining soil moisture. He felt that there are plenty of methods already for ascertaining air moisture.

Professor Seth agreed with the latter point and thought it would help in determining the former.

Dr. Bhatnagar thought that reference should be made in the scheme to its usefulness in connection with the determination of soil moisture. He felt that the objects of the scheme should be more clearly stated.

Mr. Afzal Hussain said a method of determining such moisture is greatly needed in entomological research.

In reply to a question by the Vice-President—

Professor Seth agreed that apart from the one man asked for in the scheme, the other facilities would be provided from his own laboratory.

Mr. Milne thought that the scheme might be considered to be mainly of scientific interest.

Captain Whittaker thought that as the amount asked for was small and the scheme was likely to be of importance to the agriculturist, it should be supported.

The Vice-President felt that the scheme required some elaboration to bring out its bearing on agriculture.

The Council finally recorded its general approval to such a scheme, and decided that the present scheme be elaborated by Professor Seth to bring out its application to agriculture.

By 8 votes to 6, it was decided that the revised scheme when received be circulated to members for opinion, as to whether it should be recommended to the Imperial Council of Agricultural Research.

APPENDIX IX.

SUBJECT No. 7.

APPLICATION FROM DR. A. N. PURI, PH.D., D.Sc., A.I.C., PHYSICAL-CHEMIST, IRRIGATION RESEARCH LABORATORY, LAHORE, FOR A GRANT OF RS. 13,500, SPREAD OVER FIVE YEARS, TO CONTINUE HIS WORK ON "THE STANDARDISATION OF PHYSICO-CHEMICAL 'SINGLE VALUE,' MEASUREMENTS MOST SUITABLE FOR INDIAN SOILS".

Attention is invited to the attached letter from the Government of the Punjab, No. 1494-D., dated the 28th April 1932, forwarding an application from Dr. A. N. Puri for a grant to continue his work on "the Standardisation of Physico-Chemical 'single value' measurements most suitable for Indian soils". The scheme which is fully explained in Dr. Puri's letter No. 622, dated the 10th March 1932 (Enclosure II) involves an expenditure of Rs. 13,500 spread over a period of five years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 28th May 1932.

COPY OF A LETTER FROM THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA S. W., No. 1494-D., DATED THE 28TH APRIL 1932.

SUBJECT.—*Application of Dr. Puri for a further grant of Rs. 13,500 from the Imperial Council of Agricultural Research to continue his work on "the Standardisation of Physico-Chemical 'single value' measurements most suitable for Indian soils" for five years.*

With reference to the correspondence ending with my letter (not printed) No. 854-D., dated the 29th March 1932, I am directed by the Punjab Government (Ministry of Agriculture) to forward herewith for consideration at the next meeting of the Imperial Council an application from Dr. Puri for a further grant of Rs. 13,500 to continue his work on "the standardisation of Physico-Chemical 'single value' measurements most suitable for Indian soils" for five years.

2. Dr. Puri has since obtained an appointment in the Irrigation Research Laboratory of the Irrigation Branch, Public Works Department, Punjab, Lahore, and so is no longer free to devote his whole time to the investigation. Dr. Puri has accordingly asked for provision for the employment of two Research Assistants having M.Sc. qualifications who will carry out the work under his direct supervision in consultation with Dr. McKenzie Taylor, Scientific Research Officer, Irrigation Department, Punjab.

3. Dr. Puri's application, which was received through the Chief Engineer, Irrigation Branch, Punjab, under whom Dr. Puri is employed, was considered by a sub-committee of the Punjab Council of Research appointed for the purpose. The sub-committee's report and the scheme itself were then considered by the Punjab Council of Research at its meeting held on the 2nd April 1932, when it was unanimously decided to recommend the scheme to the Imperial Council subject to the condition that the work should be done in consultation and collaboration with experts in the Agricultural Department, Punjab, working on soils. The following papers connected with the application are enclosed :—

- (a) A copy of letter (Enclosure I) No. 5659-Nor., dated the 24th March 1932, in which the Secretary to Government, Punjab, Public Works Department, Irrigation Branch, has intimated his willingness to provide the necessary facilities for the work being carried out in the Irrigation Research Laboratory;
- (b) A copy of the sub-committee's report (Enclosure III) on the application (Enclosure II), and

(a copy of the relevant proceedings of the Punjab Council of Research (Enclosure IV).

4. In conclusion I am to add that the Punjab Government (Ministry of Agriculture recommends the application of Dr. Puri to the Council for the provision of funds subject to the condition noted in paragraph 3 above. Necessary arrangements are being made to supply 100 printed copies of the scheme to the Council as soon as possible.

ENCLOSURE I.

No. 5659-Nor.

FROM

R. P. HADOW, Esqr., C.I.E.,
Secretary to Government, Punjab,
Public Works Department, Irrigation Branch,

TO

THE SECRETARY,
PUNJAB RESEARCH COUNCIL.

Dated Lahore, the 24th March 1932.

SIR,

I am directed to forward for favour of disposal by the Punjab Council of Research the enclosed application of Dr. Amar Nath, Puri, Ph.D., D.Sc., A.I.C., Physical Chemist Irrigation Research Laboratory, Lahore, for a grant to enable him to carry out a research scheme on the standardization of methods for single value measurements on Indian soils.

2. In as much as the results of the proposed investigations would be of direct value in connection with reclamation problems and being studied in the Irrigation Research Laboratory, I see no objection to the scheme being carried out, as proposed in the Irrigation Research Laboratory, by the staff applied for under the direct supervision of Dr. Puri in consultation with Dr. E. McKenzie Taylor, Scientific Research Officer.

I have the honour to be,

SIR,

Your most obedient servant,

W. G. DENCH,

Under-Secretary,

for Secretary to Government, Punjab,

Public Works Department, Irrigation Branch.

Enclosure.—The application.

ENCLOSURE II.

No. 622.

FROM

DR. AMAR NATH, PH.D., PH. D., D. Sc., A.I.C.,
Physical Chemist, Irrigation Research Laboratory,

Lahore.

TO

THE SECRETARY,
IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA.
(Through Proper Channel).

Dated Lahore, the 10th March 1932.

SIR,

In continuation of my letter, dated 8th August, 1931, I have the honour to say that the grant very kindly given by your Council enabled me to carry on work on the

standardization of methods for single value measurements on Indian soils for ten months, during which time I was able to devise four new methods for the examination of soils. As I have stated in my previous letter, this by no means exhausts the work that has to be done on Indian soils, and I am very anxious to bring the whole investigation to completion when a monograph on Indian soils could be published or a series of papers produced dealing with all the aspects of the question.

For your kind information I will outline briefly the importance of the work on single value measurements in soils.

A proper understanding of the relation between soil conditions and plant growth is absolutely essential for any advancement towards placing agriculture on a rational and scientific basis. Attempts in this direction in the past have been mainly confined to the measurement of certain ill-defined properties which roughly correlated with the behaviour of the soil in the field. However, as the work in this direction advanced it became more and more apparent that no further progress would be possible unless and until our methods of measurements were devised with the precision of theory and experiment associated with pure sciences. The essential features of any method of measurement in soils should be—

- (1) Reproducibility, *i.e.*, the method should give substantially the same results at the hands of different workers.
- (2) As far as possible, it should be free from any arbitrarily fixed conditions necessary for reproducibility, such as the employment of a special apparatus with rigidly defined specifications.
- (3) It should aim at the attainment of some sort of equilibrium and not stop short at an arbitrarily fixed point in the course of a reaction.
- (4) It should be simple both in theory and practice, and as far as possible fool-proof so that very high manipulative skill not be essential for its successful working. This is especially important for a country like India where systematic work in soils is still in its infancy, and for the collection of vast amount of data regarding soils, highly skilled experimentalists are neither available nor procurable.

The prevalence of different methods in different countries for the measurement of the same factor in soils, has been painfully reflected in this country; and at the present times the various agricultural laboratories in India are employing different methods of study; and I believe the same difficulty will be encountered in India at the time of co-ordinating soil research as is being faced by the International Society of Soil Science; namely, the reluctance of individual laboratories to agree to give up a mass of data in adopting a new method, however improved.

The importance of soil work having been universally recognised, it is inevitable that henceforth greater attention will be paid to this aspect of agricultural research, and too much emphasis cannot be laid on the fact that unless a serious attempt at standardization of methods suitable for Indian soils is made at this stage any attempt at co-ordination at a later date would not be possible, and, if at all, would involve an enormous amount of labour in the reconciliation of conflicting views.

With the object of placing before the scientists in general and workers in India in particular, I collected a number of representative samples from all parts of the country, and have been working on these soils for the last five years. As a result of my researches the following methods have been standardized and can be recommended for use to soil workers in India:—

- (1) A new method of dispersing soils for mechanical analysis (Mem. Dept., Agri., Ind., Chem. Ser., Vol. 16).

This method is one of the simplest and least drastic of all the preliminary treatments for dispersing soils for mechanical analysis and has been found suitable for all types of soils found in India. Under the auspices of the International Society of Soil Science this method is being examined by Professor Robinson who has written to me that my

method, with slight modification, could be used even for humus soils, which of course are rarely found in India.

- (2) A new method of estimating total carbonates in soils (Bull. Agril. Res. Inst. Pusa, No. 206).

All method of estimating carbonates in soils hitherto suggested are tedious and time consuming besides requiring elaborate and costly apparatus. The new method is extremely simple involving only one single titration. With this method it is possible to examine a large number of soils within a short time.

- (3) A new method of studying rate of percolation of water through soils (Agri. Jour. India, Vol. 24).

All the methods of studying percolation of water through soil hitherto suggested suffered from the defect that there was no standard method of packing the soil sample, and since the percolation of water depends on the manner of preliminary packing of the soil the results had not so far been reproducible at the hands of different workers. This difficulty has been overcome by the device of a special percolating cylinder in which the packing is done by the natural settling of the soil in water. The method has been shown to differentiate between barren alkali soil and good agricultural soils.

- (4) A new method of determining lime requirement of soils (Mem. Dept. Agri. Ind. Chem. Ser., Vol. II, No. 1).

It is a simple method involving titration with lime water in the presence of Bromthymol blue indicator. The method has been shown to give good indication of lime requirement of soils by actual field experiments at Dacca representing typical lateritic soil of Bengal.

- (5) Electrofiltration a new method of removing exchangeable bases from soil colloids (Soil Science, Vol. 31, No. 2).

The use of electric current for removing exchangeable bases from soils was first suggested by Mattson whose electro dialysis cell is well known. Mattson cell as well as its subsequent modifications suffer from the defect that they are costly and slow in action. The apparatus devised by the writer and recommended for use is very cheap and can be made in any laboratory workshop, and being based on a slightly different principle is very much quicker in action.

- (6) A new method of estimating total exchangeable bases in soils (Soil Science, Vol. 31).

Bases in soils exist in two forms: Free as carbonates, or combined with the colloidal complex. The latter are sometimes spoken of as "absorptively bound" or exchangeable bases. The evaluation of total exchangeable bases is of great importance in any system of genetic classification of soils. The methods hitherto suggested, besides being tedious suffer from the defect that free bases (carbonates) as well as soluble salts present in the soil introduce errors the magnitude of which is not determinable. It was felt that for routine work a rapid and fairly accurate method that could be carried out with the minimum of equipment would be needed. The method suggested by me consists in the determination of carbonates by my titration method, and of total, bases by dilute HCL treatment; the difference between the two values giving the exchangeable bases.

- (7) A method for studying soil tilth. (Mem. Dept. Agri. Ind. Chem. Ser., Vol. 11, No. 2).

The condition of the soil known as "good tilth" is associated with the state of a aggregation of individual particles into crumbs or compound particle. Variations in soil tilth are chiefly brought about by soil colloids particularly with reference to their flocculated or deflocculated condition. For instance, in a general way, we know that hard impervious heavy soils go into suspension readily when shaken with water, whereas soils having good tilth rarely show much suspended matter when shaken with water. Various methods for studying the state of aggregation of soil particles have been suggested from time to time such as simple shaking with water for a number of hours, rubbing, churning, boiling, etc. None of these, however, is reproducible in the hands of different workers. Besides, the nearest approach to the field condition cannot be obtained by any treatment that might alter the state of aggregation of the particles.

A method for measuring the degree of dispersion was evolved by the writer which consists in the determination of conventional clay (0.002 mm. diameter) by the pipette method after having the soil in contact with water for 24 hours (referred to as Dispersion Factor, D. F.) and expressing it as percentage on the total clay content of the soil obtainable on complete dispersion. This is referred to as Dispersion Co-efficient (D.C.) or D.C.-D. F. $\times 100/\text{Clay content}$. In other words Dispersion Co-efficient measures the percentage of the total clay that can pass into the suspensoid state by simple contact with water, and its value varies from zero to 100 per cent. depending as to whether soil is completely flocculated or completely dispersed.

Dispersion Co-efficient can be used for comparing the state of aggregation of particles in different soils and in general shows a positive correlation with the degree of alkalization in a given soil. All barren alkali soils, rich in exchangeable Na, show a high Dispersion Co-efficient (above 50 per cent.) Successful treatment of a barren alkali soil with gypsum results in a substantial lowering of the Dispersion Co-efficient and where the response is poor the change in this value is slight.

- (8) A simple method of determining sticky point of soils (Agri. Jour. India Vol. 25).

The standard technique for sticky point determination requires two weighings as well as drying in the oven for 24 hours. The new technique involves only one rough weighing and is so simple that it could be carried out even on the field.

- (9) A new type of hydrometer for the mechanical analysis of soils.

The use of hydrometer for the mechanical analysis of soils was first suggested by Bouyoucos. Apart from the serious criticisms to which the method has been subjected by Keen, Bouyoucos own comparison of results obtained by his method and those by the standard mechanical analysis method, do not show a good agreement. In the modified form the writer has aimed at producing an instrument of precision which might possess all the advantages of simplicity, accuracy, and reproducibility, and at the same time should have some fundamental basis for its working. The new type of hydrometer can be constructed in the laboratory by anyone possessing a moderate skill in glass blowing, and a special reading device enables one to take readings within the fraction of a millimeter and obviates the necessity of paving a paper scale in the hydrometer stem.

- (10) A new method of determining clay content of soils by moisture absorption at 70 per cent. humidity.

There has been so far no uniform basis for expressing hygroscopicity of soils. The conception of Hygroscopic Co-efficient, *i.e.*, the percentage of moisture taken up by dry soil from an atmosphere saturated with water vapours is an old one, and at one time was regarded as a very important constant for characterising a particular soil. The difficulty of maintaining a saturated atmosphere for any length of time led Hatcherlich to suggest that hygroscopicity of the soil should be determined by bringing it in equilibrium with the partial pressure of water vapour afforded by 10 per cent. H_2SO_4 (*i.e.*, 96 per cent. humidity). Somewhat similar considerations led the American Bureau of soil workers to recommend 3.3 per cent. H_2SO_4 (*i.e.*, 99 per cent. humidity) for the same purpose. All these concentrations are, however, fixed arbitrarily, and there are no valid grounds for the belief that they represent any fundamental advance on the original conception of the Hygroscopic Co-efficient.

Moisture from the vapour phase may be absorbed by soils in three ways. It may enter into loose chemical combination and exist as water of hydration; it may be taken up in the minut capillaries on the surface of individual particles; or it may fill up the interstitial spaces between the aggregates of various particles. The vapour pressure curve for soils, therefore, can be split up into three portions representing three forms of hygroscopic moisture, *viz.*, hydration, capillary absorbed, and interstitial. The first depends on the constitutional nature of soil colloids, the second on their surface area, and the third on their state of aggregation.

Though a sharp distinction cannot be made between the three forms of moisture there is evidence to show that we shall not be far wrong in considering 10 per cent. humidity as marking the end of the first form and 70 per cent. humidity as the end of the second form. Since the second form is dependent on the total surface area, clay content of a

soil can be estimated from moisture absorption between 10-70 per cent. humidity by the help of an empirical formula.

(11) A new manometric apparatus for the mechanical analysis of soils.

The subject of mechanical analysis of soils has received a good deal of attention from soil workers during recent years. The modern tendency has been to express the mechanical composition of a soil in the form of a continuous curve, and many ingenious methods have been suggested for this purpose. Most of these methods require complicated apparatus and are only suitable for comparatively coarser fractions. They also require a constant temperature room for their successful working. The apparatus devised by the writer for this purpose can be constructed in any laboratory with a little skill in glass blowing, and is capable of being used in a constant temperature bath. The apparatus is also useful for extremely fine suspensions—a feature which is not present in any other instrument.

(12) A new method of determining the state of saturation and pH value of soils.

The state of saturation of the soil—(V) is defined as the ratio of the amount of absorptively bound bases in the soil (S) to the amount of bases the soil is capable of binding (T), both values being expressed in equivalents. (V) is a very important constant for soils but, the utmost confusion prevails in soil literature as regards its experimental determination. Most of the methods depend on the absorption of $\text{Ba}(\text{CH}_3)_2$ by soils, and in the case of soils containing bicarbonates, a part of $\text{Ba}(\text{CH}_3)_2$ is converted into insoluble carbonates, and appears as if absorbed by the soil, thus introducing considerable error in the determination.

The method devised by the writer depends on the interaction between ammonia and soils so that the amount of ammonia that a soil can take up is directly proportional to its degree of saturation. From the values of (V) thus obtained, it is possible to calculate the lime requirement as well as the approximate pH value of the soil.

The last four methods constitute the work done during the ten months for which the Imperial Council of Agricultural Research gave me a grant. The above forms a part of the work on single value measurements on Indian soils, a good deal still remains to be done to make the investigation complete and comprehensive. The following are the lines on which further work is necessary:—

1. The most suitable method for the determination of soil reaction in Indian Soils.

The methods so far suggested for this purpose are:—

- (a) Electrometric.
- (b) Colorimetric.
- (c) Quinhydrone.
- (d) Antimony electrode.

It is found that different methods show different results. Not only this, but each method shows variations depending on the conditions under which the determination is made. It is, therefore, very important that the various methods should be compared with reference to Indian soils, to bring out the most suitable one.

2. The most suitable method for determining soluble salts in soils.

Soluble salts in soils are determined by shaking the soil with water, filtering and then analysing the filtrate. This would be simple enough if that was all, but such determination are profoundly influenced by the soil water ratio, the time of shaking, the type of filtering device, the presence or absence of CO_2 in the water, etc. The electrical conductivity or the freezing point of the suspension have also been used for measuring the absolute salt content of soils, but these methods are also subject to similar errors.

A knowledge of the concentration of soils solution is very important, and it is very necessary that a uniform method should be standardized for Indian soils.

3. Method for determining the calcium requirement of alkali soils.

It is well known that soils rich in exchangeable sodium can be corrected at least temporarily by the addition of gypsum or other calcium salts to them. However, it is necessary to be able to find out the amount of calcium salts that would be required to correct a particular soil. Some of these methods have been indicated by the writer, but it is essential that a comparison of these methods should be made under identical conditions, and the most suitable method for all types of such soils evolved.

4. A method for the mechanical analysis of soils as they exist in the field.

Almost all the methods of mechanical analysis so far suggested aim at maximum dispersion. The results thus obtained though valuable leave something to be desired; in other words, they do not show the condition of the soil as it exists in the field. A method that would cause the least disturbance in the soil is needed; this alone can show the true mechanical analysis of the soil as it exists in the field.

5. Most suitable method for expressing the Wilting Co-efficient of soils.

Wilting Co-efficient of soils is defined as the minimum moisture content below which the plants are unable to extract water from it and consequently wilt away. It was considered a very important measurement in soils at one time; but the interest in it soon declined because it was found to depend on two variable factors, viz., the nature of the soil and the nature of the plant.

Certain preliminary observations made at Lyallpur have opened a new line of attack. For instance, it is found that the Wilting Co-efficient is best expressed not as the moisture content but the vapour pressure of the soil. In this way there are indications that all types of soils would show wilting point with respect to a particular plant at the same vapour pressure. Therefore if this correlation is worked out for a number of plants it would become a simple matter to determine when a particular crop would require watering by measuring the vapour pressure of the soil.

6. Standardization of method for evaluating soil fertility.

A number of methods have been suggested from time to time which are supposed to give some idea of soil fertility from measurements carried out in the laboratory. A comparison of these methods with Indian soils is necessary for it is very important in connection with colonization and irrigation extension schemes that we should be able to gain some idea of the value of the land by examining soil samples in the laboratory.

Laboratory facilities for carrying out the above work are available at the Irrigation Research Laboratory, but suitable assistance is required for carrying out the routine work which will be done under my direct supervision in consultation with Dr. McKenzie Taylor—the Scientific Research Officer of this department,—and in consultation and collaboration with experts in the Agricultural Department working on soils. The work will take 5 years for completion. I therefore request your Council may be pleased to sanction a grant of Rs. 13,500. to cover the 5 years' period or an annual grant of Rs. 2,700 as follows:—

Rs. 200 per mensem, the pay of two Research Assistants—one a physicist and the other a chemist at Rs. 100 per mensem each, and Rs. 25 per mensem the pay of one laboratory attendant.

I have the honour to be,

Srs,

Your most obedient servant.

A. N. PURI,

Physical Chemist,

Irrigation Research Laboratory, Lahore.

ENCLOSURE III.

PROCEEDINGS OF A MEETING OF THE SUB-COMMITTEE OF THE PUNJAB COUNCIL OF RESEARCH HELD ON 31ST MARCH 1932 AT 4 P.M. AT THE UNIVERSITY CHEMICAL LABORATORIES, LAHORE, TO EXAMINE THE REVISED SCHEME OF DR. A. N. PURI FOR CONTINUING HIS WORK ON THE STANDARDIZATION OF METHODS FOR SINGLE VALUE MEASUREMENTS IN SOIL.

The following were present :—

Dr. Dalip Singh.
 Professor P. C. Speers.
 Professor J. B. Seth.
 Dr. A. N. Puri.
 Professor S. S. Bhatnagar.

Resolved that in view of the fact that the Imperial Council of Agricultural Research financed this scheme in the past and it appears to have produced interesting and useful results, this Sub-Committee is of the opinion that Dr. Puri's present application should be recommended to the Imperial Council of Agricultural Research.

(Sd.) S. S. BHATNAGAR,
Convener.

The 31st March 1932.

ENCLOSURE IV.

EXTRACT FROM THE PROCEEDINGS OF THE SIXTH MEETING OF THE PUNJAB COUNCIL OF RESEARCH HELD IN THE OFFICE OF THE FINANCIAL COMMISSIONER (DEVELOPMENT), PUNJAB, ON SATURDAY, THE 2ND APRIL 1932, AT 11-0 A.M.

* * * * *

3. Dr. Puri's revised Scheme for extension of the Grant to carry on work on "The Standardization of Physico-Chemical Single Value measurements most suitable for Indian Soils", together with the report of the Sub-Committee appointed to examine it.

* * * * *

Item No. 3.

Mr. Milne felt that the work proposed in the scheme is such as should be done by Dr. Puri personally and not by less qualified men working under his guidance as proposed. The work also required collaboration with work already going on on these lines at the Punjab Agricultural College, Lyallpur.

Dr. Bhatnagar said that the method employed by Dr. Puri is different from those adopted at Lyallpur or elsewhere. The work, he felt, would be done by Dr. Puri himself but he did require some Assistants to help him.

R. S. Jai Chand referred to paragraph No. 5 in the scheme requiring physiological study. He saw no provision in the scheme for dealing with this side of the work. Certain of the contemplated items of work had a closer connection with physiology than with Chemistry.

Mr. Milne referred to the conditions on which Dr. Puri's last grant was made. One of the conditions attached to the grant was that the grant was not made to cover routine analysis of a large number of soils but was intended for the critical study of fundamental methods to be investigated in sufficient detail to show whether or not they were suitable for adoption as standard methods.

Dr. Bhatnagar said that the method could only be standardised if applied to a large number of soils.

Dr. McKenzie Taylor said that Dr. Puri had a series of soils which required intensive study and felt that there was no question of conducting routine analysis. In reply to

a question by the Vice-President he said that he is prepared to act in a consultative capacity.

Messrs. Milne and Bhatnagar felt that it should be clearly stated that the investigation would be carried out in close consultation and collaboration with certain aspects of the work now being done at Lyallpur.

The Vice-President asked whether the Council could say in forwarding the scheme to Government that the collaboration of specialists in the Agricultural Department was assured.

R. S. Jai Chand considered that the extent of the collaboration should be stated.

Mr. Afzal Hussain felt that the scheme was so elaborate that two Assistants are insufficient.

The Council finally decided to recommend the scheme to the Imperial Council of Agricultural Research subject to it being stated that the work would be done in consultation with experts at Lyallpur.

APPENDIX X.
SUBJECT NO. 8.

**CHEAPENING THE COST OF WIRE FENCING USED FOR THE PROTECTION OF
 CROPS AGAINST WILD ANIMALS.**

Attention is invited to the attached note (Enclosure I) on the subject mentioned above which was circulated to the Advisory Board of the Imperial Council of Agricultural Research at its meeting held in June 1931 and the discussions thereon at the Board (Enclosure II). A copy of the relevant papers was forwarded (Enclosure III) to the Indian Tariff Board in September 1931 for consideration in connection with the question of the Wire and Wire Nail Industry which was then engaging their attention.

2. The Indian Tariff Board, whose report has since been published, have recommended (Enclosure IV) the exclusion from the Protective duty of barbed and stranded fencing wire and wire nettings. This is satisfactory so far as it goes but it will be necessary to watch the matter carefully and see that fencing wire is not subjected to a Protective duty when the question of substantive, in place of temporary, protection of the wire and wire nail industry comes up.

3. It will be seen from Enclosure II that the Advisory Board recommended that the duty on wire fencing, for whatever purposes imported, should in the interests of Indian Agriculture be abolished. In view of the prevailing acute financial stringency, however, it is considered that a more favourable opportunity must be awaited for taking up the question of the total removal of the duty.

These papers are now for the information of the Advisory Board.

CHARAN DAS,
 Secretary.

The 31st May 1932.

ENCLOSURE I.

COPY OF A NOTE BY MR. M. S. A. HYDARI, I.C.S., SECRETARY, IMPERIAL COUNCIL OF
 AGRICULTURAL RESEARCH, DATED THE 19TH MAY 1932.

SUBJECT:—*Cheapening the cost of wire fencing used for the protection of crops against wild animals.*

At the conference convened in Simla in October 1928 to consider the Report of the Royal Commission on Agriculture, the point was raised (i) that the duty on wire fencing acts as a deterrent to its more general use for the protection of crops from the depredations of wild animals. It was suggested that such fencing should be brought within the scope of recommendation No. 71 of Chapter IV of the Royal Commission's Report and that wire fencing sold through the Agricultural Department or certified by it to be definitely used for agricultural purposes should be admitted duty free. Since that Conference another suggestion has been placed before the Council, viz., (b) the possibility of exempting from duty woven wire fencing which is little used for purposes other than agricultural.

2. The Commerce Department to whom both the points were referred are of the opinion that none of the suggestions can be accepted. Suggestion (a) offends against the principle that the rate of duty on any article should not depend on or vary with the intention of the importer; as regards (b) an examination of the proposal shows that it is not possible to find a specification which would exclude articles used for other than agricultural purposes. In regard to (b) it is further stated that this suggestion should be looked at mainly from the points of view of the interests of manufacturers of wire and wire products in India and loss of revenue. The Indian firm manufacturing wire and wire products has applied for protection and the question of regranting protection to such manufacturers has been referred to the Tariff Board.

3. It is now for the consideration of the Advisory Board whether in the circumstances explained in paragraph 2 above the Council should let the matter drop.

ENCLOSURE II.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD, JUNE 1931.

* * * * *

Cheapening the cost of wire fencing used for the protection of crops against wild animals.—After the Chairman had introduced the subject Dr. Hyder made an impassioned appeal against sacrificing the interest of the agriculturists for the sake of a few industrialists. He said that wire fencing was useful not only for protection against wild animals but also against the depredations of tame ones. He was not impressed with the argument that it was not possible to find a specification which would exclude wire fencing used for other than agricultural purposes. It should not be, in his opinion, beyond the wit of the Customs authorities to work out a specification. If it was impossible to do so then he would rather that all woven wire fencing were admitted free of duty. Seventy-five per cent. of the 350 millions of the population of India were agriculturists. Though everyone realised his importance to the economic life of the country the agriculturist had few supporters when there came a conflict between his interests and those of the industrialist. The gradual protection of indigenous industries at the expense of the agriculturist had been going on for the last few years and he thought that time had come to cry a halt. He quite realised that if a few Indian industrialists interested in wire production claimed protection they would in the end obtain it. But it was in any case up to this Board which had solely the interests of the agriculturists to safeguard to make a stand for the latter (Applause). Mr. Milne said that while he fully appreciated what had fallen from Dr. Hyder he saw one or two difficulties. One was that much of the woven wire fencing imported into India was not used for agricultural purposes. Out of the Rs. 20—30 lakhs worth of wire fencing including all sorts imported, a great portion was probably used for engineering and building purposes. This being so what was required was a definition which would differentiate between wire used for agricultural and that used for other purposes. Dr. Agharkar invited the Board to consider the realities of the position. There were very few cultivators in India who used wire fencing or were in a position to do so. Wire fencing was used principally on Government Farms and by a few rich land owners. The customs duty was no hardship for them. Mr. Main disagreed with Dr. Agharkar. Fencing, in his opinion, represented a distinct advance in agricultural improvement. Agricultural Departments should therefore do all they could to encourage the greater use of fencing and anything like a duty which tended to discourage its use should be done away with. In the Southern Division of the Bombay Presidency, for example, they had 6 lakhs of acres menaced by wild pig. In this area there were already 42 miles of fencing half of which was stone wall and half wire fencing. The cost worked out at about Rs. 1,100 per mile. They could save Rs. 165 per mile if the duty was removed. Dr. Hyder enquired whether certain ranges of woven wire fencing could not be exempted. Mr. Milne replied that that would hardly be practicable as fencing which could be used for the protection of fields could also be used for building and engineering purposes. Dr. Hyder said that another benefit which would accrue from the greater use of wire fencing would be the saving from destruction of minor forests which were at present being denuded to provide fencing. Colonel Olver said that from the Animal Husbandry point of view also the increased use of wire fencing for stock farms was necessary. Rao Bahadur Ananda Rao said that in Madras there were not half a dozen large proprietors who used wire fencing. There was no immediate prospect of wire fencing being used. In Madras prickly pear provided a natural, efficient and cheap fencing. The cost of wire fencing in Madras worked out at about Re. 1 per yard. Mr. Henderson said that in order to avoid the difficulty of defining wire fencing for agricultural purposes a rebate might be given for every mile of erected fencing. He was informed that this suggestion had been examined but found impracticable. Dr. Hyder suggested that a conference should be held as between the representatives of the Agricultural Departments and the Commerce Department so as to come to some agreed solution of the question. He was informed that this had been done but without success.

In the result the Board recommended that the duty on wire fencing for whatever purposes imported should in the interests of Indian agriculture be abolished.

ENCLOSURE III.

COPY OF A LETTER FROM THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO THE SECRETARY, INDIAN TARIFF BOARD, STONEHOUSE HILL, COTACAMUND, NO. 2244/A., DATED THE 14/17TH SEPTEMBER 1931.

SUBJECT:—*Cheapening the cost of wire fencing used for the protection of crops against wild animals.*

In connection with the question of the Wire Nail Industry which is now engaging the attention of the Tariff Board I am directed to state that at the meeting of the Board of agriculture, held at Pusa in December 1929, a special sub-committee consisting of the Officers* noted below, was appointed "to review the progress made in regard to the protection of crops from the depredations of wild animals since 1925, and to advise whether the recommendations made by the Board of Agriculture in that year require modifications in the light of the knowledge and experience now available". The Committee after a very careful examination of the entire question recommended *inter alia* that "in view of the importance of extending the use of wire fencing for crop protection the Committee would support any suggestion to bring such fencing within the scope of Recommendation 71 of Chapter IV of the Royal Commission's report and considers that it should be exempt from import duty. In view of the difficulty of deciding whether fencing is imported for agricultural purposes or not, a rebate of the import duty paid should be given on the recommendation of an officer duly authorised to grant certificates to this effect. If this proposal is not feasible, as an alternative the Committee recommends that specified types of woven wire fencing, mainly or entirely used for agricultural purposes, should be exempt from duty. The report of the Committee in this respect was adopted by the Board.

2. This particular recommendation of the Board of Agriculture was taken up for consideration by this Department and it was ultimately decided that the question should be placed before the Advisory Board of the Imperial Council of Agricultural Research before any further action was taken. I am to forward herewith, for favour of consideration by the Tariff Board, a copy of Mr. Hydari's Note, dated the 19th May 1931 (Enclosure I) circulated to the members of the Advisory Board in June last and record of the discussion (Enclosure II) at the Board on the subject.

ENCLOSURE IV.

EXTRACT FROM REPORT OF THE INDIAN TARIFF BOARD ON THE GRANT OF PROTECTION TO THE WIRE AND WIRE NAIL INDUSTRY,

* * * * *

17. In addition to plain wire and wire nails the Indian Steel and Wire Products No duties proposed on other propose to commence the manufacture of barbed wire and wire products. stranded fencing wire for which the necessary machinery has been purchased.

*1. Mr. F. J. Plymen, C.I.E., A.C.G.I., Director of Agriculture, Central Provinces (Chairman).

2. Mr. T. Bainbrigg Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, Imperial Institute of Agricultural Research, Pusa.

3. Mr. P. V. Isaac, B.A., D.I.C., M.Sc., F.E.S., Second Entomologist (Depterist), Pusa.

4. Rao Saheb B. P. Vagholkar, Deputy Director of Agriculture, South Central Division, Bombay Presidency.

5. Mr. P. B. Richards, A.R.C.S., F.E.S., Entomologist to Government, United Provinces.

6. Mr. C. Mayadas, M.A., B.Sc., Principal and Professor of Agriculture, Agricultural College, Cawnpore.

7. Mr. Mohd. Afzal Husain, M.Sc. (Pb.), M.A. (Cantsb.), I.A.S., Locust Research Entomologist, Imperial Council of Agricultural Research, Lyallpur.

8. Mr. F. D. Odell, M.A., Deputy Director of Agriculture, West Central Circle, Magwe, Burma.

It is now in course of erection and we have therefore not been able to examine its working. The importance of wire fencing from the point of view of crop protection is a matter to which our attention has been drawn by the Imperial Council of Agricultural Research. We have had no opportunity of estimating the burden which the protection of this class of wire would impose on the agricultural interests concerned. Our aim in this enquiry has been to provide a scheme of temporary assistance for the industry which will place it in approximately the same position as before protection was withdrawn and we do not consider it desirable to extend the scope of assistance till conditions are ripe for a full examination of the case for substantive protection. Accordingly we recommend that the duty we have proposed should apply to (1) iron or steel wire of all kinds other than barbed and stranded fencing wire, wire rope and wire netting and (2) wire nails, and further that the existing arrangement for exempting wire rod imported by the Indian Steel and Wire Products from duty should be continued. We recommend also that the protection of the Wire and Wire Nail industry should be examined fully in connection with the next Statutory Steel enquiry. If it is found then that the proposed rod mill has been installed and wire is manufactured out of indigenous material, there will naturally be a strong case for considering the grant of protection on a scale sufficient to ensure the full development of the industry. The question of the tariff treatment required for bars less than $\frac{1}{2}$ ft. which is intimately connected with the proposal to erect a rod mill could then be examined in relation to the general scheme of protection for steel.

APPENDIX XI.

SUBJECT No. 9.

APPLICATION FROM THE GOVERNMENT OF THE PUNJAB FOR A GRANT OF RS. 6,60,000 SPREAD OVER A PERIOD OF FIVE YEARS, FOR A SCHEME FOR THE DEVELOPMENT OF SCIENTIFIC RESEARCH IN THE IRRIGATION BRANCH, PUBLIC WORKS DEPARTMENT, PUNJAB.

Attention is invited to the attached letter from the Government of the Punjab, Public Works Department, Irrigation Branch, No. 892-Nor., dated the 13th January 1932, on the subject of the development of scientific research in the Irrigation Branch, Public Works Department, Punjab. The scheme which is fully explained in the note (Enclosure II) of the Scientific Research Officer, Irrigation Research Division, Lahore, involves a non-recurring expenditure of Rs. 2,00,000 and an average recurring expenditure of Rs. 2,24,000 per annum, or a total expenditure of Rs. 13,20,000 spread over a period of five years. It has been suggested that the Council should contribute a sum of Rs. 6,60,000 spread over a period of five years.

2. The scheme is for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 26th May 1932.

COPY OF A LETTER FROM THE SECRETARY TO GOVERNMENT, PUNJAB, PUBLIC WORKS DEPARTMENT, IRRIGATION BRANCH, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, NO. 892-NOR., DATED THE 13TH JANUARY 1932.

SUBJECT:—*The Development of Scientific Research in the Irrigation Branch, Public Works Department, Punjab.*

I am directed by the Governor in Council to invite the concurrence of the Imperial Council of Agricultural Research in the allocation of funds at their disposal towards the scheme for the development of Scientific Research in the Irrigation Branch, Public Works Department, Punjab, as embodied in the Note (Enclosure II), dated the 4th April 1931, by Dr. E. McKenzie Taylor, copies of which I enclose accordingly for favour of distribution to, and consideration by, the President and Members of the Council.

2. The first paragraph of this note deals with the earliest history of this Scheme of Research, and makes reference to the former pronouncements of the Imperial Government up to 1923 on this question.

3. In tracing the subsequent further growth of the present research activity, the note emphasises its ever increasing importance, especially in regard to urgent and grave problems of waterlogging, which has led now to the immediate need for a strong and fully equipped Irrigation Research Institute under the administrative control of the Irrigation Branch, which is so intimately and essentially concerned with these problems.

4. In view of the vital importance of the work required and expected of this Institute as affecting the prosperity of the Punjab, which is vested in the canals, and the essential correlation with irrigation, of the problems dealing with the application of water to the soil, and the remedies for such effects as are deleterious and would lead to deterioration of irrigation, it has been accepted by this Government, and I am to make it clear that any subvention given in response to this application will be expended under the orders of Government in the Irrigation Branch (*i.e.*, the reserved side), which will be in sole control of Irrigation Research.

5. I assume that in considering the suggestion made in the penultimate paragraph of the note as to the suitable contribution to this work it will be clear that the average amount of the subsidy suggested is Rs. 1,32,000 per annum for 5 years from 1932 and this Government is proposing to meet the balance Rs. 3,79,000 per annum in addition to the non-recurring expenditure.

6. In this connection it will be borne in mind that these problems are of very considerable importance also outside the Punjab, to other provinces of India, and to other parts

of the British Empire. So far as this constitutes a general claim for Irrigation Research on Imperial funds, the possession by the Punjab of the largest irrigation system in the world, entitles it to the best means for carrying out his research into irrigation problems.

7. The Scheme has received the approval of the Punjab Council of Research, and a copy of the Secretary's letter No. 9310, dated the 20th April 1931, conveying this approval is enclosed for reference.

ENCLOSURE I.

COPY OF A LETTER FROM THE SECRETARY, PUNJAB COUNCIL OF RESEARCH, TO THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, LAHORE, NO. 9310, DATED THE 20TH APRIL 1931.

SUBJECT:—*Development of Scientific Research in the Irrigation Branch, Public Works Department, Punjab.*

I have the honour to forward herewith a copy of the scheme (Enclosure II) which has been drawn up for the development of scientific research in the Irrigation Branch.

The scheme in its present form was considered by the Punjab Council of Research at a meeting held on 18th April 1931. The Council approved of it and considered that the total expenditure involved was not excessive in comparison with the problems to be studied.

Several members of the Council did not agree with the scales of pay proposed for certain clerical and technical establishment. The feeling was expressed that the clerical establishment was very large and in some cases very highly paid whilst the pay proposed for certain of the technical establishment did not appear sufficient to attract good men. The Council, however, recommended that the scheme be sent forward to the Imperial Council of Agricultural Research for provision of funds to the extent shown, and that when funds are granted the distribution of these funds between clerical and scientific staff should be reconsidered by the Council. The Council further desired that it should be made clear to the Imperial Council of Agricultural Research that the contribution which the latter is requested to make is only half the *additional* expenditure proposed in connection with this line of research.

I have the honour to request that the scheme be submitted for the consideration of Government and, if approved, be forwarded to the Secretary, Imperial Council of Agricultural Research, Simla. The next meeting of the Advisory Body of the Imperial Council of Agricultural Research is being held in Simla from the 8th to 13th June 1931, and the Secretary has intimated that all schemes for consideration at that meeting must reach him not later than 1st May 1931.

The necessary printed copies of the scheme are being prepared and will be submitted in the course of the next few days.

ENCLOSURE II.

NOTE ON THE PROPOSED DEVELOPMENT OF SCIENTIFIC RESEARCH IN THE IRRIGATION BRANCH, PUBLIC WORKS DEPARTMENT, PUNJAB.

1. The existing Punjab Irrigation Research Laboratory at Lahore may be regarded as having come into being with the issue by the Punjab Government on 22nd August 1924 of an Order in Council directing that the services of Mr. B. H. Wilsdon, of the Punjab Educational Service, should be placed at the disposal of the Irrigation Branch for a period of two years. As early as 1915 a proposal had been made by Sir Thomas Ward as Chief Engineer for the appointment in the Irrigation Branch of a trained physicist to undertake research work in connection with various irrigation problems. The Imperial Government, while realising the importance of such expert investigation was reluctantly compelled, owing to the state of financial stringency then prevailing, to defer its approval of the proposal; and later, in 1923, when the question was again raised on the broader bases of a centralised research station with subsidised provincial substations, the province was thrown back on its own resources by a pronouncement that Provincial Governments might not look for contributions from the Imperial Government for carrying out their schemes of research.

2. Mr. Wilsdon's appointment in 1924, as Scientific Research Officer in the Irrigation Branch marks the first step taken towards giving effect to the views expressed by Sir Thomas Ward nine years earlier. In the next four years, however, substantial progress in irrigation research resulted from the keen attention given by the Provincial Government to the subject of waterlogging and the consequent deterioration of irrigated soils. In November 1925, by an order of the Governor in Council, there was formed an independent Waterlogging Enquiry Committee consisting of two technical officers working under the Revenue Department to investigate the problem of waterlogging and report its conclusions to Government. Mr. Wilsdon was appointed to this Committee, in addition to his duties in the Irrigation Branch, as Scientific Member, while Mr. E. S. Lindley of the Irrigation Branch acted as a whole-time Secretary and Engineer Member. Funds were allotted and separate staff provided for each member, that assigned to Mr. Wilsdon including a soil physicist, a field assistant, two muqaddams and two computers for statistical work, these being additional to the staff employed under him in his capacity as Scientific Research Officer, and paid from Irrigation Branch funds. In June 1927, the provincial Waterlogging Conference of some twenty members under the presidency of His Excellency the Governor held the first of its annual meetings. In November 1927, a special Waterlogging Investigation Circle under the Irrigation Branch was constituted with Mr. A. N. M. Robertson in charge. Shortly after its formation Mr. Robertson relieved Mr. Lindley as Engineer Member of the Waterlogging Enquiry Committee and in his dual capacity controlled all records and investigations relating to the rise and fall of subsoil water levels, and also to a large extent, the energetic measures taken by the Irrigation Branch to regulate these levels in irrigated tracts by drainage and pumping. In December 1928 a provincial Waterlogging Board was created under the presidency of Financial Commissioner, Revenue, for advising and offering criticisms and recommendations on the general policy and progress of departmental measures to control the evil of waterlogging. In addition to the Chief Engineer concerned, the members included the Financial and Revenue Secretaries to Government, and the Directors of Agriculture and Public Health. This Board held the first of its quarterly meetings in December 1928. As a consequence of its creation, the Waterlogging Enquiry Committee was abolished, its staff being absorbed by the Irrigation Branch and distributed between the Scientific Research Officer and Superintending Engineer, Waterlogging Investigation Circle.

3. At this stage, as a result of the amalgamation of his dual duties, the Scientific Research Officer found himself in possession of a staff which, apart from the gazetting of certain posts, is practically identical with that normally employed at the present time. This includes the following:—

Gazetted Staff.

- 1 Scientific Research Officer.
- 1 Mathematical Officer.
- 1 Statistical Officer.
- 2 Assistant Research Officers.

Non-Gazetted Staff.

- 4 Junior Research Assistants.
- 1 Sub-Overseer.
- 8 Computers.
- 4 Muqaddams.
- 1 Mechanical Driver.
- 2 Mistries.
- 1 Fitter.
- 2 Gauge Inspectors.
- 1 Laboratory Attendant.
- 1 Storekeeper.
- 1 Draftsman.
- 1 Accountant Head Clerk.
- 6 Clerks.

Of the two Assistant Research Officers one is a physicist in charge of the physical laboratory, and one a soil-chemist and agriculturalist in charge of the chemical laboratory and of soil survey and farm reclamation work in the field. Of the four Junior Assistants, one is the Farm Manager, one is in charge of the workshops, one assists the soil-chemist and one is in charge of gravity survey work under the direction of the Mathematical Officer.

4. The above staff is employed partly in the Research Laboratory at Lahore, and partly at Chakanwali Reclamation Farm or in the field. The laboratory building was completed and occupied in 1928. A plan (marked A) of this building is attached.* It is provided with a supply of water gas and electricity, and includes well-equipped chemical and physical laboratories, a workshop with three lathes and a drilling-machine, and a hydraulic laboratory with a 60-feet glass sided flume. A circulating supply up to 5 cusecs is delivered to the flume by a battery of motor-driven centrifugal pumps, while facilities are provided for direct volumetric measurement as well as for continuous measurement by Venturimeters.

The Chakanwali Farm, situated alongside the main line of the Lower Chenab Canal and some twenty miles from its headworks at Khanki has an area of about 3,600 acres. It was acquired in May 1926 for the purpose of carrying out experiments on the reclamation of waterlogged and alkaline lands of which it mainly consisted.

5. A general idea of the extent and growth of research activities undertaken by the Scientific Research Officer may be gathered from the following approximate figures of actual or budgeted expenditure during the last six years :—

Year.	From funds allotted by		Total.
	Revenue Department.	Irrigation Department.	
	Rs.	Rs.	Rs.
1924-25		30,800	30,800
1925-26	12,000	41,200	53,200
1926-27	26,900	1,81,800	2,08,700
1927-28	39,000	3,78,900	4,17,900
1928-29	49,000	2,42,000	2,91,000
1929-30 .. .. .	..	1,97,300	1,97,300
Total	1,26,900	10,72,000	11,98,900

The above total expenditure was distributed as below :—

	Rs.
Establishment and work in Laboratory	3,46,900
Waterlogging Investigations	1,35,200
Reclamation work at the Farm	4,86,400
Suspense	36,700
Laboratory Buildings and Equipment	1,93,700
Total	11,98,900

As an offset to the third item above, the farm has yielded during the period in rent and produce a direct revenue of about Rs. 1,33,000 which takes no account of the appreciation in value of some 640 acres of reclaimed land.

* Not printed.

6. Although not formally recognised, the work of the Laboratory has been carried out under the following sections :—

- I.—Mathematical Section under the Mathematical Officer.
- II.—Statistical Section under the Statistical Officer.
- III.—Soil Chemistry and Agricultural Section under the Soil-Chemist Assistant.
- IV.—Physics Section under the Physicist Assistant.

With the exception of the Mathematical Officer, the sectional officers mentioned above acquired the greater part of their training as research workers under the direct personal guidance of Mr. Wilsdon. Some of the more important work done to date is briefly summarised below :—

I.—Mathematical Section :—

- (a) Theoretical treatment of the flow of a fluid in a saturated homogeneous porous medium.
- (b) Treatment of problems connected with subsoil flow from open channels and into wells, and the determination, from actual observations on wells, of the value of the transmission constant of soils.
- (c) Torsion Balance survey of the submerged rock barrier traversing the Rechna and Chajh Doabs of the Punjab.
- (d) Mathematical treatment of various problems arising in other sections.
- (e) Preparation of various controlling and measuring devices in connection with the 5-cusecs hydraulic flume recently installed.

II.—Statistical Section :—

- (a) Determination, for several of the perennial canal systems of the Punjab, of regression curves giving the relation between the time-distribution of water applied to land (as rainfall and irrigation) and the rate of rise of the subsoil water table.
- (b) Application of such regression curves to predict the effect of changes in the application of irrigation water.
- (c) Analysis of the results of watercourse experiments with a view to determine the extent and distribution of wastage of water in normal irrigation practice.
- (d) Investigation of the relations between the discharges of the river Indus at Sukhur and the discharges at upstream sites.

III.—Soil Chemistry and Agricultural Section :—

- (a) Soil analysis of various irrigated tracts of the Punjab and of the alkaline soils of the Chakanwali Farm and other areas.
- (b) Analysis of subsoil waters and the waters of wells and open drainage channels.
- (c) Investigation of the osmotic forces of soils.
- (d) Investigation of the effect of light on the hygroscopic co-efficients of thin films of colloidal clay.
- (e) Study of the efflorescence of salts from brickwork and of methods of its prevention.
- (f) Reclamation of waterlogged land by open and subsoil drainage and its cultivation by steam tackle and tractor.
- (g) Experimental cropping and manuring of reclaimed land.
- (h) Reclamation of alkaline land by leaching and treatment with gypsum and green manures.

IV.—Physics Section :—

- (a) Investigation of the hydrostatic pressure of water under conditions of partial saturation.
- (b) Determination of the hydrogenion concentration of soil extracts and suspensions by means of the glass electrode apparatus.
- (c) Grading of river and canal borne silts by a new method involving the continuous photographic record of minute changes of pressure in a manometer.
- (d) Installation at numerous canal stations of a new type of instrument, devised in the Laboratory, for measuring the evaporation from all causes from the surface of a porous pot exposed to sun and wind.
- (e) Application of a conducto-metric method to the analysis by titration of waters and soils extracts.

7. While the work carried out during the last six years by the Research Division in the Laboratory and in the field, has added materially to an understanding of fundamental principles, and has elucidated many of the factors involved in the process of soil deterioration in irrigated tracts, it has yet to find an economic solution of such problems as the prevention or cure of progressive salinity of soils with a rising water table, or the treatment of unproductive alkaline soils so as to render and maintain them fertile. The pressing need, in view of the increasing seriousness of these problems, and of the vast interests at stake, of intensified research on a much wider scale than hitherto attempted has now been recognised by the Punjab Government. In a comprehensive note, dated the 9th August 1929, Mr. Calvert, as Financial Commissioner, Development, emphasised the vital importance to the Punjab of the early development of an institute devoted exclusively to research into problems other than those of a purely agricultural nature, connected with the application of irrigation water to soil. Basing his views on the evidence collected by the Royal Commission on Agriculture in India, and on the opinions of such high authorities as Dr. Keen of Rothamsted and Mr. Howard of Indore, Mr. Calvert revealed the inadequacy of existing efforts to deal with the problems of Irrigation and strongly urged the collaboration in a single fully equipped institute of a group of specialists, each responsible for a particular branch of research, working under the immediate guidance of a Director as head of the Institute placed under the administrative control of Irrigation Branch.

8. Under the orders of Government a scheme, based on Mr. Calvert's proposals, was recently formulated for developing the existing Research Laboratory into an Irrigation Research Institute of greatly increased scope and strength. It aims at a programme of gradual expansion spread over a period of five years, and provides for the ultimate employment of the staff enumerated in the appended schedule. The staff will be organised in five research sections with Central Section in which all work of a general nature will be placed under the Director and his Personal Assistant. The Statistical Officer and his staff, all clerical, accounts and drawing office establishment, and that concerned with stores, library and publication work will be placed under this section. The five research sections will be accommodated in the existing building extended by the addition of an upper storey. The cost of additional buildings will be about Rs. 2,00,000. Annual recurrent expenditure is now Rs. 2,87,000 and is expected to reach a figure of about Rs. 6,75,000 by the time expansion is complete.

The Irrigation and Engineering Section—will undertake all field work connected with river and canal discharges, silt transportation and channel regime water distribution and the performance of modules, tube-well and open-well research connected with water-logging, water-course experiments and the collection of crop data, and all land and water-table surveys. It is proposed that the independent Discharge Division now working under the direct control of the Chief Engineers, as well as all investigational work now in the hands of the Waterlogging Investigation Circle, should be absorbed by the Institute and placed under the head of this important section.

The Mathematics and Hydraulics Section—will carry out laboratory experiments on modules, meters, outlets and small scale models of actual works such as weirs, falls and sluices; theoretical and experimental investigation of problems connected with such phenomena as sub-soil flow and percolation, and the streamline and turbulent flow of fluids. The Director would also, when necessary, submit the work of other sections to this section for mathematical treatment or scrutiny.

The Physics Section.—The work of this section will be concerned with both hydraulics and soils. Physical investigation connected with the texture of soils and water-borne silts, soil-moisture relations and the movement of water in soils, evaporation from soils and the problems of silt transportation will be conducted. The Sub-Committee of the Punjab Research Council appointed to consider this scheme have suggested that two soil physicists should be appointed, one to work at Lyallpur and the other at the Irrigation Research Institute.

The Soil Section—would investigate the chemical changes arising from irrigation and waterlogging, methods of reclamation of land from salt and alkalinity, the possibility of using of drainage waters for the reclamation alkaline soils and the effects of salts and chemical composition on soil properties. Soil surveys are required in connection with drainage and reclamation work. This section will control the field work of the Soil Survey Officer and his staff. The Sub-Committee of the Punjab Research Council referred to above recommend that two Physical Chemists be appointed, one to be stationed at the Irrigation Research Institute and the other at the Agricultural College, Lyallpur.

The Agricultural Section—will investigate the application of the findings of the laboratory to field conditions. It will also conduct the experiments at the Reclamation Farm at Chakanwali, be responsible for the collection of data connected with the field experiments, and generally manage the farm.

The scheme has met with general approval and active measures are now being prosecuted to carry it into effect. Anticipated expenditure during the period of expansion is approximately as follows :—

			Non-Recurring Rs.	Recurring. Rs.
Average current expenditure	..	..	..	2,87,000
1931-32	..	..	..	3,20,000
1932-33	..	..	1,20,000	4,30,000
1933-34	..	..	80,000	5,30,000
1934-35	..	..	..	6,00,000
1935-36 and after	..	..	..	6,75,000
			2,00,000	25,55,000
Average during period of extension	..	..	..	5,11,000
Deduct current expenditure	..	..	..	2,87,000
				2,24,000

The above figures show that during the next five years the Province is faced with an additional expenditure of Rs. 13,20,000. In view of the present state of financial stringency and the possibility of its continuance during the period of expansion and bearing in mind the benefit that is likely to accrue to other provinces from the prosecution of a vigorous and comprehensive programme of research in the premier irrigating Province of India, it would appear reasonable to hope for a generous contribution towards the projected expenditure of the Institute on the part of the Imperial Council of Agricultural Research. A contribution of Rs. 6,60,000 spread over the next five years, representing about one-half of the anticipated increase of expenditure, is suggested as suitable.

In accordance with the reservation of the Irrigation Members of the Sub-Committee, a further sum of Rs. 20,000 per annum, will be required if it is found necessary to establish a Microbiological Section. At present it was agreed that the work of this section might be carried out at the Agricultural College, Lyallpur, with the existing staff. The development of Microbiological Section, if found necessary, would not take place until the fourth year.

E. MCKENZIE TAYLOR,
Scientific Research Officer,
Irrigation Research Division, Lahore.

The 4th April 1931.

Schedule of Establishment required for the Punjab Irrigation Research Institute.

Serial No.	Post.	Existing.	Ultimately re- quired.	Grade proposed.	Duties.
	CENTRAL SECTION.			Rs.	
1	Director	1	1	Under discussion ..	Will be administrative Head of the Department and in charge of the Institution.
2	Personal Assistant ..	..	1	375—50—975/50— 1,375.	Will be working as an Assistant to the Director in all technical and scientific matters.
3	Statistical Officer ..	1	1	250—25—650—30— 800.	Will be in charge of all kind of statistical work in the institute. The work will consist of investigations in connection with water-logged areas and experimental work at the farm.
4	Assistant to Statistical Officer.	..	1	160—12—340/15— 400.	Will be working as an Assistant to the Statistical Officer. The appointment will be made when the work develops on a large scale.
5	Office Superintendent	..	1	350—25—500/30— 650.	Will be the head of all office Establishment and will control all the office work of correspondence and accounts, etc.
6	Head Assistant, Accounts and Budget.	1	1	250—10—350	
7	Head Assistant, Works and Correspondence.	1	1	250—10—350	
8	Assistant, Press Section.	..	1	100—10—300	
9	Senior Clerks ..	2	6	75—5—150	
10	Junior Clerks ..	5	12	45—3—90—3—105	
11	Stenographers ..	..	3	100—10—200/300	
12	Head Computers ..	..	1	75—5—150	They will be employed in Statistical Section under Statistical Officer for calculating and arriving at the data required for statistical purposes.
13	Computers ..	7	9	45—3—90—3—105	
14	Head Storekeeper ..	..	1	75—5—150	These men will be in charge of all stores that are purchased and handled in the laboratory.
15	Assistant Storekeeper.	1	1	40—2—90	

Schedule of Establishment required for the Punjab Irrigation Research Institute—contd.

Serial No.	Post.	Existing.	Ultimately required.	Grade proposed.	Duties.
16	CENTRAL SECTION— <i>contd.</i> II Class Head Draftsman.	1	1	110—5—160	In charge of Drawing Section of the Institute.
17	Assistant Draftsmen	3	3	60—2—100	These are meant for the existing men employed in Discharge Division on drawing work.
18	Tracers ..	4	4	30—2—60	
19	IRRIGATION AND ENGINEERING SECTION. Irrigation Officer	1	1,750—100—2,150 (plus O. S. P. if eligible).		Will be in charge of all field work connected with river and canal discharges, silt transportation and channel regime, water distribution and the performance of modules, tube-well and open well research, water-course experiment, collection of crop data and all land and water table survey.
20	Executive Engineer, Discharge.	1	1	775—50—1,375	He will be in charge of discharges of the Province and will take the place of the present Executive Engineer Discharge.
21	Sub-Divisional Officer, Discharge.	3	3	250—20—750	These posts are meant for the present Sub-Divisional Officers of Discharge Division which will come under this Institute.
22	Overseers for Sub-Divisional Officer, Discharge.	8	8	80—7—255	These are meant for the present Overseers of Discharge Division.
23	Sub-Divisional Officer, Tubewell.	1	1	250—20—750	Will work on the investigation of geological conditions and the effects of the existing wells on the water-table.
24	Sub-Divisional Officer, Water Distribution.	..	1	250—20—750	They will be employed in the field on a variety of investigational work in connection with the collection of more precise data bearing on wells and water table levels, seepage drains, silt transportation and channel regime, water distribution, the behaviour of modules with reference to silt extraction and economy in the use of water-course experiments and crop data required for statistical investigations.
25	Sub-Divisional Officer, Survey.	..	1	250—20—750	
26	Overseers for Sub-Divisional Officers, Tube-well, Water-distribution and Survey.	..	8	80—7—255	
27	Calculating Clerks	4	4	40—3—90—3—105	These are meant for the present calculating clerks in Discharge Division.

Schedule of Establishment required for the Punjab Irrigation Research Institute—contd.

Serial No.	Post.	Existing.	Ultimately re- quired.	Grade proposed.	Duties.
	MATHEMATICAL AND HYDRAULIC SECTION.				
28	Mathematical Officer	1	1	400—50—600/50—1,250 with O. S. P. if eligible.	Will be in charge of Hydraulic Laboratory and Mathematical work connected with other experiments.
28½	Assistant Executive Engineer.	..	1	375—50—975/50—1,375.	He will deal with the practical side of the investigations in the Hydraulic Laboratory.
29	Overseer ..	..	1	80—7—255	Will be required for observations in the laboratory.
30	Gauge Inspectors ..	2	2	25—1—30	
31	Instrument maker	1	1	100—10—300	In charge of Workshop and all mechanical work connected with the making and repairs of all instruments required for research work.
32	Mechanical Driver..	1	1	75—2—115	Will be employed as a Driver when necessary and as a mechanic in the workshop under the Instrument maker.
33	Artificers.. ..	2	3	45—2—75	} Will be employed in the Workshop.
34	Fitters	1	2	30—2—50	
	PHYSICAL SECTION.				
35	Physicists .. ..	..	2	400—50—1,200	One Officer will be located at Lyallpur and the other at Lahore. The former will deal with the physical properties of normal soils under Irrigation. The latter will deal with the physical properties of water-logged and kallar soils in the Province.
36	Assistant to Physicist	1	1	250—25—650/30—800.	Will work under the Physicist.
37	Junior Assistant ..	1	1	100—10—300	Ditto.
38	Photographer .. ..	..	1	100—5—200	Will be employed for taking photos of experimental work in the Institute.
39	Laboratory attendant.	..	1	20—1—30—2—50	

Schedule of Establishment required for the Punjab Irrigation Research Institute—contd.

Serial No.	Post.	Existing.	Ultimately re- quired.	Grade proposed.	Duties.
40	SOIL SECTION. Physical Chemist ..	..	2	400—50—1,200	One officer will be located at Lyallpur and the other at Lahore. The former will be employed on physico-chemical problems connected with the irrigation of normal soils, and the latter will be employed on physico-chemical problems connected with the water-logged and kallar soils.
41	Soil Survey Officer..	..	1	250—25—750	He will be employed in connection with survey work of water-logged and kallar areas.
42	Senior Assistant to Physical Chemist.	..	1	160—12—340/15—400	Will be employed under the Physical Chemist.
43	Senior Assistant to Soil Survey Officer.	..	1	160—12—340/15—400.	Will be employed under the Soil Survey Officer.
44	Junior Assistant to Physical Chemist.	..	1	100—10—300	
45	Junior Assistant to Soil Survey Officer.	1	2	100—10—300	
46	Surveyors ..	..	2	100—10—300	Will be employed on survey work under the Soil Survey Officer.
47	Analyst ..	..	4	70—4—100/8/150	Will be employed on analytical work in the laboratory.
48	Muqadams ..	2	2	20—1—30/2—50	
49	Laboratory attendant.	..	2	20—1—30/2—50.	
50	AGRICULTURAL SECTION. Agriculturist ..	..	1	400—50—1,200	Not to be employed at present.
51	Assistant to Agriculturist.	1	..	250—25—750	Will be in charge of the farms and would be responsible for the management of the experiments and for the detailed field observations in connection with experimental and survey work.
52	Junior Assistant to Agriculturist.	..	3	100—10—300	
53	Muqadams ..	2	3	20—1—30/2—50	
54	Storekeeper ..	1	1	4—2—80	
55	Laboratory Attendant.	..	2	20—1—30/2—50	

E. MCKENZIE TAYLOR,

Scientific Research Officer, Irrigation Research Division, Lahore.

APPENDIX XII.

SUBJECT No. 10.

APPLICATION FROM THE GOVERNMENT OF BIHAR AND ORISSA FOR A GRANT OF RS. 78,680 SPREAD OVER A PERIOD OF FIVE YEARS FOR A SCHEME OF RESEARCH ON THE ECONOMICS OF IRRIGATION FROM TUBE-WELLS.

Attention is invited to the attached letter from the Government of Bihar and Orissa, No. 120-D.R., dated the 20th May 1932 forwarding a scheme of research on the economics of irrigation from tube wells. The scheme which is fully explained in Mr. Sethi's note involves in so far as the Council is concerned a non-recurring expenditure of Rs. 13,000 and a recurring expenditure of Rs. 65,680 or a total expenditure of Rs. 78,680 spread over a period of five years.

The scheme is for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 26th May 1932.

COPY OF A LETTER FROM THE SECRETARY TO GOVERNMENT, EDUCATION AND DEVELOPMENT DEPARTMENT, RANCHI, TO THE SECRETARY TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NO. 120-D.R., DATED THE 20TH MAY 1932.

SUBJECT :—*Scheme of research on the economics of irrigation from tube wells.*

I am directed by the Government of Bihar and Orissa in the Ministry of Education to submit for the approval of your Council a scheme (enclosure) of research on the economics of irrigation from tube-wells, Bihar and Orissa.

2. The scheme has been drawn up by Mr. D. R. Sethi, I.A.S., officiating Director of Agriculture, Bihar and Orissa, and approved by the Bihar and Orissa Agricultural Research Committee. I am to request that steps may be taken to place it, before the meeting of the Advisory Board of your Council in June 1932 and allot funds in case the scheme meets with the approval of your Council.

ENCLOSURE.

RESEARCH ON THE ECONOMICS OF IRRIGATION FROM TUBE WELLS, BIHAR AND ORISSA.

1. In recent years the tendency on the part of estate owners and not having facilities for irrigating their lands from canals has been to go in for large diameter tube-wells. The capital cost of such wells, however, is comparatively large and the total cost per irrigation much higher as compared to that of supplies from canals. In order that existing and prospective tube-well farmers be placed in possession of accurate information on all relevant points it is necessary to carry out research on this method of irrigation farming with special reference to its economic aspects.

2. That such studies are of more than provincial importance is evident from their nature. While it is true that the results obtained at any one station may not be applicable in their entirety wherever tube-wells are used for irrigation farming yet in their general applicability they would be of immense assistance to all concerned.

3. The position in Bihar and Orissa is that during the past few years there has been an increasing demand on the part of zamindars for large diameter tube-wells. Realizing the great necessity of studying all the problems connected with irrigation farming from the tube-wells, the Local Government set apart 60 acres of land at Patna farm for this purpose. This area has been fully equipped in every way including a 12-inch diameter 310 feet deep tube-well, about 1,500 feet of main cement masonry channels, and a 15-30 B. H. P. International Tractor outfit. The rated capacity of the well is two cusecs with a depression of 8 feet.

4. The financial conditions of the Province have so far precluded the recruitment of trained staff necessary to carry out the work. The future prospects also do not hold out any hope that it will be possible to get together the funds and staff necessary for the work.

without extraneous help. It is, therefore, necessary to approach the Imperial Council for the sanction of a modest grant to enable the investigations to be carried out for a period of five years in the first instance.

5. Research on irrigation farming, irrespective of the source of irrigation, requires studies on agricultural engineering, soil physics and plant physiological aspects of the problems involved. The first two of these are mainly concerned with the economic aspects of the problem and these being of immediate importance it is considered that the present scheme should confine itself to them. The other two are concerned more with the scientific aspects and as these are to be taken up in detail at the proposed Irrigation Research Station to be established in the Punjab it is not intended to take up these in Bihar for the present.

6. The whole scheme of investigations will be under the control of the Director of Agriculture, Bihar and Orissa. The Deputy Director of Agriculture, South Bihar, assisted by a separate research Assistant Director of Agriculture will be in charge of the Agricultural investigation while the Assistant Engineer will carry out the engineering investigations. It is not possible to provide accommodation for the proposed staff on the farm but as the farm is situated within the municipal limits of the town of Patna, the staff will find no difficulty in securing accommodation. Office accommodation, etc., however will be available at the farm. The farm, consisting as it does of 200 acres has a resident staff of Agricultural Assistants, sardars, etc., and there would, therefore, be no difficulty in the proper supervision of the research station when the expert officers are not on the spot. In fact it is proposed to partially utilise the resident farm staff for ordinary farm operations at the Research Station.

7. The cost per unit of water at the pump head from tube-wells, varies with the size of wells and the machinery employed. It is therefore essential that data regarding capital cost and working expenses of various sizes of tube-wells should be collected in order to arrive at reliable figures regarding the cost per unit of water from such wells. It is therefore proposed to utilize the Engineering staff provided for in the scheme in collecting data from the wells that are already operating in the province. As this will involve touring provision in the scheme has been made for expenditure on this account.

Technical Aspect.

8. In tube-well irrigation farming the most important problems are :—

- (1) The cost per unit of water ;
- (2) the prevention as far as practicable of wastage in distribution ;
- (3) the optimum quantities of water to be allowed to different crops consistent with yield and profit ; and
- (4) most profitable systems of framing that will fully utilize the available water.

9. That the results obtained from investigations that are proposed to be carried out at this station will be of fairly wide applicability is evident from the fact that the proposed research station has a fairly wide variety of soils varying from Gangetic alluvium to heavy black clays which are to be met with over extensive tracts in this as well as other neighbouring provinces. It is, therefore, proposed to take up the following lines of investigations :—

- (a) Cost per unit of water at pump head using two types of Power Plant—Oil Engine and Electric Motor.
- (b) Total cost including distribution cost per unit of water applied to the land.
- (c) Total cost per acre irrigation of major crops.
- (d) Measurement of losses of water in distribution.
- (e) Effective methods of distributing water so as to minimise losses in distribution.
- (f) Suitable size and shape of fields for different discharges.

- (g) Suitable methods of preparing tube-well irrigated fields so as not to disturb surface levels leading to wastage of water.
- (h) Optimum quantity of water required by major crops from the point of view both of outturn and profit.
- (i) Most suitable rotations for tube-well irrigated lands in order to fully use the available supply.
- (j) Effects of varying depths of preparatory tillage on the subsequent water requirements of crops.
- (k) Economics of flat vs. ridge and furrow irrigation from tube-wells.
- (l) Frequency of irrigation :—
- (i) Best intervals at which to apply water to various crops.
- (ii) Effects of interculture of crops on frequency of irrigation and economics of the same.

10. As has already been stated the 12-inch tube-well at the Patna Government Farm has a rated capacity of 2 cusecs. It is equipped with an 8-inch Centrifugal pump driven by a 20-25 B. H. P. Rustan Crude Oil Engine. It is proposed to instal a 20 B. H. P. Motor complete with starter, etc., for purposes of comparison. Current at industrial rates is available from a large town-supply steam station adjoining the farm.

11. In order to minimize losses due to seepage in the main channels, about 1,500 feet of cement masonry mains have been constructed during the past three years. To complete these and to construct a few sub-mains additional funds are necessary.

12. The proposed research station is at present laid out in 4-acre plots and the whole area is adequately drained and well served with *pucca* and *kacha* roads. The shape and size of the plots can, however, be altered to suit experimental needs.

13. For its cultivation the station is fully equipped both with Bullock and Tractor power and with a representative collection of implements.

14. It is proposed to demonstrate the results obtained from the research station on the adjoining 140 acres of farm.

Financial Aspect.

15. That the Government of Bihar and Orissa attach very great importance to this research will be evident from the following non-recurring and recurring contributions which they are willing to make, in spite of their financial difficulties, in the financing of the proposal.

Local Government's contributions.

A. Non-recurring—	Ra.
(i) 60 acres of fully equipped research station including office accommodation, etc.—Price of 60 acres of land at Rs. 1,500 an acre.	90,000
(ii) One 12-inch tube-well fully equipped with 20-25 B. H. P. Engine, Engine house, pump, pump house and pucca distribution channels.	12,000
(iii) One set of 15-30 Tractor complete with its implements	.. 9,000
(iv) Farm equipment consisting of bullocks, implements, etc.	.. 2,500
Total	.. .. 1,13,500
B. Recurring—	
(i) All annual expenses of working the research station including cost of running tube-well and tractor.	8,000
(ii) Part-time services of the Resident Farm staff consisting of 3 Agricultural Assistants, 2 sardars, and mechanic.	2,000
Total	.. .. 10,000
Five years' cost	.. .. 50,000

NOTE.—All receipts from the Research station to be credited to the Government of Bihar and Orissa.

16. The Imperial Council of Agricultural Research is requested to sanction the following:—

A. Non-Recurring—

	Rs.
(i) One 20 B. H. P. Motor complete with starter, etc.	2,000
(ii) One self-registering water-meter	6,000
(iii) Construction of main and sub-main masonry channels (3,000 feet at Re. 1 a foot).	3,000
(iv) Iron outlets	500
(v) Furniture, Typewriter, Levelling instruments, stationery, etc.	1,500
Total	13,000

B. Recurring—

(a) Staff—

Agricultural Section.

	Rs.
(i) One A. D. A. at	250—20—330
(ii) One Agricultural Research Assistant at	80—5—100
(iii) One sardar at	20—1—24
(iv) One clerk at	40—2—48
(v) Two peons at	10—each

Engineering Section.

	Rs.
(i) One Assistant Engineer at	300—25—400
(ii) One Sub-overseer at	60—5—80
(iii) One Sardar at	20—1—24
(iv) Two peons at	10—each

(b) Travelling allowance at Rs. 1,500 per annum.

(c) Contingencies including stationery, stamps, liveries, etc., Rs. 500.

17. The attached table shows details of annual expenditure for five years which is requested from the Imperial Council. Abstract statement below shows the total cost for five years to Local Government and the Imperial Council:—

ABSTRACT OF EXPENDITURE.

Share of the Government of Bihar and Orissa. Share of the Imperial Council of Agricultural Research.

	Rs.	Rs.
	1,13,500	13,000
	<i>Recurring.</i>	
		Rs.
1st year	10,000	11,720
2nd year	10,000	12,428
3rd year	10,000	13,136
4th year	10,000	13,544
5th year	10,000	14,552
Total	50,000	65,880
Grand total of Non-Recurring and Recurring..	1,63,500	78,680

18. If to the annual contribution of the Local Government is added the depreciation and interest on the plant and machinery provided the total contribution will amount to nearly the same as that of the Imperial Council. It is also clear that on a 50/50 basis the Local Government are contributing much more than their fair share. In fact the request to the Imperial Council amounts to nothing more than the bare minimum of expert staff required and a very small non-recurring grant which the Local Government are unable to provide. In the view of the above and in view of the importance of the research scheme and its wide applicability it is hoped that the Council will sanction the scheme.

It may be added that when sanctioned it is proposed to recruit the Assistant Director of Agriculture and the Assistant Engineer through the Public Service Commission, India.

(Sd.) D. R. SETHI,
Offg. Director of Agriculture,
Bihar and Orissa.

PATNA :
The April 1932.

Items.	1st year.	2nd year.	3rd year.	4th year.	5th year.
1. One Asstt. Dir. of Agri. ..	3,000	3,240	3,480	3,720	3,960
2. One Asstt. Engineer ..	3,600	3,900	4,200	4,500	4,800
3. One Agril. Asstt. ..	960	1,020	1,080	1,140	1,200
4. One Sub-overseer ..	720	780	840	900	960
5. One clerk ..	480	504	528	552	576
6. Two Sardars ..	480	504	528	552	576
7. Four peons ..	480	480	480	480	480
8. Travelling allowance ..	1,500	1,500	1,500	1,500	1,500
9. Contingencies ..	500	500	500	500	500
Total ..	11,720	12,428	13,136	13,344	14,552

APPENDIX XIII.

SUBJECT No. 11.

INVESTIGATION OF THE TRAFFIC OF LIVESTOCK THROUGH THE PROVINCE OF BIHAR AND ORISSA.

Attention is invited to the attached application from the Bihar and Orissa Government for a non-recurring grant of Rs. 1,800 and a recurring grant of Rs. 29,920 spread over two years for investigating the traffic of livestock through Bihar and Orissa. The scheme involves a total grant of Rs. 31,720 and the Bihar and Orissa Government have expressed their inability to share any portion of the cost.

2. It has been suggested to the Bihar and Orissa Government (Encl.) *inter alia* that the scheme should be worked with the help of the existing livestock breeding and veterinary organisations of the province with an additional staff consisting of a clerk, 3 veterinary surgeons and 3 cattle sardars so as to bring down the cost of the scheme approximately to Rs. 20,000. The reply from the Bihar and Orissa Government will be circulated to the members of the Advisory Board as soon as it is received.

SIMLA, S. W.,
The 30th June 1932.

CHARAN DAS,
Secretary.

COPY OF LETTER FROM B. K. GHOKHALE, Esq., I.C.S., OFFICIATING SECRETARY TO GOVERNMENT, EDUCATION AND DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 272-D., DATED THE 27TH JANUARY 1932.

Scheme for investigating the passage of livestock through the province of Bihar and Orissa.

I am directed to submit for the consideration of the Imperial Council of Agricultural Research a scheme for the provision of staff for reporting on the livestock which annually passes through Bihar from North-West India to Bengal and Assam which has been drawn up by Mr. G. S. Henderson, Director of Agriculture, Bihar and Orissa. The scheme has been considered and approved by the Bihar and Orissa Agricultural Research Committee.

2. I am to request that the Imperial Council may be pleased to approve the scheme and provide the necessary funds for carrying on the investigation which is likely to be useful not only to this province but to all the provinces in Northern India. On account of the present financial stringency, the Local Government regret that they will not be able to bear any share of the cost in case the scheme is sanctioned.

Scheme for the provision of staff for reporting on the livestock which annually passes through Bihar from North-West India to Bengal and Assam to be put up before the Imperial Council of Agricultural Research.

There is a steady flow of cattle of all classes passing through the province of Bihar and Orissa from West to East. It is probable that while a certain number of cattle remain in the province yet a large proportion passes on from Mela to Mela in order to replenish the demand in Bengal and in Assam. It is essential to have accurate data about this movement before comprehensive schemes for cattle improvement can be formulated. It is expected that with the staff suggested the information realised would be of considerable importance not only to Bihar and Orissa but to all the other neighbouring provinces. The data obtained is likely to facilitate marketing surpluses of livestock in North-West India and likewise information regarding probable demands can be disseminated. Owing to the present state of financial stringency, it is quite impossible for the Bihar and Orissa Province to do more than help the collection of the information required by means of the existing staff of district veterinary officers. A list of some of the Melas and the number of animals attending is appended. From the statement the magnitude of the proposition may be gathered. In addition to the Melas mentioned there are large number of subsidiary *hats* or markets. It is proposed that the period of investigation should extend for 2 years.

The staff and equipment required are given in the statement attached. This staff is necessary in view of the fact that a number of the cattle fairs are held simultaneously. There is also a smaller stream south of the Ganges river and also a movement of cattle from Bihar into and back from Nepal.

The share taken in this investigation by the local Government would consist in provision of headquarters and office accommodation where available and in the assistance of local veterinary officers. These local veterinary officers attend the larger fairs except in the event of a serious outbreak of disease when they may be called off to deal with such an epidemic.

Initial Expenditure.

	Rs.
1. Office equipment and typewriter	800
2. Tents and Pals	1,000
	1,800

Recurring Expenditure.

	Rs.
1. One livestock expert @ Rs. 500 p.m. for 2 years. $Rs. 500 \times 2 \times 12=12,000$.	12,000
2. One Veterinary Inspector @ Rs. 200 p.m. for 2 years. $Rs. 200 \times 2 \times 12=4,800$.	4,800
3. Two Veterinary Assistant Surgeons @ Rs. 60 each for 2 years. $Rs. 60 \times 2 \times 12 \times 2=2,880$.	2,880
4. One Typist Clerk @ Rs. 50 p.m. for 2 years. $Rs. 50 \times 2 \times 12=1,200$.	1,200
5. Three Cattle Sardars @ Rs. 20 each p.m. for 2 years. $Rs. 20 \times 3 \times 2 \times 12=1,440$.	1,440
6. Travelling Allowance Rs. 3,000 for 2 years. $Rs. 3,000 \times 2=6,000$.	6,000
7. Contingencies Rs. 800 for 2 years. $Rs. 800 \times 2=1,600$	1,600
	29,920
Grand Total	31,720

Statement showing fairs and shows cattle hats in the Province of Bihar and Orissa.

Name of fairs and hats.	District.	Approximate date on which the fair is held.	Remarks.
1. Nuan Fair	Arrah	(1) 16-24th February. (2) 16-24th April. (3) 16-24th June. (4) 16-24th November.	
2. Karakat Fair .. ..	.. ..	16 to 24th February.	
3. Latihar Fair .. ..	.. ..	16th to 24th February. Last year there was cattle fair.	
4. Babumath Khas Fair .. ..	.. ..	10th to 20th January.	
5. Sherghati Fair	Gaya	April (middle).	
6. Kako Fair .. ..	.. ..	June (1st week).	
7. Manikpur Fair .. ..	.. ..	March (Ramnavami).	
8. Hulasganj hat .. ..	.. ..	Tuesday and Friday.	
9. Tehta hat .. ..	.. ..	Saturday and Sunday.	

Name of fairs and hats.	District.	Approximate date on which the fair is held.	Remarks.
10. Nasaratpur hat ..	.. Gaya	Monday.	
11. Sunduganj Fair ..	.. "	15th January.	
12. Bariawan Fair ..	.. "	End of February.	
13. Sanda Fair ..	.. "	End of March.	
14. Kara Fair ..	.. "	Middle of May.	
15. Barahat hat ..	.. Bhagalpur	Every Tuesday and Friday.	
16. Barakahat hat ..	.. "	Every Wednesday and Friday.	
17. Hijlamela hat ..	.. "	Last week of January.	
18. Maheshpur ..	.. "	Every Saturday.	
19. Mohanpur ..	.. "	Every Wednesday.	
20. Hiranpur Government cattle market.	.. "	Every Thursday or some time Friday in winter season.	
21. Sehra Fair ..	.. Patna	October.	
22. Samdah Fair ..	.. "	January and April.	
23. Ain khan Fair ..	.. "	February and April.	
24. Aktiarpur Fair ..	.. "	April and May.	
25. Karaipersarai hat..	.. "	Every Sunday.	
26. Kumuda—Jaipur hat	.. "	Saturday and Tuesday only in summer.	
27. Sauri hat ..	.. "	Wednesday and Sunday.	
28. Nischintakilli hat	.. "	Saturday and Tuesday.	
29. Agrahat hat ..	.. Cutteack	Thursday and Sunday only in summer.	
30. Chhapur hat ..	.. "	Friday.	
31. Jaipur hat ..	.. "	Sunday.	
32. Maranandapur hat	.. "	..	
33. Hariarajpur Fair	.. Puri	In the latter part of March.	
34. Ghordia Fair ..	.. "	1st week of April.	
35. Bhadrak hat ..	.. Balasore	Wednesday.	
36. Khakihat hat ..	.. "	Monday and Friday.	
37. Kantpara hat ..	.. "	Saturday and Tuesday.	
38. Banibahal hat ..	.. Angul	Sunday.	
39. Kamilbazar hat ..	.. Sambalpur	"	
40. Talpatia hat ..	.. "	Saturday.	
41. Karpabahal hat ..	.. "	Thursday.	
42. Kairapali hat ..	.. "	Tuesday.	
43. Barharh hat ..	.. "	Friday. During rains no one comes.	
44. Bhukta hat ..	.. "	Wednesday. During rains no one comes.	
45. Chaibaasa hat ..	.. Singhbhum	Tuesday.	
46. Katras hat ..	.. Manbhum	Sunday.	
47. Murma Fair ..	.. Ranchi	Letter part of October.	
48. Be'ro hat ..	.. "	Tuesday.	
49. Inki hat ..	.. "	Friday.	
50. Chatti hat ..	.. "	Saturday.	
51. Sous hat ..	.. "	Monday.	
52. Ormanghi hat ..	.. "	Tuesday and Friday.	
53. Pakarduar hat ..	.. "	Sunday.	
54. Laasya hat ..	.. "	Friday.	

Name of fairs and hats.	District.	Approximate date on which the fair is held.	Remarks:
55. Phulbani hat ..	.. Angul	Wednesday	} During rainy season cattle do not come.
56. Phiringia hat ..	.. "	Tuesday	
57. Khejuripara hat ..	.. "	Sunday	
58. Gumla hat ..	.. Ranchi	Saturday.	
59. Murhee hat ..	.. "	Monday.	
60. Siladon hat ..	.. "	Tuesday.	
61. Maranjhada hat ..	.. "	Saturday.	
62. Birda hat ..	.. "	Thursday.	
63. Gobindpur hat ..	.. "	Saturday.	
64. Soda hat ..	.. "	Wednesday.	
65. Tabkara hat ..	.. "	Saturday.	
66. Parsanni Fair ..	.. Muzaffarpur	April.	
67. Kafain Fair ..	.. "	During Ramnavami (April).	
68. Tirki Fair ..	.. "	Latter part of Baisakh (May).	
69. Sewar Fair ..	.. "	May.	
70. Ratwara fair ..	.. "	October.	
71. Mahwa fair ..	.. "	October (during Puja festival).	
72. Sustha Fair ..	.. "	November.	
73. Athari Fair ..	.. "	Do.	
74. Khajauri Fair ..	.. "	December.	
75. Dawami Fair ..	.. "	January.	
76. Babhagawan Fair ..	.. "	March.	
77. Patipur Fair ..	.. "	Do.	
78. Sonbarra fair ..	.. "	Do.	
79. Raja Paker hat ..	.. "	Saturday.	
80. Sarai hat ..	.. "	Sunday and Thursday.	
81. Mujawalia hat ..	.. "	Wednesday and Thursday.	
82. Sursand hat ..	.. "	Wednesday and Sunday.	
83. Pupri hat ..	.. "	Wednesday and Saturday.	
84. Moli hat ..	.. "	Monday and Friday.	
85. Mahawa hat ..	.. "	Do.	
86. Bahoree hat ..	.. "	Tuesday and Saturday.	
87. Baspitta hat ..	.. "	Monday and Friday.	
88. Sitamarhi hat ..	.. "	Sunday and Wednesday.	
89. Bairangnia hat ..	.. "	Do.	
90. Jatmalpur Fair ..	.. Darbhanga	February.	
91. Birsingpur Fair ..	.. "	March.	
92. Basanti hat ..	.. "	Twice a week.	
93. Muktapur Fair ..	.. "	March.	
94. Ambikapur Fair ..	.. Saran	April.	
95. Solhauri Fair ..	.. "	May. Same fair held twice in a year.	
96. Hathwa Fair ..	.. "	October (Dashara festival).	
97. Manjha Fair ..	.. "	Do.	
98. Silhauri Fair ..	.. "	February.	
99. Dumarron Fair ..	.. "	March.	
100. Karanchighi Fair ..	.. Purnea	April.	
101. Forbesganj Fair ..	.. "	October.	

Name of fairs and hats.	District.	Approximate date on which the fair is held.	Remarks.
102. Bihganj Fair ..	.. Purnea	December.	
103. Simebani Fair ..	.. "	March.	
104. Shankerpur Fair ..	.. "	Do.	
105. Jainagar Fair ..	.. "	Do.	
106. Panjipara hat ..	.. "	Sunday and Tuesday.	
107. Chokalia hat ..	.. "	Wednesday and Friday.	
108. Gangi hat ..	.. "	Monday and Saturday.	
109. Bibiganj hat ..	.. "	Thursday and Friday.	
110. Roma hat ..	.. "	Thursday once a week only.	
111. Phalka hat ..	.. "	Sunday.	
112. Billaun hat ..	.. "	Do.	
113. Sonaili hat ..	.. "	Friday.	
114. Gobindganj Fair ..	.. Champaran	November.	
115. Chainpatia Fair ..	.. "	November (Kartik-purnama).	
116. Maharanganj Fair ..	.. "	January (Magh).	
117. Kesaria Fair ..	.. "	Do.	
118. Madhuban hat ..	.. "	Sunday and Wednesday.	
119. Chintamani hat ..	.. "	Friday and Tuesday.	
120. Razaul Bazar hat ..	.. "	Twice a week except rainy season.	
121. Ramgarhwa hat ..	.. "	Do.	
122. Dubaha hat ..	.. "	Twice a week.	
123. Gauradam hat ..	.. "	Do.	
124. Chainpura hat ..	.. "	Do.	
125. Supaul hat ..	.. "	Monday and Thursday.	

ENCLOSURE.

COPY OF LETTER FROM RAI SAHIB MALIK CHARAN DAS, SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO THE SECRETARY TO GOVERNMENT, BIHAR AND ORISSA, EDUCATION AND DEVELOPMENT DEPARTMENT, PATNA, NO. 230-VET., DATED THE 23RD JUNE 1932.

Referring to your letter dated January the 27th, 1932, submitting a scheme for investigating the passage of livestock through the province of Bihar and Orissa, which will be submitted to the Advisory Board Meeting to be held from the 18th to the 22nd July 1932, I am directed to say that in consequence of the heavy reductions which have been made in the funds available to this Council for research, and the fact that the Bihar and Orissa Government is not willing to make any contribution to the cost of this scheme, it is considered that the likelihood of the scheme being approved would be much greater if it were possible to arrange for the work to be carried out on more economical lines and if more details of the precise information to be collected were given.

Both from the point of view of development of trade in cattle and for the control of disease it is generally agreed that fuller information is needed than is at present available of the movements of cattle, which take place year by year throughout India, and as to their source of origin. For the purpose of grading up stock what is most required however, is an accurate survey of the breeds and types of cattle which exist and are required in the different areas which would have to be dealt with in any general programme of livestock improvement such as is required to produce results of any broad significance. For this purpose it is necessary to obtain not only information as to the movements of cattle but also to have for reference precise descriptions, with photographs and exact measurements of height, girth, etc., of typical animals of the recognised breeds, now existing in particular areas, which are considered worthy of preservation. If such descriptions were taken in

connection with the enquiry which is proposed regarding movements of cattle, and the areas defined in which valuable breeds are found and should be preserved, it is considered that greater value would be derived from the scheme, as this survey would be valuable as a basis on which to lay down a definite policy for the distribution of sires and as a check on the progress being made in the grading up of cattle in the future.

It is suggested moreover that the cost of the proposed scheme might be considerably reduced if the work were carried out under the existing livestock breeding and veterinary organizations of the province, working in collaboration, with an extra clerk at headquarters and three specially selected and experienced veterinary assistant surgeons, with a cattle sardar each as proposed in the original scheme, working under the Assistant Directors of Veterinary Services of ranges and furnishing the necessary information to Headquarters, as it is obtained.

In this way the necessity for employing a Livestock Expert costing Rs. 12,000 for the 2 year period and a veterinary inspector costing Rs. 4,800 might perhaps be avoided, while travelling allowances and contingent expenses could be correspondingly reduced, so as to bring the total cost of the scheme down to approximately Rs. 20,000 for the 2 years, and if an arrangement of this sort could be made it is felt that the scheme would have a better chance of being approved. This Council would be glad therefore to have the views of the Bihar and Orissa Government on the above suggestions as early, as is conveniently possible, so that they may be circulated to members for consideration when the subject is discussed at the next Advisory Board meeting due to take place from July 18th to 22nd.

SUBJECT II.

INVESTIGATION OF THE TRAFFIC OF LIVESTOCK THROUGH THE PROVINCE OF BIHAR AND ORISSA.

With reference to paragraph 2 of the note (Appendix XIII), already circulated on the subject mentioned above, attention is invited to the enclosed letter from the Government of Bihar and Orissa No. 312-D.R., dated the 10th July 1932, forwarding a revised scheme which should be substituted for the original scheme. The revised scheme which involves a non-recurring grant of Rs. 1,000 and a recurring grant of Rs. 16,040 spread over a period of two years, is now submitted for consideration.

SIMLA, S.W.,
The 15th July 1932.

CHARAN DAS,
Secretary.

COPY OF A LETTER FROM THE SECRETARY TO THE GOVERNMENT OF BIHAR AND ORISSA, EDUCATION AND DEVELOPMENT DEPARTMENT, TO THE SECRETARY TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 312-D.R., DATED THE 10TH JULY 1932.

With reference to your letter No. 230-Vet., dated the 23rd June 1932, I am directed by the Government of Bihar and Orissa in the Ministry of Education to forward herewith a revised scheme for investigating the passage of livestock through the province of Bihar and Orissa. The revision has been made on the lines suggested in your letter subject to local conditions and the total cost has been reduced to Rs. 17,000 for 2 years.

2. I am to request that the revised scheme may kindly be placed before the next meeting of the Advisory Board for discussion in substitution of the scheme previously submitted.

REVISED SCHEME FOR INVESTIGATING THE PASSAGE OF LIVESTOCK THROUGH THE PROVINCE OF BIHAR AND ORISSA.

A.—Technical.

Before any well considered programme of live-stock improvement can be devised or measures adopted for the control of diseases it is essential to have precise information on the following points :—

- (i) What are the types or breeds of cattle that are brought into the province from other parts of India for local use.

- (ii) What are the types or breeds of animals that pass through the province for use in the neighbouring provinces and what is the source of their origin.
- (iii) What types or breeds are bred in the province for local use and in what areas and
- (iv) What are the types or breeds bred locally for which there is a market in adjoining provinces.

2. There is a very large flow of cattle through Bihar and Orissa from West to East. There is also believed to exist a good deal of export of animals bred or reared locally in the province. No definite data, however, are available on the subject. Investigations on the above noted points are therefore essential in the interest of not only Bihar and Orissa but other neighbouring provinces which export or import cattle through this province. During the course of these investigations it is proposed to record detailed description of typical animals belonging to various types or breeds.

3. The result of these investigations will make it possible to lay down the correct policy to be adopted regarding the distribution of Sires of suitable type in particular areas. It will also help in controlling diseases and in checking progress in future in grading up of cattle in these areas.

B.—Financial.

1. Investigations to be carried out properly require the following minimum staff and expenditure. This special staff will work in close collaboration with the local Ranges staff and it is expected that the investigations will be completed within a period of two years. The direction of work will rest with the Director of Agriculture.

a. Non-recurring expenditure :—

	Rs.	A.	P.
Field equipment, Typewriter, etc.	1,000	0	0
Total	1,000	0	0

b. Recurring.

i. Staff :—

One Livestock Superintendent on Rs. 200 p.m. for two years	4,800	0	0
Two Livestock Inspectors on Rs. 60 p. m. each for two years	2,880	0	0
Three Cattle Sardars on Rs. 20 p. m. each for two years ..	1,440	0	0
One Typist Clerk on Rs. 50 p. m. for two years	1,200	0	0
Three peons on Rs. 10 p. m. each for two years	720	0	0

Total staff for two years 11,040 0 0

ii. Travelling allowance @ Rs. 2,000 per annum for two years 4,000 0 0

iii. Contingencies @ Rs. 500 per annum for two years .. 1,000 0 0

Total recurring Ra. .. 16,040 0 0

Grand total (Recurring and non-recurring

for two years 17,040 0 0

Or say .. 17,000 0 0

4. The Government of Bihar and Orissa owing to financial stringency are unable to finance the scheme. As the scheme is of more than provincial importance it is submitted to the Imperial Council of Agricultural Research for their favourable consideration. As the revised scheme now submitted is very modest it is hoped that the Imperial Council of Agricultural Research will sanction it.

APPENDIX XIV.

SUBJECT No. 18.

A SCHEME FOR THE CONTINUANCE OF INVESTIGATIONS ON DIFFERENT ASPECTS OF THE CEREAL RUST PROBLEM AND THE RECOMMENDATION OF THE SPECIAL COMMITTEE OF MYCOLOGISTS THEREON.

PROCEEDINGS OF THE MEETING OF THE SPECIAL COMMITTEE OF MYCOLOGISTS APPOINTED BY THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH TO WORK OUT A CO-ORDINATED SCHEME OF RUST RESEARCH AND TO CONSIDER THE REPORT ON THE WORK DONE ON 'WITHER TIP' INVESTIGATION OF CITRUS TREES BY DR. H. C. CHOWDHURY FOR THE YEAR ENDING 31st MARCH 1932.

The Committee sat at Rock House from 12 NOON to 2-30 P.M. on Saturday the 16th July 1932.

2. The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman*.
 2. Mr. R. G. ALLAN.
 3. Dr. W. McRAE.
 4. Dr. K. C. MEHTA.
 5. Mr. D. MILNE.
 6. Rai Bahadur SHEO RAM KASHYAP.
 7. Dr. B. N. UPPAL.
- Rai Sahib Malik CHARAN DAS, *Secretary*.

3. *Continuance of investigations on the different aspects of the cereal rust problem in India.*—The Committee first took up the scheme for the continuance of investigations on the cereal rust problem. The Committee had before it two definite schemes, viz., (i) Dr. Mehta's scheme for the continuance of his investigation for a further period of two years from the 1st April 1933 to 31st March 1935 (Enclosure III) and (ii) the Bombay Government's (Dr. Uppal's) scheme on physiologic forms of black rust fungus of wheat (Enclosure I).

4. At the request of the Chairman, Dr. Mehta indicated briefly the nature of the work he was doing. Thirty three random samples of black rust, 18 of brown and 19 of yellow were tested from 16 stations in the case of black rust and 10 in the case of brown and yellow rust. Dr. Mehta hoped to test between 125 and 150 single spore cultures during the next two years. Also 14 isolations and 4 single spore cultures of black rust and 2 single spore cultures of brown rusts had been established and tested. The scheme under consideration was sufficient to carry on the work till even 50 physiologic forms were found, if such a large number exists, which is not likely. If more than that number be found, then the work will have to be decentralised by the opening of subsidiary stations in the Punjab and in the South. Then alone would such an expansion be justifiable but not at this stage. In such an eventuality Dr. Mehta would be prepared to hand over his material in order to make room for his own work. If the number of physiologic forms was not found to be large, there would be no need to start subsidiary stations at all and by waiting for two years more no risk would be run of spending money needlessly now.

5. All the members of the Committee were convinced that Dr. Mehta had made remarkably good progress in the research since the original scheme was sanctioned and Mr. Milne and Dr. McRae both having visited the laboratory in Simla, spoke highly of the work. Mr. Milne thought that the study of physiologic forms would be best done by Dr. Mehta because he was already making study of life histories and conditions of spread. He was strongly of the opinion that Dr. Uppal's scheme should be postponed till April 1935 by which time Dr. Mehta had thrown a flood of light on the problem and further work might show whether it will be necessary to start a station in the South at all. Professor Kashyap said that from the data already recorded by Dr. Mehta, the conclusion was clear that the spores that infected the plains came from the hills. Since *Barberry* and *Thalictrum* have not been found to be connected with black rusts respectively placed in them, they might be left out of account. The solution of the problem then was simple; either

wheat-growing should be discontinued in the hills for a short period of years or resistant varieties should be grown there. The first alternative was impracticable and he hoped that the Council would continue the scheme as proposed by Dr. Mehta.

Mr. Allan said that at first he was inclined to think that there should be more than one station but he was now convinced that in present financial conditions and in view of the fact that the acreage of wheat in the south was so very small compared to that in the north, one station should suffice for the present.

6. Dr. Uppal said that in 1931 the Bombay scheme was postponed for two chief reasons: (1) on account of the expense, and (2) because the physiologic forms were expected to be few. The data recorded up to the present on physiologic forms covering only a few places on this vast Continent were not enough to settle the question as to their likely number. So far 3 physiologic forms had been isolated and Dr. Mehta had sufficient material to make it likely that more will be isolated, though in 1931 he (Dr. Mehta) had thought that it was very unlikely that we might have even half a dozen forms. The negative evidence was not sufficient to warrant the inference that *Barberry* and *Thalictrum* did not play a part in the production of physiologic forms. Random samples of rusts from the places mentioned would not solve the problem of the number of physiologic forms. What was wanted was intensive information for zones or wheat-growing tracts and to get that information a number of test wheats should be grown in nurseries in various places. That would give a surer indication of the physiologic forms present. Such work might be placed under the charge of one or two provincial mycologist who were interested in this problem. This would result in an intensive investigation of different wheat-growing areas and would thus lead to more rapid clearing up of the problems. The case of America was not parallel. Because of the central position of the State of Minnesota in the wheat-belt of the United States the work on black rust had been done at the University of Minnesota, that on brown at Maine in Indiana and that of yellow at Idaho. It would be seen that the centralisation of the work in the U. S. A. had been more or less on the basis of different wheat rusts.

7. Dr. Uppal pointed out that in 1929 black rust appeared in the Bombay Deccan and Karnatak much earlier than it did in the north. This observation has been confirmed and Dr. Mehta has shown that we have to look to local foci of infection for the annual outbreaks of rust in the Bombay Presidency and the surrounding areas and that the Himalayan ranges do not furnish inoculum to the wheat crop in western and southern India. This showed that there are two distinct zones which lend themselves to intensive study as regards over-summering and epidemiology of rust as well as the distribution of physiologic forms. It seemed then almost necessary to have at least two stations. Such an arrangement would enable a very intensive study to be made in the southern area simultaneously with that in the north. As regards the cost, the Bombay scheme provided for an annual expenditure of about Rs. 7,000 for a thorough and intensive study of the distribution of physiologic forms in the Bombay Presidency, the Southern part of the Central Provinces, the Kathiawar States and surrounding areas. As against this Dr. Mehta had incurred during the last year an expenditure of Rs. 6,500, had been able to cover only a few places and had isolated three physiologic forms. Further, Dr. Mehta now proposed that the Bombay scheme be postponed for another two years. In short in July 1932 the same arguments were brought forward as in January 1931.

8. Dr. McRae said that the solution of the problem of the part played or not played by the alternative hosts seemed to be a most important part of the work in hand. If it could be proved, and the results were negative so far, that the alternative hosts played no part, then we would be in the safe position that we would not expect to have new physiologic forms produced. Then the problem would be simply to find out those we had. He was not satisfied that the present method of getting the information by random sampling would furnish adequate information in a reasonably short period of time to be placed before those who are to undertake the work of breeding rust-resistant varieties of wheat. The suggestion in this connection made by Dr. Uppal would be more effective. If there were in India only a few physiologic forms, if they were universally distributed, i.e., if there were no more physiologic forms in the south than in the north and if there were no danger of others appearing, then we might not need other stations in the plains. The

conditional factors were too many. Dr. McRae was in favour of decentralising the work at this stage by starting the Bombay scheme in a modified form both for reasons of economy of time and of efficacy in carrying on the work.

9. In the end the Committee agreed by a majority of 4 to 2 to recommend for the Advisory Board's approval Dr. Mehta's scheme for continuance of his investigations for a further period of two years from 1st April 1933 to 31st March 1935 subject to certain modifications in the estimate of expenditure of the scheme (*vide* Section I of the Estimate of Expenditure attached to Enclosure III to the attached printed papers) as indicated below; Dr. Uppal's scheme to be held up meanwhile:—

I. Establishment.

1. *2 Assistants.*—The incremental scale of salary proposed by Dr. Mehta for the first two Assistants, namely, 200—20—220 was reduced by the Committee to a fixed salary of Rs. 200 per mensem.

2. *3rd Assistant.*—The scale of Rs. 150—10—160 was reduced to a fixed pay of Rs. 150 per mensem.

3. *4th Assistant.*—The grade of Rs. 150—10—160 was reduced to a fixed pay of Rs. 120 per mensem.

II. Equipment.

1. 3 greenhouses, one at Simla and 1 or 2 at Agra as required. The lump sum provision of Rs. 6,000 under this head was reduced to Rs. 5,500.

V. Compensation to the Officer-in-Charge.

For rent-free house at Agra College (for duties outside teaching) and out-of-pocket expenses. Dr. Mehta explained that the lump sum of Rs. 3,000 proposed under this head consisted of:—

	Rs.
(a) For rent free house at Agra College ..	1,200
(b) For duties outside teaching, i.e., Warden of the College.	900
(c) Out-of-pocket expenses, i.e., additional expenses incurred by him on account of his visits to Simla, etc., in connection with his investigation	900

The Committee allowed (a) and also (b) on the condition that Dr. Mehta was appointed as permanent Warden of the College. As to (c) the Committee considered that these expenses formed part of travelling allowance and should be met, subject to the operation of ordinary rules, out of the provision for Travelling Allowance and for this purpose the Committee decided to increase the provision under 'Travelling Allowance for officer.' [Item VI (1)] from Rs. 2,000 to Rs. 2,500. A revised estimate showing the expenditure as revised by the Committee is attached and shows a net decrease of Rs. 2,740 as compared with Dr. Mehta's estimate.

10. The Chairman asked Dr. Uppal to produce a revised estimate of expenditure on his scheme in case the Advisory Board wanted to consider it.

11. The Committee then took up consideration of Dr. Chowdhury's report on "Wither Tip" investigation of the Citrus (Subject 30-d of the Agenda) (Appendix XLVI) and expressed the view that good progress had been made in the investigation and suggested that Dr. Chowdhury's attention should be invited to the fact that *Colletotrichum gloeosporioides* is generally considered to be weak parasite usually attacking plants which for some reasons or other have become weak and that control measures should be directed towards keeping trees in good health as well as to prevention by spraying and dusting.

The Committee then terminated.

SIMLA;
The 17th July 1932.

CHARAN DAS,
Secretary.

ESTIMATE OF EXPENDITURE OVER THE CONTINUANCE OF INVESTIGATION ON " CEREAL RUSTS " BY DR. K. C. MEHTA AS REVISED BY THE COMMITTEE OF MYCOLOGISTS.

SECTION I.—*Extension of work at present in hand for a period of two years. April 1st 1933—March 31st 1935.*

Particulars.	@	1933-34.	1934-35.	Total of each item 1933-35.
<i>I. Establishment.</i>				
	p. m.			
1. 2 Assistants	200	4,800	4,800	9,600
2. 1 Assistant	150	1,800	1,800	3,600
3. 1 Assistant	120	1,440	1,440	2,880
4. 1 Assistant for work with kites and balloons at Agra Observatory for 4 months each year.	75	300	300	600
5. 1 typist and clerk	70-5-75	840	900	1,740
6. 2 laboratory bearers and 2 fieldmen	16	768	768	1,536
7. 1 bearer for assistant at Observatory—for 4 months each year.	15	60	60	120
8. 1 Chowkidar for greenhouses and other articles at Agra.	10	120	120	240
<i>II. Equipment.</i>				
1. 3 greenhouses, 1 at Simla and 1 or 2 at Agra as required.	..	5,500	..	5,500
2. Miscellaneous equipment including a small refrigerator for the Simla laboratory, glass and muslin cases, etc.	..	1,500	..	1,500
<i>III. Contingent Expenses.</i>				
1. Rent of laboratory at Simla up to Rs. 1,000 per year.	..	1,000	1,000	2,000
2. Maintenance and contingent expenses .. .. .	..	1,500	1,500	3,000
3. Collection of rust samples .. .. .	..	250	250	500
<i>IV. To Agra College.</i>				
For teaching arrangements	4,800 per year.	4,800	4,800	9,600
<i>V. Compensation to the Officer-in-Charge.</i>				
1. For rent-free house at Agra College	1,200 per year.	1,200	1,200	2,400
2. For duties outside teaching*	900 per year.	900	900	1,800
<i>VI. Travelling Allowance.</i>				
1. Travelling allowance for officer .. .. .	..	2,500	2,500	5,000
2. Travelling allowance for assistant .. .. .	..	1,500	1,500	3,000
Total .. .. .	..	30,778	23,838	54,616

*Provided Dr. Mehta is appointed permanent Warden of the College. He is at present officiating.

CONTINUANCE OF WORK ON THE DIFFERENT ASPECTS OF THE CEREAL RUST PROBLEM IN INDIA.

The Advisory Board of the Imperial Council of Agricultural Research at its meeting held in January 1931 considered certain proposals (Enclosure I) for investigations on the

physiologic forms of wheat rusts in Bombay, and decided (Enclosure II) that the proposals should lie over for the present and that in the meantime a reference should be made to a Committee of Mycologists, including Dr. Mehta, to work out a co-ordinated scheme of rust research; no definite time was fixed for the Committee, whose personnel it was left for the Chairman to fix, to submit its report.

2. It was intended that the Committee should meet as soon as possible after the results of investigations of Dr. Mehta's scheme on cereal rust which had been in progress since April 1930 were available as a discussion on inconclusive information was not desired and should be avoided.

3. Dr. Mehta has now submitted a scientific note (Enclosure III) in connection with the proposed scheme for the continuance of work on the different aspects of the cereal rust problem in India. In this connection copies are also enclosed of the Annual Reports of Dr. Mehta for the years 1930-31 (Enclosure IV), and 1931-32 (Enclosure V) and of his article on the cereal rust problem in India (Enclosure VI).

4. The Chairman of the Advisory Board has now appointed the undermentioned Committee for the purpose:—

1. Sir T. Vijayaraghavacharya, K.B.E., *Chairman (ex-officio)*.
2. Dr. W. McRae, M.A., D.Sc. (Ed.).
3. Dr. B. N. Uppal, B.Sc., D.Sc. (Iowa),
Plant Pathologist to the Government of Bombay.
4. Mr. D. Milne, B.Sc., C.I.E., I.A.S.,
Director of Agriculture, Punjab.
5. Mr. R. G. Allan, M.A., I.A.S.,
Director of Agriculture, United Provinces.
6. Rai Bahadur Sheo Ram Kashyap, M.Sc., I.E.S.,
Professor of Botany, Government College, Lahore.
7. Dr. K. C. Mehta, M.Sc., Ph.D.,
Professor of Botany, Agra College, Agra.

Rai Sahib Malik Charan Das, *Secretary (ex-officio)*.

5. The Committee will meet at Rock House, Simla, at 11 A.M. on Saturday the 16th July 1932 and submit a report which will be placed before the Advisory Board of the Imperial Council of Agricultural Research for consideration at its forth-coming meeting to be held at Simla on the 18th to the 22nd July 1932. This will enable the necessary sanction of the Governing Body being obtained in time to prevent any interruption in the present scheme of investigations on cereal rusts by Dr. K. C. Mehta which the Council has sanctioned for a period of three years and which sanction normally expires on the 31st March 1933.

6. The subject is now for the consideration of the Committee. It will appear that in his scientific note (Enclosure III) Dr. Mehta has proposed a certain amount of centralization of the survey work which forms the feature of the work between 1933 and 1938. This is specially a point on which the opinion of the Committee will be valuable.

CHARAN DAS,

Secretary.

The 4th June 1932.

ENCLOSURE I.

LETTER FROM THE ACTING CHIEF SECRETARY TO THE GOVERNMENT OF BOMBAY, REVENUE DEPARTMENT, TO THE SECRETARY TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NO. 4675-A./28, DATED THE 21ST MAY 1930.

SUBJECT.—*Investigations on virus diseases of plants and physiologic forms of wheat rust.*

I am directed by the Government of Bombay (Transferred Departments) to forward an application (Annexure I) from the Director of Agriculture for a grant-in-aid of

Rs. 1,03,710 for investigations on virus diseases of plant and physiologic forms of black rust fungus of wheat on the lines of the schemes drawn up by the Plant Pathologist. I am to add that the Government of Bombay support the application and trust that it will receive favourable consideration at the hands of the Imperial Council of Agricultural Research.

Annexure I.

LETTER FROM THE DIRECTOR OF AGRICULTURE, BOMBAY PRESIDENCY, POONA, TO THE CHIEF SECRETARY TO GOVERNMENT, REVENUE DEPARTMENT, BOMBAY, No. 493 OF 1930, DATED THE 5TH APRIL 1930.

SUBJECT.—*Application to the Imperial Council of Agricultural Research for grant-in-aid for schemes on Virus Diseases.*

I have the honour to forward herewith copy of letter No. F-74/370 of March 29th. 1930 (Annexure II), from the Plant Pathologist to the Government of Bombay (Dr. B. N. Uppal) and a scheme drawn up by him for co-operative investigation on virus diseases of plant (not printed) and another on physiologic forms of black rust fungus of wheat. I have the honour to request that these schemes may be put before the Imperial Council of Agricultural Research at their next meeting and I trust that the amount required will be sanctioned.

With regard to the research on the physiologic forms of black rust fungus of wheat, I would like to insist on the fact that although a very substantial subvention has been given by the Imperial Council of Agricultural Research to Dr. Mehta for work on wheat rust his investigation is of a totally different character dealing with the way in which the rust fungus is carried over from year to year, while the research now proposed deals with another problem and one of vital importance not only to plant pathologists but also to plant breeders and to farmers. I think, therefore, that the fact that one worker has already been subsidized for work on wheat rust should not prevent other workers being subsidized for the study of totally different aspects of the problem. I would also like prominently to bring to your notice the co-operative nature of this research. This co-operation is in accordance with the best principles of modern science and brings to bear on these two problems the concentrated efforts of three highly equipped men. Dr. B. N. Uppal is B.Sc. of the Punjab University and D. Sc. of Iowa. Dr. V. N. Likhite is B. A. B. S. (Bom.) and D. Sc. of Strasbourg and has experience in work in Holland and America. Mr. J. F. Dastur is M. Sc. (Bom.) and D. I. C. (Lond.). These three scientific workers with their differing outlook and equipment but with a single aim should therefore be able to do effective works towards the rapid clearing up of the problems which they now propose for assistance from the Imperial Council of Agricultural Research. The researches will be under the administrative control of Dr. B. N. Uppal, i.e., will be under the Bombay Government (the other two workers being collaborators) and the headquarters will be Poona, the laboratory being in the Poona College of Agriculture.

I would ask you to forward these schemes as early as possible with your strong recommendation for the necessary gift of money. The Imperial Council of Agricultural Research is to meet in Simla in the end of May and it is desirable that these schemes should be forwarded to the Secretary, Imperial Council of Agricultural Research, without delay. I am sending one advance copy of both the schemes and also a copy of this letter to the Secretary, Imperial Council of Agricultural Research for information.

Annexure II.

COPY OF LETTER NO. F-74-370, DATED 29TH MARCH 1930, FROM THE PLANT PATHOLOGIST TO GOVERNMENT, BOMBAY, POONA, TO THE DIRECTOR OF AGRICULTURE, BOMBAY PRESIDENCY, POONA.

SUBJECT.—*Research scheme on (1) virus diseases and (2) the physiologic forms of wheat rust.*

With reference to your letter No. 493, dated 5th December 1929 (not printed), I have the honour to enclose herewith two schemes, and to request that you will be good enough to approach the Imperial Council of Agricultural Research for a grant-in-aid for carrying

out research on these schemes. I also beg to state that the co-operation of Dr. V. N. Likhite, Director of Agriculture, Baroda, and Mr. J. F. Dastur, Mycologist to Government, C. P., Nagpur, has been arranged in connection with the schemes on virus diseases (not printed) and the physiologic forms of wheat rust (Annexure III) respectively, and that both these officers have obtained the permission of their respective Governments to collaborate with me in these investigations. It may, however, be noted that these officers will not, in any way, be responsible for the administrative control of the schemes; but they will fully collaborate with me in directing the research and by providing the necessary facilities in their provinces to the men engaged in the work.

2. I have enclosed detailed statements of the recurring and non-recurring expenditure for which it is requested that provision may be made for a period of five years in the first instance. It will also be noted that it is proposed to appoint a Special Mycologist, who will be in charge of both the problems. He will be assisted in his work by two Graduate Assistants, one in charge of each scheme. Since both the problems are of a highly technical nature, it will be necessary to appoint a well-trained person. The proposal that the Special Mycologist should be in charge of both the problems has certain advantages; it would enable us to effect a saving in the pay of the chief investigators (one for each scheme) who would ordinarily be required, as well as have a man of ripe experience in charge of the schemes. The headquarters of the Special Mycologist and his staff will be at Poona, where he will have adequate laboratory facilities at the Poona College of Agriculture. As regards investigation into the virus diseases of cardamom, it will probably be necessary to do a major portion of this work at Sirsi, and I feel that it will be possible to make provision for a small laboratory there within the contingent grant of Rs. 3,000 per annum provided for in connection with the scheme on virus diseases.

Annexure III.

PHYSIOLOGIC FORMS OF BLACK RUST FUNGUS OF WHEAT.

Co-operative investigation between Dr. B. N. Uppal, Department of Agriculture, Bombay, and J. F. Dastur, Esquire, Department of Agriculture, Central Provinces.)

The discovery of the phenomenon of physiologic specialisation in the fungi is undoubtedly one of the most important developments in plant pathology. Perhaps the most classical example of this phenomenon is furnished by the fungus, *Puccinia graminis*. It has been shown that this fungus consists of composite group-forms or varieties such as *P. graminis tritici* on wheat, *P. graminis avenae* on oats and some grasses and *P. graminis secalis* on rye, barley and some other grasses but not on wheat or oats. It has also been shown by Stakman and others in the United States, that the wheat variety is composed of component strains or physiologic forms. They have isolated and studied forty or more forms of *P. graminis tritici*. Some of the physiologic forms on wheat show slight morphological differences; but they are chiefly distinguished by their power of infecting different varieties of wheat, that is a variety of wheat may be immune from one or several physiologic forms of the rust fungus and susceptible to several others. There are varieties of wheat such as *Little Club* which is completely susceptible, and *khapli* which is extremely resistant to all the known physiologic forms in North America. However, in 1929 there was present in the breeding plots at Kirkee, Poona, a physiologic form to which *khapli* was highly susceptible. Further, it has been shown that several of the physiologic forms differ in their geographical distribution. Several factors affect the prevalence and distribution of these forms and it is likely that the difference in the climatic conditions in the various parts of a country plays no small part in the distribution of these forms.

It will be seen from the foregoing statement that in any work on the breeding of varieties of wheat resistant to black rust, it is of primary importance to know the prevalence of the physiologic forms in the area in which the new types of wheat are to be grown. It is therefore necessary that a thorough survey of the physiologic forms of the wheat rust should be made in the principal wheat-growing areas of this country. Stakman and others have also shown the value of these surveys in the study of the epidemiology of black (stem) rust. That is to say they have suggested the possibility that the physiologic

form survey may be used not only to explain certain facts in connection with the development of epidemics but also to predict the probable occurrence of epidemics. To explain more clearly, let us suppose that the only sources of infection in India are the barberries in the Himalayas, which produce aeciospores. Observations made in the United States have shown that the aeciospores are not carried any great distance from the infected barberry bush and that they are not able to withstand such adverse conditions as urediniospores, so that infection of nearby grains and grasses must take place soon after they are discharged from the aecia. Therefore, the infection of grains and grasses by aeciospores is for the most part local or limited in area. From the primary infection on wheat, the stem rust spreads outwards by the succeeding generations of urediniospores, which can be carried by wind long distances. Thus the urediniospores reach the wheat crops in the plains in the United Provinces and the Punjab (a matter of about 25 miles) and by secondary spread by urediniospores, the spread of stem rust may be traced for miles. Now, if it were possible to determine the physiologic forms in the North (i.e., in the plains at the foot of the Himalayas), it would be of value in predicting the probability of rust epidemics in the United Provinces, the Central Provinces, the Kathiawar States, Gujarat and North Deccan. That is to say, if the forms of rust in the North in any given year are predominantly those which cannot attack the wheats in the Central Provinces, Gujarat, etc., there would be little to fear even if the weather conditions were favourable for the development of epidemic in these areas. However, if the forms of rust in the North were such as could attack wheat normally in the Central Provinces, Gujarat, etc., there would be likelihood of an epidemic if the weather conditions were favourable.

It has been pointed out above that for breeding rust resistant varieties of wheat for a given area, it will be necessary to know the physiologic forms prevalent in that area. In India, the work on the breeding of rust resistant wheats has been done without any reference to the forms, and indications are that some of the work done in the Bombay Presidency will prove a failure. For instance, resistant wheats developed at the Kirkee Wheat Breeding Station have been found susceptible to rust when grown at Dharwar. Why is it that even under normal conditions Pusa 4 becomes severely rusted in certain areas and not in others, and then again in certain years in the same area where it is normally resistant? I am afraid it may not be possible to explain all the facts on the basis of weather conditions as the only factor in determining the resistance or susceptibility of a variety of wheat under different conditions. This problem is one of the most important in the field of plant pathology, and unless a breeder, is in possession of the necessary information about the relative prevalence and distribution of the physiologic forms in the different areas of this country, his work will be imperfect and may result in his labour of many years being wasted.

In order to determine the physiologic forms in different areas, the procedure to be followed will be somewhat as follows. A series of rust nurseries each consisting of a uniform set of wheat varieties, would be established at suitable points in the Bombay Presidency, the Kathiawar States and the Central Provinces (the United Provinces and the Punjab will be included as the work progresses). A number of selected varieties of wheat would be grown at these nurseries every year, each variety to be grown in two or three rod rows. They would be allowed to become infected in the natural way. Specimens of fresh uredinial material would then be collected at each of these nurseries, and would be sent to Pooona, where they would be used promptly to inoculate as many of the differential wheats as possible, grown in the greenhouse there [Details of the greenhouse are furnished below (Annexure I)]. The reactions of the differential hosts would be tested and the identity of the physiologic forms would be determined by means of a key to be worked out like the dichotomous key used by Stakman and Levine in their studies.

It has been pointed out above that the discovery of physiologic specialisation in *Puccinia braminis tritici* has made the work of the Plant breeder more complex since now he must take into consideration a large number of physiologic forms with their differential reactions. As these forms vary in number, prevalence and severity from year to year in the same area, it is therefore reasonable to assume that certain factors influence the prevalence of the forms and thereby the development of rust epidemics in the area. Seasonal weather conditions appear to be an important factor; but an attempt to analyse the relation

of this factor to the development of stem rust must take into consideration the effect of weather on all the phases of the life cycle of the rust, since the effect of weather on one phase of the life cycle may profoundly influence the development of another stage. We therefore also propose to study the relation of seasonal weather conditions to the development of rust epidemics in the wheat growing areas.

It is requested that these schemes may be sanctioned for a period of five years in the first instance, and the grant-in-aid required for five years for both the schemes will come to Rs. 1,03,710, the details of which are furnished below :—

Non-recurring Expenditure.

	Ra.
1. Greenhouse	2,000
2. One research microscope	750
3. Frigidaire model M.-12, capacity 12 cubic feet	1,600
Total	4,350

Recurring Expenditure.

Establishment.	1st year.	2nd year.	3rd year.	4th year.	5th year.
I. Pay—					
(1) Special Mycologist (Rs. 320-40-800).	3,840	4,320	4,800	5,280	5,760
(2) Clerk (40-5/2-80) ..	480	480	540	540	600
(3) Peon at Rs. 18 per mensem	216	216	216	216	216
Virus Diseases Scheme—					
(1) Graduate Assistant (Rs. 150-5-200).	1,800	1,860	1,920	1,980	2,040
(2) Non-Graduate Assistant (Rs. 40-5/2-80).	480	480	540	540	600
(3) Laboratory Boy at Rs. 18 per mensem.	216	216	216	216	216
Physiologic Forms Scheme—					
(1) Graduate Assistant (Rs. 150-5-200).	1,800	1,860	1,920	1,980	2,040
(2) Non-Graduate Assistant (40-5/2-80).	480	480	540	540	600
(3) Laboratory Boy at Rs. 18 per mensem.	216	216	216	216	216
II. Travelling allowance—					
(1) Special Mycologist and his peon.	2,500	2,500	2,500	2,500	2,500
(2) Staff	500	500	500	500	500
III. Contingencies—					
Including apparatus chemicals and cultivation charges—					
(1) Virus diseases scheme ..	3,000	3,000	3,000	3,000	3,000
(2) Physiologic forms scheme	2,000	2,000	2,000	2,000	2,000
IV. Reserve	1,000	1,000	1,000	1,000	1,000
Total	18,528	19,128	19,908	20,508	21,288

Total for above (non-recurring and recurring) is Rs. 1,03,710.

Greenhouse.—The details for building a greenhouse may be given as below :—

(1) Dimensions—15×30 ft.

(2) Glass roof and wooden trellies work on sides and Shahabad stone paving.

					Ra.	A.	P.
Roof—(glass pans 540 sq. ft.)	..	..	..	..	300	0	0
Trellis—(90'×8'=720 sq. ft.)	..	..	..	..	400	0	0
Brick pillars—(8×1½×1½×8)	..	..	..	..	60	0	0
Paving—(30×15=450 sq. ft.)	..	..	..	..	250	0	0
Wooden benches—(three)	..	..	..	..	75	0	0
Water basin	..	..	..	..	40	0	0
Piping (perforated) to make showers of rain	..	..	..	..	200	0	0
Finishing (paint, etc.)	..	..	..	..	100	0	0
Curtains (to protect from heat in summer)	..	..	..	..	100	0	0
Glass moist chamber	..	..	..	..	100	0	0
Mulin chambers for rust cultures and inoculation	..	..	..	..	100	0	0
Miscellaneous	..	..	..	..	275	0	0
					<hr/>		
					2,000	0	0

Frigidaire.—This is a very essential piece of apparatus which will be used in connection with both the investigations. In the investigation of physiologic forms, the uredinia material has to be preserved in a cool place before it will be used for inoculating the differential hosts. While studying the physiology of the different plant viruses and its making cross-inoculation studies, the viruses should be kept in a cool place, as high temperatures inactivate them. The importance of this apparatus is therefore obvious.

Special Mycologist.—As has been pointed out in the forwarding letter, the advantage of appointing one man to hold charge of both the schemes is to effect saving in the pay as ordinarily two men will be required, and in this way it will also be possible to engage a well-trained investigator by offering him a better pay.

Clerk.—There will be considerable office work and it will not be possible for the office clerk of the Plant Pathologist to Government, Bombay, to help the Special Mycologist in typing reports, preparing contingent, pay and travelling allowance bills, and carrying on the normal correspondence which these investigations will make necessary.

Travelling allowance.—It will be necessary for the Special Mycologist to undertake extensive touring in the Bombay Presidency, the Central Provinces and the Kathiawar States in connection with both the investigations, and the provision of Ra. 2,500 for the Special Mycologist and his peon for this purpose will barely be sufficient. It may be noted that the Special Mycologist will be able to manage his work within this grant, since in his tours, he will be able to collect data bearing on both the problems. This arrangement will effect considerable saving on the travelling allowances.

The provision of Ra. 500 for the staff is very moderate.

Contingencies.—The sum of Ra. 5,000 per annum has been provided for contingencies under both the schemes, and this may be considered as the *minimum* requirement. These include many miscellaneous charges, and some of the important items may be shown as follows ; (1) cost of maintaining the greenhouse at Poona ; (2) cultivation expenses at the various rust nurseries in Bombay, C. P. and the Kathiawar States ; (3) provision for labour ; (4) cultivation expenses in connection with the virus diseases of chillies, *bhendi* and cardamom ; (5) maintaining a small laboratory at Sirsi for the virus diseases of cardamom ; (6) cost of making insect proof muslin cages ; (7) cost of insecticides for the control of insect vectors ; (8) cost of transport of plant materials and specimens ; (9) sprayers, etc. ; (10) laboratory material including reagents for cytological work ; (11) seed and plant material for study ; (12) contingent charges of the office of the Special Mycologist including postage stamps, etc., etc. In fact, the provision will represent the minimum requirement, and it will not be possible to reduce this figure.

Reserve.—A reserve of Rs. 1,000 per annum is provided as it is not always possible to make provision for unforeseen expenditures. If at the end of the year, a portion or whole of this grant is not used, it will lapse to the Imperial Council of Agricultural Research.

Annexure IV.

NOTE BY DR. K. C. MEHTA, M. SC., PH. D., ON THE SCHEME FOR CO-OPERATIVE INVESTIGATION BETWEEN THE PLANT PATHOLOGIST TO GOVERNMENT, BOMBAY AND THE MYCOLOGIST TO GOVERNMENT, CENTRAL PROVINCES ON THE PHYSIOLOGIC FORMS OF BLACK RUST FUNGUS OF WHEAT.

- (1) A scheme for investigations on rusts of cereals in India is already in force under the auspices of the Imperial Council of Agricultural Research.
- (2) As far as India is concerned even the life-history of the black rust of wheat is yet obscure and the problem is being investigated at Simla and Almora.
- (3) It is premature therefore to conclude that barberry is definitely responsible for fresh out-breaks of black rust in India. In fact, work done during the last 8 years indicates that the factor of outstanding importance is the survival of uredospores from season to season in the hills.
- (4) In the absence of a definite proof of *Berberis* being an intermediate host for black rust of cereals in this country it is unsound to presume that there is a large number of physiologic forms of black rust that one has to deal with. Recent work in America has clearly shown that the ever increasing number of physiologic forms is due to hybridisation of different strains on *Berberis vulgaris*.
- (5) It may be mentioned here that *Berberis vulgaris* is exceedingly rare over the greater part of the area under cultivation in the hills in India.
- (6) I have recently had an opportunity of discussing the present position of the cereal rust problem in India with some of the foremost workers in the field including Professor Stakman, the discoverer of "physiologic forms" of black rust of cereals.
- (7) It is my candid opinion that before rushing into a big scheme we have to make sure of the fundamental fact whether there is at all a large number of physiologic forms of black rust in our country. I am of the opinion that on account of the absence of *Berberis vulgaris* over the greater part of the crop area in the hills it is very unlikely that we may have even half a dozen forms as against nearly 100 forms in U. S. A. In support of the above statement I would like to quote the case of Australia and Kenya where work on Physiologic forms has been recently done. Like India barberry is rare in both those areas and what do we find only 6 forms in Australia out of which only one is dominant and there are only 2 forms in Kenya.
- (8) Another important fact to bear in mind is that in India there are *two other rusts*—on wheat and one on barley which demand the same amount of attention at our hands as they are *even more destructive* than black rust in several important areas under wheat and barley.
- (9) As far as the scheme under report is concerned work on rusts without a laboratory in the hills is possible only for 2—3 months in the year and each year would mean a repetition of previous work because cultures cannot be kept going during a summer on the plains.
- (10) The basic work on rusts in India has got to be done in the hills and there is no getting out of that because of the conditions of weather. Workers like Prof. Stakman, Dr. Newton, Dr. Butler, Sir Biffen and others are in complete agreement with me on this point.
- (11) Work on physiologic forms of *all the three rusts of wheat* is badly needed in India and the problem being an all-India one, it is only right that work on different aspects be properly correlated in the interest of efficiency and economy. I for one cannot see the advantage of divorcing the scientific part of the investigations from the applied part because the former forms the basis for all measures of control.

(12) As a result of the discussion which I have recently had with Professor Stakman, I am going to start work of isolating collections of rust material from several places in the country with the object of making a preliminary study of physiologic forms of all the three rusts. Seeds of differential hosts are expected shortly from Messrs. Stakman, Mains and Hungerford, the three authorities on physiologic forms of black, brown and yellow rusts, respectively. The work will be done in the laboratories at Simla and Almora where cultures of rusts can be kept going all the year round.

(13) It is hoped that by April 1932 we will be able to get at the truth of the phenomenon, whether there are many physiologic forms under each of the three morphological species. By that time we also hope to know more about the life histories of black and brown rusts. A comprehensive scheme will then be prepared for work on all the three rusts and the co-operation of plant pathologists with provincial governments in the area of wheat cultivation would be indispensable.

(14) I am very glad to learn that besides myself there are workers interested in the cereal rusts problem in India and it would be a source of great pleasure and encouragement to me to seek their co-operation and to render them whatever help I can. When a more comprehensive scheme for different aspects of the problem is under preparation the plant pathologist of Bombay will be consulted along with others for the share of work each is willing to take up.

(15) Work on Cereal rusts and the breeding of resistant varieties is a large national scheme and cannot be undertaken without adequate equipment and laboratory facilities at suitable hill stations.

(16) For all practical measures the plant pathologists and plant breeders will have to work conjointly.

(17) I am sure that without preliminary study of the phenomenon of physiologic forms and until such time that we understand the life histories of the parasites concerned, isolated investigations on one single aspect of this huge problem will serve no useful purpose.

Appendix V.

NOTE BY DR. W. McRAE, M.A., D.Sc. (IOWA), IMPERIAL MYCOLOGIST, IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA.

* * * * *

Research on physiological forms of wheat rust.—This investigation is required in India and the time is ripe to commence it. The incidence of rust on the varieties of wheat in various localities points to the probability of there being several physiological forms of each rust and that these forms are not uniformly distributed throughout the area nor are they uniformly active but vary in intensity according to climatic conditions. As I mentioned to Dastur when he was acting for me in Pusa last year I think it necessary to have several centres of investigation throughout the wheat-growing area of India in the Punjab, U. P., C. P., Bihar and Bombay and the investigator in each centre should carry on the investigation much in the way suggested in the Bombay Scheme in order to discover and determine the various physiological forms in his area. Then a central station would be required where the forms from all the five stations indicated above could be collected, compared and unified. It would be convenient if this central station could be attached to one of the five centres of investigation at which a wheat-breeder was stationed. The work of the five stations might be considered as part of the normal work of the mycologist with or without financial help and guidance from the Research Council according to circumstances and the central station might be financed by the Council. When the investigation is complete each province interested will have an investigator with first-hand knowledge of the subject and the material and personnel of the central station, no longer required for the work, can be distributed or used for other suitable work. I think that for convenience of access it would be advantageous to have the central station situated in Northern India.

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ENCLOSURE II.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF THE
IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD AT NEW DELHI IN JANUARY
1931.

* * * * *

3. *Proposals for investigations on the physiologic forms of wheat rust in Bombay*:—Dr. Mehta spoke in explanation of his note (Enclosure VIII) on the Bombay scheme which had been circulated to the Board. He considered that there would be a definite advantage if this scheme were postponed till he could put before the Council the results of his investigations which he hoped would be completed by 1932. What he was after in his scheme was to breed rust resisting varieties for the hills. If this could be done the advance of the rust into the plains would be stopped to a great extent. He therefore felt that consideration of the Bombay scheme (Enclosure I) should be postponed for the time being and that later when the results from his own investigations were available a co-ordinated scheme should be drawn up with the help of Mycologists in India for an attack on the problems which would then remain to be solved. Dr. Mehta informed Professor Ganguli that his first report would be submitted in March 1931 but that would only be a progress report containing no conclusions. Dr. McRae said that the problem appeared to him to be as follows. Supposing Dr. Mehta found that the rust only came through the hills the thing became simple. There was no necessity then for breeding rust resisting varieties in the plains. If, however, it was found that forms of rust did exist in the plains then infection was not eliminated but only reduced by the growing of rust resisting varieties in the hills. In the latter contingency it would mean that instead of tackling the problem of rust in the plains now along side with Dr. Mehta's investigation into rust in the hills they would have to start two or three years later; he was not in favour of this loss of time. Mr. Burt said that he was in favour of waiting till the Council had before it Dr. Mehta's preliminary results. The big wheat growing area was concentrated in the North where the solid weight of wheat cultivation lay. Before therefore subsidiary investigations like the one proposed by Bombay (Enclosure I) were supported he should like to see the preliminary results and then have the matter discussed in the summer session of the Advisory Board in 1932. If Dr. Mehta was right that the rust came solely from the hills then the problem was simplified; if he was not correct then a much bigger organisation than had hitherto been contemplated would have to be evolved to tackle the problem on an all-India basis. He was therefore in favour of passing no opinion on the Bombay scheme (Enclosure I) till the summer meeting of the Advisory Board in 1932. In reply to Mr. Hilson who enquired whether the wheat plant was the only one which passed on rust to the plains Dr. Mehta replied that the chances were remote that plants other than wheat would transmit the kind of rust which affected wheat in the plains. The rusts of wheat and those found on grasses were totally different. Answering Dr. McRae, Dr. Mehta said that he was convinced that there was no rust which lived through the summer in the plains. The high temperature killed it. Mr. Carpenter was in favour of Mr. Burt's proposal to postpone consideration of the Bombay scheme, Dr. Agharkar in supporting the Bombay scheme said that rust appeared in the Deccan at the same time as in Northern India. If therefore it came from the hills how was it that it did not appear later in the Deccan than in Northern India. He thought it might be possible therefore that there were other sources of infection and he was in favour of allowing Bombay to carry on the investigation at the modest financial cost proposed. In reply to Dr. Hyder Mr. Main informed him that the altitude of Poona was about 2,000 feet above sea level, the maximum temperature being about 105° in the hot weather and in the seventies in the cold weather, while the minimum was about the freezing point. The maximum height of the Western Ghats was 4,500 to 5,000 feet. Dr. Mehta also in reply to Dr. Hyder said that the limit of cultivation in the Himalayas went up to about 9,000 feet. In the Kumaon hills no rust survived below 4,000 feet. Mr. Plymen referring to Dr. Agharkar's point as to the simultaneous appearance of rust in Northern India and Deccan said that there was no question of a race from north to south. The rust was probably there already. It was the climatic conditions which brought it out. He agreed that a comprehensive scheme should be drawn up with the help of Mycologists in India including Dr. Mehta and that the Punjab and the United Provinces which were the largest wheat growing areas in India should be brought into the scheme. Mr.

Milne agreeing with Mr. Plymen said that he noticed that the intensity of the rust did not seem to decrease with the distance from the hills and he thought that there might just be a possibility that rust survived in the plains from year to year. He therefore suggested that a committee should be appointed which would formulate a co-ordinated programme of research. Mr. Main pointed out that there was no reference to physiological forms in the Wheat Rust Scheme drawn up by Mr. Mehta a year ago and sanctioned by the Imperial Council of Agricultural Research. He pointed out that the Bombay Scheme was before the Council before Dr. Mehta turned his attention to the physiological forms of rust, and he thought that the argument that the scheme should be postponed, pending the discovery of the origin of rust, was not convincing especially as all the mycologists, except Dr. Mehta, including Dr. McRae, Dr. Uppal and Mr. Dastur were in favour of proceeding with the scheme. Mr. Devadhar was in favour of approving the Bombay's scheme.

The Board was of opinion that the Bombay scheme should lie over for the present and that in the meantime a reference should be made to a committee of Mycologists, including Dr. Mehta, to work out a co-ordinated scheme of rust research; no definite time was fixed for the committee, whose personnel it was left for the Chairman to fix, to submit its report.

ENCLOSURE III

A Scheme for the continuance of Investigations on "Cereal Rusts."

This note has been written in continuation of an article on "The Cereal-rust problem in India" published by the writer in *The Ind. Journ. Agr. Sc.*, Vol. I, Part III, 1931 (Enclosure I), where the various aspects of the problem on which further work is needed have been discussed in detail.

The present scheme of work on "Rusts of wheat and barley", which was sanctioned by the Council in 1930, will expire on March 31st, 1933.

Since the scheme was sanctioned two annual reports (Enclosures IV and V) have been submitted giving detailed information on the progress of the investigations in hand. A third report (Enclosure VII), dealing with preliminary studies of rust dissemination and physiologic forms of wheat rusts, for which an additional grant of Rs. 6,500 was made in October 1931, has also been sent to the Council.

In some previous publications, the writer has recorded the results of his study of the influence of weather conditions on rusts and the information collected up to the end of 1929 on the factors of their annual recurrence in India.

The following statement will show the present state of our knowledge on the different aspects of the problem, including the data obtained since 1929. The scope of further enquiry is also indicated under each head:—

- (1) Survey of the regional distribution of all the five rusts in India including the location of such places where over-summering of rusts is likely in the near neighbourhood of all important areas of wheat and barley cultivation.

At the outset it may be noted that on the plains of India in general, which occupy nearly 95 per cent. of the total area under wheat and barley, rusts are killed from year to year during the hot summer which follows the harvest. This undoubtedly is the most hopeful feature of the problem in this country, from the point of view of measures of control which may be adopted in course of time.

Rusts of cereals are perpetuated from season to season, largely by their uredospores, which are definitely known to over-summer on volunteers at different altitudes in the hills, wherefrom in all probability they are disseminated by wind, to the plains each year.

Evidence of the over-summering of rusts has been obtained from several additional stations in the hills since the present scheme was sanctioned. Black rust has been found to survive even at an altitude of 4,700 ft. above sea-level.

Study of the incidence of rusts in Nepal (Terai and higher altitudes) has yielded valuable information towards our understanding of fresh outbreaks in the neighbouring parts of British India.

Fresh outbreaks of yellow rust on new crops, within 1-2 months of sowing, near Simla and Muktesar have definitely been traced from rusted volunteers occurring within a few yards.

Study of the influence of weather conditions on rusts grown in miniature plots at Almora (5,000 ft. above sea level), Simla (6,700 ft.) and Muktesar (7,500 ft.) has given interesting data, which has an important bearing on the incidence of rusts at different altitudes.

Incidence of rusts has also been studied in the central parts of the country (both hills and plains) and in 1931-32 the area of study was extended to Bombay-Deccan and Madras including the Nilgiris.

We know now the approximate range of altitude and the weather conditions under which each rust should normally over-summer.

Further survey is needed in order to definitely locate the places which act as foci of infection in the different hills, where over-summering has been found to take place.

(2) A thorough survey of the *Berberis* situation in the hills and a study of the suspected connection between *B. vulgaris* or *B. aristata* and black rust as well as between species of *Thalictrum* and brown rust of wheat in nature.

The data obtained so far suggest, that as far as the plains are concerned species of *Berberis* and *Thalictrum* play little part in the yearly origin of black and brown rust of wheat respectively.

Inoculation experiments on wheat with the acedial stage occurring on *Th. javanicum* and *Th. neurocarpum* have given negative results in each case. Similarly, tests with aecidiospores occurring on some species of *Berberis*, have been ineffective and the typical aecidia of black rust have not been found so far either at Narkunda or in Nepal.

It is hoped, that further work will settle this doubt.

Survey of the part which *Berberis vulgaris* or *B. aristata* and species of *Thalictrum* may be playing at least locally is absolutely essential, because of the important bearing which their aecidia have on the number of physiologic forms of black and brown rusts, respectively.

(3) A complete study of the physiologic forms of rusts and their distribution in the different hills as well as the plains.

With regard to the study of physiologic forms, it may be mentioned, that random samples of black rust from Simla, Agra, Almora, Pusa, Poona, Bellary and Kotagiri (Madras) showed resemblances in their parasitic behaviour. Out of the 3 physiologic forms of black rust isolated so far, one is found in Kumaon, another in Simla hills and the third in Kumaon as well as Bombay-Deccan.

In the case of yellow rust it is significant to note, that random samples from Tansing (Nepal), Gorakhpur, Pusa and Saugor (C. P.) resembled in their parasitic behaviour.

Similarly, in the case of brown rust, samples from Gorakhpur and Agra, resembled each other, so did samples from Simla, Pusa and Jubbulpore.

It is needless to stretch the importance of this study because without adequate information about the different physiologic forms, studied from single spore cultures, the breeding of resistant varieties of wheat cannot be undertaken.

(4) Study of rust dissemination.

Results obtained from the study of aeroscope, slides exposed in the Punjab, United Provinces, Bihar, Rajputana, Central Provinces and Bombay-Deccan are of great interest and have corroborated the writer's contention that rust inoculum is wind-borne.

In the case of Bombay-Deccan this study has given a definite guidance towards the location of the foci of infection in the Nilgris or the ghats. Further work should soon settle this point.

With the help of ordinary kites it has been devised to secure longer exposure of slides, for catching spores from the air, than was possible with the mechanical spore trap on a hydrogen balloon, which was tried first.

One of the kite slides caught as many as 45 spores of black rust in 2 hours nearly 3 weeks before that rust appeared on the crop at Agra.

The importance of this study is evident and it should be continued till we have thoroughly understood the epidemiology of rusts in this country.

When adequate information on the various aspects of the problem outlined above has been obtained and we know the physiologic forms that may be occurring in the country the co-operation of plant breeders would be needed for breeding resistant varieties suitable for cultivation, in the hills and hilly tracts of the country, wherefrom the inoculum is blown down to the plains.

From a perusal of the facts stated above, it would be clear that these investigations should be continued for the sake of a fuller understanding of the problem as a whole in this country before actual measures of control can be adopted.

Keeping in mind the importance of the problem and its all-India nature, the estimate of expenditure, as given below, is very modest. In preparing the estimate fullest attention has been paid to the present financial stringency and the scheme has therefore been split up into two sections.

Section I.—For continuance of the work in hand at present for two years, April 1st, 1933—March 31st, 1935.

Total cost Rs. 57,400.

Section II.—For expansion of the scope of work, including survey in different provinces and provision for a sub-station in the South, if found necessary.

	Total cost Rs.
Period 3 years	1,55,000
Grand total for both the sections	2,12,400

The writer hopes that Section I of this scheme will be sanctioned now. Section II may be taken up two years hence, with any alterations, that are found to be necessary at that time.

In conclusion it may be repeated that a good deal of the ground has already been covered and in the light of the promising nature of the data obtained, the furtherance of investigations on this problem should lead to results of incalculable value to Agriculture in this country, as has been found in U. S. A. and Canada.

Reference may here be made to the following resolution which was passed at the fifth International Botanical Congress which the writer attended on behalf of the Council.

Resolution No. 4.—"That this Congress considers that the Government of all cereal producing countries should undertake investigations on cereal rusts in order to obtain general co-operation in the breeding of resistant cereals.

K. C. MEHTA,

M.Sc., Ph.D. (Cantab.),

Professor of Botany, Agra College, Agra.

SMLA ; †

The 30th May 1932.

**ESTIMATE OF EXPENDITURE OVER THE CONTINUANCE OF INVESTIGATIONS
ON " CEREAL RUSTS ".**

*Section I.—Extension of work at present in hand for a period of 2 years.—April 1st, 1933—
March 31st, 1935.*

Particulars.	@ Rs.	1933-34.	1934-35.	Total of each item 1933-35.
		Rs. As. P.	Rs. As. P.	Rs. As. P.
I. ESTABLISHMENT :—				
1. 2 assistants	200—20—220	4,800 0 0	5,280 0 0	10,080 0 0
2. 1 assistant	150—10—160	1,800 0 0	1,920 0 0	3,720 0 0
3. 1 assistant	150—10—160	1,800 0 0	1,920 0 0	3,720 0 0
4. 1 assistant for work with kites and balloons at Agra Observatory— for 4 months each year.	75 p. m. ..	300 0 0	300 0 0	600 0 0
5. 1 typist and clerk	70—5—75	840 0 0	900 0 0	1,740 0 0
6. 2 laboratory bearers and 2 field- men.	16 p. m. ..	768 0 0	768 0 0	1,536 0 0
7. 1 bearer for assistant at Observa- tory—for 4 months each year.	15 p. m. ..	60 0 0	60 0 0	120 0 0
8. 1 Chowkidar for greenhouses and other articles at Agra.	10 p. m. ..	120 0 0	120 0 0	240 0 0
II. EQUIPMENT :—				
1. 3 greenhouses, 1 at Simla and 1 or 2 at Agra as required.	..	6,000 0 0	..	6,000 0 0
2. Miscellaneous equipment including a small refrigerator for the Simla laboratory, glass and muslin cases, etc.	..	1,500 0 0	..	1,500 0 0
III. CONTINGENT EXPENSES :—				
1. Rent of laboratory at Simla up to Rs. 1,000 per year.	..	1,000 0 0	1,000 0 0	2,000 0 0
2. Maintenance and contingent expen- ses.	..	1,500 0 0	1,500 0 0	3,000 0 0
3. Collection of rust samples .. .. .	..	250 0 0	250 0 0	500 0 0
IV. TO AGRA COLLEGE :—				
For teaching arrangements ..	4,800 per year	4,800 0 0	4,800 0 0	9,600 0 0
V. COMPENSATION TO THE OFFICER-IN- CHARGE :—				
For rent-free house at Agra College (for duties outside teaching) and out-of-pocket expenses up to.	..	3,000 0 0	3,000 0 0	6,000 0 0
VI. TRAVELLING ALLOWANCE :—				
1. Travelling allowance for officer ..	..	2,000 0 0	2,000 0 0	4,000 0 0
2. Travelling allowance for assistants	..	1,500 0 0	1,500 0 0	3,000 0 0
Total ..	..	32,038 0 0	25,318 0 0	57,356 0 0 or 57,400

ESTIMATE OF EXPENDITURE OVER THE CONTINUANCE OF INVESTIGATIONS ON "CEREAL RUSTS".

Section II.—Expansion of the scope of work including survey in different provinces and provision for a sub-station in the South (if necessary).

Period.—April 1st, 1935—March 31st, 1938.

Particulars.	@Rs.	1935-36.			1936-37.			1937-38.			Total of each item 1935-38.
		Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.	
I. ESTABLISHMENT :—											
1. 2 assistants—1 for Simla Lab. and 1 for survey Punjab, U. P., Bihar, Bengal and Assam.	240—20—280	5,760	0	0	6,240	0	0	6,720	0	0	18,720 0 0
2. 1 assistant to work at Agra Lab.	170—10—190	2,040	0	0	2,160	0	0	2,280	0	0	6,480 0 0
3. 2 assistants—1 for Agra Lab. and 1 for survey Punjab, U. P., Bihar, Bengal and Assam.	80—10—100	1,920	0	0	2,160	0	0	2,400	0	0	6,480 0 0
4. 3 assistants for survey C. P., Bombay, Deccan and Madras.	75—5—85	2,700	0	0	2,880	0	0	3,060	0	0	8,640 0 0
5. 1 Typist and clerk	80—10—100	960	0	0	1,080	0	0	1,200	0	0	3,240 0 0
6. 5 laboratory bearers and fieldmen.	16 p. m. each	960	0	0	960	0	0	960	0	0	2,880 0 0
7. 1 chowkidar for green-houses and other articles at Agra.	10 p. m. . .	120	0	0	120	0	0	120	0	0	360 0 0
8. To arrangements for study of dissemination with kites and balloons at Agra Observatory—4 months each year :—											
(a) one assistant	75 p. m. . .	360	0	0	360	0	0	360	0	0	1,080 0 0
(b) one bearer . .	15 p. m. . .										
II. TO ARRANGEMENTS— <i>if necessary.</i> for whole-time services of officer in charge on the basis of income at time of appointment for the whole period of 3 years.	up to Rs. 50,000.	16,666	10	8	16,666	10	8	16,666	10	8	50,000 0 0
III. TO A VISIT— to U. S. A., Canada and Europe for comparative study.	..	6,000	0	0	..	..	..	..	..	..	6,000 0 0
IV. TO ONE SCHOLARSHIP— for training in synthetic breeding in U. S. A.	..	12,000	0	0	..	..	..	..	..	..	12,000 0 0
VI. CONTINGENT EXPENSES :—											
1. Rent of lab. at Simla.	1,000 per year	1,000	0	0	1,000	0	0	1,000	0	0	3,000 0 0
2. Contingent expenses and maintenance.	2,000 per year	2,000	0	0	2,000	0	0	2,000	0	0	6,000 0 0

Particulars.	@Rs.	1935-36.	1936-37.	1937-38.	Total of each item 1935-38.
		Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.
VII. TRAVELLING ALLOWANCES:—					
1. Travelling allowance for officer.	..	2,500 0 0	2,500 0 0	2,500 0 0	7,500 0 0
2. Travelling allowance for 5 assistants.	..	2,500 0 0	2,500 0 0	2,500 0 0	7,500 0 0
3. Travelling allowance for an annual meeting of mycologists co-operating in the scheme.	1,000 per year	1,000 0 0	1,000 0 0	1,000 0 0	3,000 0 0
Total ..	..	58,486 10 8	41,626 10 8	42,766 10 8	1,42,880 0 0
VIII. TO ARRANGEMENTS FOR A SUB-STATION IN THE SOUTH (IF REQUIRED):—					
1. 1 assistant ..	150—10—170	1,800 0 0	1,920 0 0	2,040 0 0	5,760 0 0
2. Rent of laboratory, one greenhouse, general equipment and contingent expenses.	..	3,840 0 0	1,200 0 0	1,200 0 0	6,240 0 0
Total ..	..	64,126 10 8	44,746 10 8	46,006 10 8	1,54,880 0 0 or 1,55,000 0 0
Total of Section I ..	..	..	..	..	57,400 0 0
Grand Total of Sections I and II.	..	..	..	..	2,12,400 0 0

ENCLOSURE IV.

INVESTIGATIONS ON "CEREAL RUSTS" UNDER THE AUSPICES OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, INDIA.

Annual Report 1930-31.

In December 1929 the Council sanctioned a grant of Rs. 45,000 for a period of three years for the continuance of my work on "Rusts of wheat and barley" in India which was started in the year 1923.

Accommodation for two rust research laboratories, one at Simla and the other at Almora and initial equipment were secured by March 1930. By the middle of April following work was commenced at both the places.

Three research assistants, each with an M.Sc. degree in Botany and special training in Mycology, were appointed in the grade of Rs. 150—25—200.

In October 1930 the assistant at Almora left service on account of ill-health and was relieved by one with similar qualifications.

Considering the fact, that it was the first year of their work on a problem of a difficult nature, the progress made by the assistants has been satisfactory.

Within two months of the commencement of the work, I had to go out of India, to attend the International Botanical Congress and Mr. Babu Lal Gupta, one of my colleagues at the Agra College, kindly supervised the work during my absence. My hearty thanks are due to him.

In addition to the three research assistants, the establishment consists of one clerk, two laboratory bearers and two fieldmen.

1. *Study of the incidence of rusts.*—During the period under report, the area for the study of incidence of all the five years (3 of wheat and 2 of barley) was extended, to include some more districts on the plains of U. P., Garhwal, Almora, neighbourhood of Simla, Narkunda, Saugor, Pachmarhi, Jubbulpore, Nagpur and Nepal Terai.

2. *Over-summering of rusts in the uredostage in the hills.*—Viable uredospores of all the rusts under study, were obtained on self-plants and tillers near Muktesar, (7,600 ft. above sea-level) during the critical period following the harvest of 1930. Yellow rust was also obtained on self-sown plants at altitudes of 6,400-7,000 ft., in the districts of Almora and Garhwal during the same period.

3. *Cultures of rusts at Almora and Simla.*—Throughout the period under report, cultures of all the rusts flourished at the laboratory at Simla. At Almora as anticipated the culture of yellow rust died during summer on account of warmer weather. It was re-established in October with material on volunteers occurring near Muktesar.

Both brown and black rusts flourished at the laboratory at Almora.

The most interesting evidence obtained during the period was, that both brown and black rusts of wheat survived during summer of 1930 as well as the last winter at Almora in miniature plots in the open. That suggests, the probability of the propagation of these two rusts by uredospores, from season to season, at lower altitudes, where summer is not so hot as on the plains and the winter is milder than at the higher altitudes.

4. *Experimental work with alternate hosts.*—No aecidia have been found on *Berberis Vulgaris* even at Narkunda and consequently no inoculations could be made.

Aecidia on *Thalictrum javanicum* and *T. Neurocarpum* were obtained from Muskhobra near Simla. Inoculations made on wheat with that material gave negative results.

5. *Cross inoculations with yellow and black rusts on wheat and barley.*—Yellow rust of wheat, when put on barley, always gave negative results. Similarly inoculations on wheat with yellow rust of barley, produced no infection.

It is clear therefore that as elsewhere these two rusts are rigidly specialized in this country.

On the other hand the black rust of wheat produced mild infection on barley and *vice versa*. They are not rigidly specialized as expected. Whether the black rust of barley is *P. graminis secalis* or not is under investigation and this point should soon be cleared up.

6. *Study of rust dissemination.*—I have already recorded, in the paper which was read by me at the last International Botanical Congress, results of preliminary tests on the dissemination of rusts by winds and the probability of the wind borne material being a source of initial infection of crops on the plains.

In 1929-30 uredospores of black rust were caught at Agra, on a slide, sent up on a hydrogen balloon and another exposed in an aeroscope 2 and 3 weeks respectively before that rust appeared on the crops at that locality. One of the slides exposed at Lyallpur caught spores of brown rust 2 weeks before it was noticed on the wheat crop.

This study was continued during the current year and the results have been very promising.

At Agra, Gorakhpur and Cawnpore rust spores were caught on several slides exposed in aeroscopes long before the period of appearance of rusts at those localities. On slides exposed at Nagpur only spores of black rust were caught.

A few spores of black rust were caught on a slide, sent up on a hydrogen balloon at Agra, as early as December 20th.

7. *Physiological forms of rusts of wheat.*—In December 1930 preliminary work on the "physiologic forms" of wheat rusts was undertaken by me at Agra, with the object of finding out, in a general way, if there is a large number of such forms occurring in the country and if their regional distribution is different.

This important study is entirely outside the original scheme and so far has meant no additional expense.

Work on physiologic forms will be continued at the laboratories at Simla and Almora during the coming summer.

With additional facilities, it should be possible to test a larger number of samples from each province during the next cold weather.

I hope that by April, 1932, we may get adequate data in the light of which, the number and location of provincial laboratories for intensive work on physiologic forms could be decided.

So far, samples of rusts from the following places have been tested :—

Simla, Almora, Adhartal (Jubbulpore), Saugor, Poona, Pusa, Gorakhpur, Agra, Lyallpur and Ropar (Punjab).

8. *Summary of additional data obtained during the period under report.*—(i) Yellow rust was observed on the wheat and barley crops near Muktesar on December 8th, nearly one month earlier than previous record. The occurrence of this rust on volunteers, during the critical period and at the time of sowing at Muktesar and places similarly situated, leaves little doubt, about its propagation from season to season by the uredospores and its spread to the plains later by wind borne infection.

(ii) At Barabanki (Lucknow district) a fair amount of brown and traces of yellow and black rusts of wheat were noticed as early as the last week of December 1930.

It is interesting to note, that in Nepal Terai, a regular epidemic of brown rust was found in the earlier part of January, 1931, whereas only traces of yellow and black were noticed.

(iii) The survival of brown and black rusts in miniature plots at Almora, throughout the summer of 1930 and the winter following, strongly suggests the probability of the propagation of these two rusts from season to season, at lower altitudes in the hills by uredospores. That lends experimental to proof my contention that these two rusts are disseminated to the plains from lower altitudes where on account of a mild winter their uredospores occurring at the time of sowing may cause outbreaks on the new crop rather early in the season. It is difficult otherwise to explain so early an outbreak of these rusts on the plains.

9. *Acknowledgment of co-operation.*—I am glad to be able to record the kind help and co-operation of the following to each of whom I offer my hearty thanks :—

(i) Drs. E. C. Stakman, C. C. Johnston and W. M. Bever of the United States Department of Agriculture for the seeds of differential varieties of wheat and keys, etc., for work on physiologic forms.

(ii) The Meteorological Department of India and Mr. G. Chatterji, the Meteorologist incharge of the Upper Air Observatory at Agra for help on the study of rust dissemination.

(iii) Rai Sahib J. C. Luthra, Agricultural College, Lyallpur, Mr. J. F. Dastur, plant pathologist to Government Central Provinces; Professor S. C. Roy, Agricultural College, Cawnpore; Mr. M. O. Varkery, St. Andrew's College, Gorakhpur and Mr. Babu Lal Gupta, Agra College, Agra for co-operation in the study of rust dissemination.

(iv) Dr. B. N. Uppal, plant pathologist to Bombay Government. The Imperial mycologist and the assistant mycologist at Pusa, Rai Sahib J. C. Luthra, Mr. J. F. Dastur, and Mr. M. O. Varkery for the supply of rust samples for study of physiologic forms.

10. Programme of work for the year 1931-32—

(i) During the year 1931-32, the area for the study of rust incidence will be extended to include the hilly tracts of Bombay, Deccan, the Punjab, Interior of Nepal and North-West Frontier Province.

(ii) for the study of rust dissemination slides will be exposed in aeroscopes at 12 different stations over the area of cultivation.

It is also proposed to give long-time exposure to slides on kites flown at Agra during the next cold weather for catching spores from the air on such days when the winds are blowing from the Himalays to the plains.

(iii) Some more inoculations will be made with aecidial material on *Thalictrum* if available. Inoculation will also be made with sporidia of brown rust on healthy *Thalictrum*.

Plant of *Berberis Vulgaris* have been obtained and they will be inoculated with sporidia of black rust at Simla and Almora.

(iv) In order to be able to test a larger number of samples of rust for study of physiologic forms it would be necessary to get a hot-house constructed at Agra and another at Simla. Besides, a research assistant would be needed for work at Agra.

Under separate cover I am sending two applications for an additional grant of Ra. 6,500 for suitable arrangements for work on physiologic forms during the next cold weather.

I take this opportunity of expressing my warmest thanks to the Council for having afforded the necessary facilities without which any further progress of the work in hand would have been impossible.

I am very grateful to the officers of the Council for their encouragement and prompt help in arrangements with Nepal Government for permission to one of my assistants to visit that area in connection with the work.

My thanks are also due to Dr. E. J. Butler, Director, Imperial Mycological Institutes, London and Dr. E. C. Stakman, Cereal Rust pathologist with United States Government for some valuable suggestions on the problem under investigation.

AGRA :

(Sd.) K. C. MEHTA,

M.Sc., Ph.D. (Cantab.),

Professor of Botany, Agra College,

Agra.

Dated the 7th April 1931.

ENCLOSURE V.

INVESTIGATIONS ON "CEREAL RUSTS" UNDER THE AUSPICES OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, INDIA.

Annual Report for 1931-32.

During the period under report work on cereal rusts was extended in the following directions—

- (i) For the study of incidence of rusts the interior of Nepal, Chakrata, Dalhousie, Murree, Quetta, several stations in Bombay-Deccan and Madras were visited in addition to those mentioned in the report for 1930-31.
- (ii) Aeroscope slides for the study of rust dissemination were exposed at 11 more stations, making a total of 16, over the area of wheat cultivation in different provinces.
- (iii) With the help of an additional grant of Ra. 6,500 which the Research Council kindly sanctioned in October last, scope of work on physiologic forms of wheat rusts was considerably enhanced. In the case of black rust, samples from 15 different stations were tested on its differential hosts. Samples from 8 different stations in the case of brown and 11 in the case of yellow were also tested on their respective differential hosts this year. (Annexure I).

Details of this work and tabulation charts for all the three rusts will be submitted soon as a separate report in accordance with the conditions of the grant.*

- (iv) With the kind co-operation of the Meteorologist in charge of the Upper Air Observatory at Agra study of rust dissemination was made locally with the help of hydrogen balloons as before and also with kites that were sent up thrice a week throughout the period—December 3rd—March 14th.

By the courtesy of the Delhi Flying Club a few slides were also exposed on aeroplanes in the neighbourhood of Delhi.

- (v) A miniature plot was established inside a cage at Muktesar to study if brown and black rusts can overwinter at that altitude (7,600 ft. above sea level).

1. *Study of the incidence of rusts.*—As before incidence of rusts was studied at several stations in the United Provinces, Punjab, Central Provinces, Bihar and this year also in Bombay-Deccan and Madras.

Visits were also paid to suitable localities in the hills at the time of sowing, to study the incidence of rusts on volunteers and tillers which may be directly responsible for the infection of the new crop at those places.

2. *Over-summering of rusts in the uredo-stage in the hills.*—Viable uredospores of rusts of wheat and barley were again found on volunteers and tillers several times near Muktesar during the critical period (June—September).

At several places in the districts of Almora and Garhwal a similar phenomenon was observed.

In the Simla hills yellow rust was found throughout the critical period at most of the following places:—

Theog, Patina, Mushobra, Narkunda, Fagu, Hindustan-Tibet Road, Kaithu, Kothkhai, etc. This rust was not found to oversummer below 6,000 ft. above sea level.

It is interesting to note that as early as October 31st this rust was found at Kothkhai side by side on self-sown plants and the new crop, which was hardly three weeks old.

In November it was observed at Kaithu on the new crop by the side of diseased volunteers.

Brown rust was also found to oversummer in the Simla hills and it broke out on the new crop by the end of November at Kaithu.

Black rust was fairly common during the critical period in the Simla hills and was observed on volunteers till the beginning of December last.

3. *Cultures of rusts at Simla and Almora and their study from miniature plots at Simla, Almora and Muktesar.*

Simla.—All the rusts under study flourished in cultures at the Simla laboratory.

The study of rusts in miniature plots has yielded interesting results:—

- (a) *Yellow rust.*—It survived during summer although the viability of the uredospores was not high (30—58%). Throughout winter this rust flourished in the miniature plot showing a germination of over 90%.
- (b) *Brown rust.*—This rust stood the summer better than yellow but showed poorer germination during winter. The percentage viability being as low as 38 in December last.
- (c) *Black rust.*—It flourished during summer showing nearly 30% higher viability than the yellow rust. As was expected the viability of this rust during winter was the lowest (26% in December). Its behaviour during the last winter suggests the possibility of its overwintering at places like Simla (6,000—7,000 ft. above sea level) if the weather happens to be mild and there is a little snow as happened to be the case in 1931-32.

*Since received. Please see Enclosure VII.

Almora.—Cultures of brown and black rusts flourished in the laboratory at Almora (5,900 ft. above sea level) but that of yellow died by the end of May. It may be pointed out here, that the culture of yellow rust died in the laboratory at Almora in the summer of 1930 as well. This fact explains why yellow rust cannot overwinter at lower altitudes.

In the miniature plots at Almora a similar phenomenon was observed :—

- (a) *Yellow rust* died by May 24th.
- (b) *Brown rust* died in the open by the middle of June but survived under shade. After the middle of July it flourished in the miniature plot.
- (c) *Black rust* flourished in the miniature plots throughout summer.

During winter all the three rusts flourished in the miniature plots at Almora, where on account of a lower altitude winter is rather mild.

Muktesar.—At Muktesar a miniature plot was started in October 1931.

Yellow rust flourished throughout the winter of 1931-32 at Muktesar showing a viability of 45-70%.

Brown rust stood the cold better than black and showed a viability of 10-40%. The lowest germination was found in December.

Black rust suffered most from cold showing a drop from 30% germination in November to only 1% in December and January.

As low a viability as 1% in the case of black rust even during a comparatively mild winter of 1931-32 strongly suggests, that in normal years this rust is killed during the excessive cold at places similarly situated like Muktesar (7,600 ft. above sea level) where there is a heavy snow-fall.

Brown rust may occasionally survive, at least as mycelium inside the host.

The yellow rust as has been remarked by the writer before, stands cold very well and is always the first to appear on the crop at higher altitudes year after year.

The fact stated above strongly support the contention which has been made before by the writer that the brown and black rusts are disseminated as uredospores from lower altitudes where summer is not so hot as on the plains and the winter is milder than at the higher altitudes.

4. *Experimental work with alternate hosts.*—No typical acidia of *Puccinia graminis* (black rust) have been found in nature so far. Consequently no inoculations could be made on wheat and barley. Inoculations with aecidiospores from species of *Berberis* other than *vulgaris* have yielded negative results as before.

Several attempts have been made to stimulate germination of teleutospores by treatment with chloroform vapour and 1% citric acid but so far without success. Straw with teleutospores of black rust collected in May—June 1931 at Simla and Almora and kept in the open throughout at those places was frozen in the refrigerator for 1-2 weeks and then subjected to alternate drying and wetting. So far no germination has been obtained.

This work will be continued and in the event of teleutospores germinating inoculations will be made on plants of *Berberis vulgaris* that have been raised from seed and transplanted from Narkunda.

If attempts to infect *Berberis vulgaris* succeed cross inoculations will be tried on the original hosts.

Several inoculations have been made on wheat with aecidiospores from *Thalictrum javanicum* and *Th. neurocarpum* at Simla but with negative result in every case.

It is very doubtful if the aecidial stage occurring on the above mentioned species of *Thalictrum* have any connection with the brown rust of wheat.

5. *Cross inoculations with black rust.*—Some cross inoculations were tried with black rust occurring on wheat and barley and they were both tried on Rye. Black rust of wheat

infected wheat and barley but not Rye. Black rust of barley infected barley, wheat as well as Rye. That shows that the rust on barley, as elsewhere, is not rigidly specialised as far as wheat is concerned. With regard to the infection on Rye it is not yet clear if the rust on barley is a mixture of *Puccinia graministritici* and *Puccinia graminis secalis* or it is *Puccinia graminis tritici* alone with power to infect Rye. This matter needs further elucidation and will be taken up during the next season.

6. *Study of "Rust dissemination" in relation to first outbreaks on the plains.*—This aspect of the work was extended to include as many as 11 more stations making a total of 16 for the year under report.

In order to provide for a longer exposure than was possible with balloon slides kites were sent up at Agra thrice a week for a period of nearly three months.

The data obtained are very interesting and clearly show that at each locality uredospores of a rust were caught from the air long before that rust appeared on the crop at that station. (Annexure II.)

From some of the stations where aeroscope slides were exposed reports stating dates of first appearance have not been received. It is necessary for a work of this kind that farm superintendents should record those dates as required by the instructions which were sent out with each aeroscope. It is hoped that next year dates of first appearance of the different rusts will be communicated to the writer in good time. At one of the stations all slides were exposed with the wrong side facing the wind.

7. *Preliminary study of physiologic forms of rusts of wheat.*—As stated above a separate report on this work will be submitted to the Council by the end of this month.*

8. *Summary of additional data obtained during the period under report*—

- (i) *Yellow rust.*—This rust was observed on the new crop as early as the end of October at Kotkhai (Simla hills) within ten yards of rusted volunteer wheat. The earliest previous outbreak of this rust on the new crop was observed at Muktesar in December 1930. At Kaithu near Simla this rust broke out on the new crop in November last by the side of diseased volunteers.

At Muktesar it was observed on the new crop on November 27th last and by the middle of January over 40% plants had got heavily infected by this rust.

The occurrence of this rust on self-sown plants and tillers throughout summer at comparatively high altitudes and its incidence at the time when the new crop comes up leaves no doubt about its propagation from season to season as uredospores. Evidently it gets disseminated by wind from the higher altitudes where it oversummers and as has been remarked before, it flourishes during winter.

- (ii) *Brown rust.*—This rust stands cold better than black and was observed on the crop near Simla for the first time as early as November 27th. It was found oversummering in the Simla hills several times and its appearance on the new crop so early as that, seems to be due to be last winter being mild. During the last winter the first snow-fall at Simla occurred in February and it was rather light.

At Simla up to the end of March this rust was rather rare showing only 1% plants infected. At lower altitudes in the Simla hills like Kandaghat, Solan, Dharampore, etc., it was fairly common in March.

At Muktesar this rust was not found on the crop up to the end of March last.

At Almora it was noticed in the 1st week of March.

It is interesting to note in this connection that in Nepal Terai this rust was very common in December—January (1930-31), and was actually an epidemic at some of the places in that area. At that time there was no trace of this rust in the Central parts of United Provinces and it had just started appearing on the border line of Nepal towards Gorakhpur.

*Since received. Please see Appendix VII.

This year again this rust was found fairly well advanced at Tansing (3,500 ft. above sea level) and at several places in Nepal Terai during the month of January when it was completely absent in the Central parts of United Provinces and was found only in traces at a place likely Bareilly.

It seems very probable that this rust should oversummer also at comparatively low altitudes (near about 5,000 ft.) under moist conditions. At such localities there seems to be no reason why it should not flourish throughout winter as it does at Almora.

The data obtained so far strongly suggest that there are several localities in the Himalayan range wherefrom this rust is blown down comparatively early (December—January) each year. A thorough survey should enable one definitely to locate such foci before long.

This rust like the other two has been observed to appear earlier at the foot of the hills than on the plains for the last 9 years.

(iii) *Black rust.*

The observations made above apply in a general way to this rust also. This rust can stand warmth better than brown but suffers more from cold than the latter.

At Someswar (4,750 ft. above sea level) this rust was found overwintering on self-sown plants and tillers in July 1931.

It was also found to overwinter at Kandaghat (nearly 4,700 ft. above sea level) in the Simla hills in July last.

Overwintering of this rust at altitudes of below 5,000 ft. in Kumaon and Simla hills suggests that it may survive through summer even at altitudes of near about 4,000 ft. under moist conditions. It seems probable that this rust should survive, at any rate as mycelium inside the host, at those localities where normally the maximum temperature keeps below 100°F. provided there is enough of moisture.

With regard to the annual outbreak of this rust over the Indo-Gangetic plain during January—February there seems to be little doubt that the inoculum gets blown down from comparatively low altitudes in the Himalayas. Knowing as we do that normally this rust does not appear on the crops at Simla and Muktesar even by the end of March the higher altitudes could never act as foci of infection for crops on the plains.

(iv) *Incidence of rusts at the time when the new crop comes up as a direct source of infection.*

In addition to regular observations that are made in the Kumaon and Simla hills several other stations were visited during October—November last to study the incidence of rusts near about the time when the new crops are up.

October 1931 :—

Chakrata (nearly 7,000 ft.) only yellow rust was found on self-sown plants.

Murree (nearly 6,000 ft.) both brown and black rusts were observed on self-sown plants.

Dalhousie (nearly 6,500 ft.) yellow and brown rusts were present.

Quetta (5,500 ft.) no rust was found.

November 1931 :—

Mount Abu (3,800 ft.) no self-sown plants and no rust.

Ahmednagar (nearly 2,000 ft.) no rust.

Mahabeshwar (4,000 ft.) self-sown plants were healthy. Only a pustule or two of black rust on the new crop.

Satara (over 2,000 ft.) no self-sown plants, no rust.

Pachmarhi (nearly 3,500 ft.) no rust. Crop perfectly healthy.

(v) *Study of rust incidence in Bombay-Deccan and Madras.*

In view of the outbreak of black rust at Dharwar (Bombay-Deccan) in the last week of November it was found necessary to study the incidence of that rust in Bombay-Deccan.

The Plant Pathologist at Poona kindly arranged a tour and accompanied the writer to Mahabaleshwar, Ahmednagar, Dohad and some places in the neighbourhood of Poona towards the end of December last.

At Panchgeni black rust had just started appearing. At Lingmala one of the fields showed 15-20% plants infected. At Shiraval (25 miles from Poona) and between the first and second ghats there was a heavy infection. At Poona the infection was moderate.

In continuation of the same tour the writer went to Madras Presidency. At Bellary there was a severe epidemic of black rust. At Coimbatore the crop was perfectly rust free.

In the Nilgiris the writer found the following rusts :—

Yellow and dwarf rusts of barley.

Yellow and brown rusts of wheat and only traces of black rust on stubble from the crop that had been harvested some weeks before.

Judging from so early an outbreak of black rust at Dharwar which appeared more than a month earlier than the earliest outbreak known to the writer in the United Provinces it is clear that the inoculum for the crops in Bombay-Deccan, Madras, Hyderabad, etc., is disseminated from a different source.

The writer has already pointed out the possibility of the overwintering of this rust at comparatively low altitudes under moist conditions.

It is almost certain that this rust should survive the summer at suitable altitudes in the hills in the South and possibly also in the hilly tracts.

Further work with the help of aeroscope slides should soon clear up the matter. Arrangements for the exposure of slides in aeroscopes have already been made with the departments of Agriculture in Mysore, Madras and Hyderabad.

9. *Programme for work for the year 1932-33 :—*

- (i) For a further study of rust dissemination aeroscopes will be exposed at 18 more stations in Mysore State, Madras, Hyderabad, Bombay-Deccan, Sind and Bengal.
- (ii) Study of slides exposed on kites and aeroplanes will be continued.
- (iii) Incidence of rusts will be studied at suitable times of the year in the ghats, Nilgiris and the Palni hills.

This study will also be extended to the Kangra valley and on the route between Simla and Mussoorie.

- (iv) Work on physiologic forms of rusts of wheat will be further enhanced by establishing single spore cultures from samples already received. Fresh samples from new stations will also be tested.

10. *Acknowledgment of co-operation from workers outside India, officers of the Department of Agriculture in different provinces and others :—*

The writer is very grateful to the following workers for their kind help and co-operation in the investigation in hand :—

- (i) Drs. E. C. Stakman, C. O. Johnston and W. M. Bever of the United States Department of Agriculture.
- (ii) Drs. Th. Roemer, C. C. Allison and K. Isenbeck, of the University of Halle, Germany.
- (iii) Dr. H. T. Gussow, and M. Newton of the Department of Agriculture, Canada.
- (iv) Mr. J. McDonald, of Kenya.
- (v) Dr. W. L. Waterhouse, University of Sydney, Australia.

- (vi) Dr. E. J. Butler, of the Imperial Mycological Institute, London; Professor Sir R. H. Biffen, Professor F. L. Engledow; and Mr. F. T. Brooks of the University of Cambridge.
- (vii) Agricultural officer, North-West Frontier Province; Rai Sahib J. C. Luthra Agricultural College, Lyallpur; M. O. Varkey, Esq., St. Andrew's College, Gorakhpur; P. K. Dey, Esq., Agricultural College, Cawnpore; the Imperial Mycologist, Pusa; Deputy Directors of Agriculture, Jubbulpore and Hooshangabad, Central Provinces; J. F. Dastur, Esq., Agricultural Institute, Nagpur; Kanhaya Lal, Esq., Government College, Ajmer; Dr. B. N. Uppal, Agricultural College, Poona, Economic Botanist, His Exalted Highness Nizam's Agricultural Department Meteorologist in charge of the Upper Air Observatory at Agra.

The writer is very grateful to the Directors of Agriculture in the different provinces of India for making arrangements with their officers for the supply of rust samples and exposure of slides on aeroscopes.

The writer hopes to get still greater co-operation from the superintendents of the various farms where aeroscopes are exposed and wherefrom samples are despatched.

The writer is very grateful to the Government of Nepal for kind permission granted to one of the assistants for visiting that territory in connection with the study of incidence of rusts.

The officers of the Imperial Council of Agricultural Research have always been very kind and accommodating and the writer wishes to express his warmest thanks for facilitating the work in every way.

AGRA :

Dated the 9th May 1932.

K. C. MEHTA, M.Sc., Ph.D. (Cantab.),

Professor of Botany, Agra College,
in charge of the Investigations on
"Cereal Rusts."

ANNEXURE I.

Statement showing the names of stations from which samples of rusts were obtained and tested for the study of Physiologic Forms.

(1931-32).

Province.	Station.	Rust tested.	Remarks.
I. Punjab, N.-W. F. P., Baluchistan, and Sind.	1. Lyallpur ..	Yellow and Black.	
	2. Gurdaspur ..	Yellow.	
	3. Simla	Yellow, Black and Brown.	
	4. Kurram valley ..	....
	5. Sakrand ..	....
II. United Provinces and Nepal.	6. Gorakhpur ..	Yellow and Brown.	Yellow received late, culture established.
	7. Chandausi ..	Do.	
	8. Lucknow ..	Brown.	Black received late, culture established.
	9. Cawnpore ..	....
	10. Muktesar ..	Yellow.	Black and Brown received late, cultures established.
	11. Almora.. ..	Yellow, Black and Brown.	
	12. Agra	Do.	
	13. Allahabad ..	....
	14. Tansing ..	Yellow.	

Province.	Station.	Rust tested.	Remarks.	
III. Rajputana, Central India and Central Provinces.	15. Ajmer ..	Black.	<i>Brown</i> received late, culture established.	
	16. Jubbulpore ..	Black and Brown.		
	17. Nagpur ..	Black ..		
IV. Bihar, Bengal and Assam.	18. Saugor ..	Yellow and Black.		No rust reported from Bengal.
	19. Pusa ..	Yellow, Brown and Black.		
V. Bombay-Deccan and Hyderabad.	20. Poona ..	Black.		
	21. Niphad ..	Black.		
	22. Dharwar ..	Black.		
VI. Madras ..	23. Hyderabad ..	Black.		
	24. Bellary ..	Black.		
	25. Kotagiri ..	Black.		

ANNEXURE II.

STUDY OF "RUST DISSEMINATION" IN RELATION TO THE FIRST OUTBREAKS ON PLAINS.
Data obtained with the help of slides exposed on hydrogen balloons, aeroscopes and kites
1931-32.

Station.	Date of first spore shower.	Date of appearance.	Remarks.	
YELLOW RUST.				
Lyalpur ..	9th January 1932 ..	22nd January 1932.		
Gurdaspur ..	24th December 1931 ..	15th January 1932.		
Rupar (Shiampur)..	30th December 1931 ..	15th January 1932.		
Agra (Bichpuri) ..	30th January 1932 ..	2nd week February 1932.		
Gorakhpur ..	18th December 1931 ..	1st week January 1932.		
Pusa ..	20th December 1931 ..	23rd January 1932.		
Agra (kite slides) ..	24th December 1931 ..	2nd week February 1932.		
BROWN RUST.				
Agra (Bichpuri) ..	20th January 1932 ..	2nd week February 1932.		Material was collected by our assistant on that date.
Pusa ..	24th December 1931 ..	23rd January 1932.		
Ajmer ..	18th November 1931 ..	26th February 1932.		
Nagpur ..	22nd January 1932 ..	6th March 1932 ..		
Agra (Kite slides) ..	11th January 1932 ..	2nd week February 1932.		
BLACK RUST.				
Agra (Bichpuri) ..	27th January 1932 ..	3rd week February 1932.	Ditto. Ditto. Very early spore shower. The very first slides exposed caught spores. Crop sown very late.	
Pusa ..	13th December 1931 ..	22nd February 1932.		
Ajmer ..	14th November 1931 ..	26th February 1932.		
Nagpur ..	14th December 1931 ..	6th March 1932 ..		
Jubbulpore ..	19th January 1931 ..	3rd March 1932 ..		
Dharwar ..	22nd October 1931 ..	26th November 1932..		
Poona ..	15th October 1931 ..	2nd week November 1931.		
Niphad ..	22nd October 1931 ..	1st week January 1932.		
Agra (Kite slides) ..	2nd January 1932 ..	3rd week February 1932.		

ACTUAL EXPENDITURE INCURRED DURING 1931-32.

	Rs.	as.	p.	Rs.	as.	p.
I. Establishment:—						
1. Pay of three Research Assistants (from March 1st, 1931—February 29th, 1932)	5,592	13	8			
<i>Less 10% emergency cut</i>	157	0	0			
				5,435	13	8
2. Pay of a typist and clerk (from March 1st, 1931—February 29th, 1932)	642	9	0			
<i>Less 10% emergency cut</i>	18	0	0			
				624	9	0
3. Pay of 4 laboratory bearers (from March 1st, 1931—February 29th, 1932)	680	5	6	680	5	6
II. Travelling Allowances—						
4. Travelling allowance of officer	2,674	15	0			
5. Travelling allowance of Assistants.. .. .	1,218	2	9			
				3,893	1	9
III. Contingencies—						
6. Rent of laboratories	1,161	4	0			
7. Equipment and contingent expenses	1,100	15	3			
				2,262	3	3
Grant Total				12,896	1	2
Expenditure during 1930-31				13,219	3	6
Total				26,115	4	8
Balance				18,884	11	4
Amount granted for this scheme Total				45,000	0	0

K. C. MEHTA.

ENCLOSURE VI

THE CEREAL-RUST PROBLEM IN INDIA BY DR. K. C. MEHTA, M.Sc., Ph.D. (CANTAB.), PROFESSOR OF BOTANY, AGRA COLLEGE, AGRA.

In view of the fact that only two years ago the writer published an account of his study of the "Annual recurrence of rusts on wheat in India" [Mehta, 1929] along with a review of earlier and contemporary work on the problem of cereal rusts done in other countries, a detailed discussion of the problem again would mean unnecessary repetition.

This article has been written at the instance of the Imperial Council of Agricultural Research and may be read in continuation with a paper on "Annual outbreaks of rusts on wheat and barley in India", which will be found elsewhere in this journal and was read by the writer as an invitation paper for a discussion on the "Dissemination of cereal-rusts" at the last International Botanical Congress held at Cambridge in August, 1930.

It is unnecessary to stress the importance of investigations on cereal-rusts for a country like India where there are as many as 30,500,000 acres under wheat, and the barley crop covers another 7,000,000 acres each year.

The writer has already suggested the possible measures of control which will have to be adopted in course of time if a considerable part of the huge sum of Rs. 40,000,000 has to be saved out of an annual loss due to rusts of wheat alone in this country.

It is time we reviewed the problem in the light of recent work done in the United States of America, Canada and other important wheat-growing countries of the world. Work on similar lines will be necessary for a proper understanding of the problem as a whole in this country, before actual measures of control can be adopted over the entire area under wheat and barley.

The present state of our knowledge of the recurrence of rusts in this country may be summarized as follows:—

- (1) Rusts of cereals are perpetuated from season to season largely by their uredospores which oversummer at different altitudes in the hills.
- (2) As far as the plains are concerned, *Berberis vulgaris* and species of *Thalictrum*, the two alternate hosts for the black rust of cereals and the brown rust of wheat respectively, play little part in the yearly origin of those rusts.

Study of cereal-rusts in India has furnished one of the most interesting examples of the influence of weather conditions, particularly temperature, on the different parasites concerned. Data obtained so far about yellow rust in India have corroborated the observations previously recorded by the writer [Mehta, 1923]. This rust can stand cold very well but cannot oversummer in India except at higher altitudes. Outbreak of this rust on wheat and barley crops at higher altitudes as early as December-January each year suggests the probability of its dissemination to the plains by wind-blown uredospores.

With regard to the brown rust of wheat and the black rusts of wheat and barley, the writer has already recorded that the source of infection seems to spread to the plains from lower altitudes where, on account of a mild winter, uredospores of these rusts occurring at the time of sowing may cause outbreaks on the new crops rather early in the season. The above contention of the writer has been recently corroborated by work done at Almora, where both these rusts have survived in the open on miniature plots since the beginning of May 1930 and are alive up to the time of writing (8th February, 1931). Recent work has also cleared up our doubts about the disappearance of the uredo-stage of these two rusts during winter at Muktesar, which is only 14 miles from Almora but is nearly 2,500 ft. higher (altitude 7,600 ft.), and where the winter is intensely cold. The oversummering of brown and black rusts is not unlikely even at altitudes slightly lower than that of Almora (nearly 5,000 ft.) because they can stand warm weather better than yellow rust. At any rate the black rust, which can resist warm weather even better than brown, should be able to oversummer at altitudes of nearly 3,000—4,000 ft. above sea-level under moist conditions.

The data obtained so far clearly indicate that in India yellow rust survives in the uredo-stage all the year round at higher altitudes on account of a temperate climate. The brown and black rusts oversummer at higher as well as lower altitudes, but survive during winter only at the latter. The brown rust may survive as mycelium inside the host, but there is little likelihood of black rust surviving the winter at the higher altitudes because of plenty of snow.

In the light of the circumstances mentioned above the cereal-rust problem in India appears to be unique and should be far easier to tackle than is the case elsewhere. For instance, if our rusts are mainly propagated year after year by the uredospores, as seems probable, the serious complication in the way of breeding varieties of wheat resistant to brown and black rusts, on account of a large number of physiologic forms, does not arise. In the United States of America, on account of the hybridization on *Berberis vulgaris* which occurs over the greater part of the area under cultivation, there are 100 physiologic forms of black rust of wheat alone. In view of this serious difficulty in the way of breeding resistant varieties, the United States government are spending large sums of money every year over the eradication of barberry bushes in order to save their cereal crops.

In India the absence of *Berberis vulgaris* and *Thalictrum* on the plains, which cover nearly 95 per cent. of the entire area under cultivation, is the most hopeful feature for measures of control.

If a careful survey in the hills ultimately establishes the fact, which seems probable, that *Thalictrum* and *Berberis vulgaris* (which occurs only at altitudes of 8,000—12,000 ft.) get rusted late in the season (March-May), and are therefore ineffective as far as the crops on the plains are concerned, the solution of this problem should be within sight in this country. The writer finds it difficult to understand as to how our crops on the plains could get rusted as early as December-January if the alternate hosts were responsible for fresh outbreaks of both brown and black rusts, because we know it definitely that these

two rusts appear at higher altitudes nearly three months later. That should leave little doubt about the part which alternate hosts play at any rate as far as outbreaks on crops on the plains go. Consequently survival of all the five rusts in the uredo-stage in the hill strikes one as a factor of outstanding importance in the annual recurrence of rusts on the plains of India.

Under the auspices of the Imperial Council of Agricultural Research a physiological study of all the rusts under report is in progress at the laboratories at Simla and Almora, where the life-histories of brown and black rusts are also under investigation. A study of the dissemination of rusts by wind was started in January, 1930, with the co-operation of the Meteorological Department, and the results obtained so far are very promising. It is proposed to extend the scope of this work by catching spores on kites at Agra in addition to the exposure of slides in aeroscopes, which is being done at present at six different stations over the area under cultivation.

Only recently a preliminary study of physiologic forms of rusts of wheat has been started by the writer with the object of finding out, in a general way, if there are many physiologic forms in this country, and if the forms occurring in various localities, including the hills, are different.

The following are the different aspects of the cereal-rust problem which still need intensive work in this country :—

- (1) A thorough survey of the barberry situation in the hills and a study of the suspected connection between barberry and black rust as well as between species of *Thalictrum* and brown rust of wheat in nature.
- (2) A combined survey of the regional distribution of all the five rusts in India and a survey of places, where oversummering of rusts is likely in the near neighbourhood of all important areas of wheat and barely cultivation.
- (3) A study of the different physiologic forms of rusts, their regional distribution in the hills and the neighbouring plains. Side by side with this work a study of the pathogenicity of the different physiologic forms on well-known varieties of Indian wheats would be of immense use for the selection of varieties suitable for cultivation and breeding purposes.
- (4) Study of rust dissemination.
- (5) When adequate information on the various aspects of the problem outlined above has been obtained and we know the physiologic forms that may be occurring in the country, the co-operation of plant-breeders would be indispensable for the breeding of resistant varieties suitable for cultivation in the hilly tracts of the country.

In India the control of rusts by the cultivation of resistant varieties should be more easily practicable than elsewhere because the perpetuation of rusts by uredospores is possible only over three to five per cent. of the entire area under wheat and barley. Consequently the cultivation of resistant varieties in the hills only should check outbreak of rust epidemics at those localities that are now working as foci of infection for crops on the plains.

The cereal-rust problem is an all-India concern, and being essentially a case of dissemination of infection by winds that know no territorial restrictions, it is hoped that the Indian States will offer all facilities they can in the investigation, and later on co-operate in the adoption of control measures.

At its last session, the International Botanical Congress made a strong case for investigations on cereal-rusts by passing unanimously a resolution drawing the attention of all cereal-producing countries of the world to the importance of the problem.

It will be clear from what has been stated above that at its present stage the problem under report needs a band of trained workers in India who should carry out investigations on the lines indicated above for a number of years.

In the United States of America and Canada work on this problem has been in progress for several years on lines of elaborate national schemes, and countries like Australia, Russia and Kenya have also undertaken investigations in the light of results obtained in the U. S. A. and Canada.

It is a problem full of promise, and when fully understood, should lead to results of incalculable value to agriculture in this country.

References.

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ENCLOSURE VII.

INVESTIGATIONS ON "CEREAL-RUSTS" UNDER THE AUSPICES OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Report on preliminary studies of rusts dissemination and physiologic forms of rusts of wheat in India.

Introduction.—Data of rust dissemination obtained by the writer in 1930 have already been recorded in Proc. Vth Int. Bot. Congress of 1930 and Ind. Journ. Agr. Sc. Vol. I, Part III, June 1931). (Enclosure VIII).

This study has been further extended and during 1931-32 slides were exposed in aeroscopes at as many as 16 stations, over the area of wheat cultivation.

In view of a resolution passed by the Fifth International Botanical Congress, drawing the attention of the governments of all cereal producing countries, to the importance of investigations on "Cereal-rusts" on the lines of work recently done in U. S. A. and Canada, the writer decided to undertake a preliminary study of physiologic forms of wheat rusts, on his return from the Congress, which he attended on behalf of the Imperial Council of Agricultural Research.

In the light of the information which the writer had obtained from a study of the incidence of rusts extending over a period of 7 years preceding the Congress and as a result of a personal discussion with Professor Stakman, the discoverer of the existence of physiologic forms in nature, it was thought desirable first to study random samples of rusts from different parts of the country and gradually extend the scope of detailed investigations according to the requirements.

A. Rust dissemination.—Early in 1930 a few preliminary tests were made with an automatic spore trap, which was kindly designed by Mr. G. Chatterji, the Meteorologist in charge of the Upper Air Observatory at Agra, at the request of the writer.

A descriptive account of the spore trap used has been published in Ind. Journ. Agr. Sc. Vol. I, Part III, 1931.

By the courtesy of the Meteorological department telegraphic messages were sent to Agra, on such days when the prevailing winds were blowing from the Himalayas to the plains of U. P. On the receipt of such messages balloons were sent up and spores of black rust were caught more than 3 weeks earlier than the date of appearance of that rust at Agra.

Data obtained from the study of slides exposed in aeroscopes, at two stations in U. P. and one in the Punjab were also promising.

Details are given in Table I, appended herewith.

During the year 1930-31 some additional information was obtained—Table II.

In order to provide for a longer exposure of slides, than was possible in the case of spore traps sent up on hydrogen balloons, ordinary kites were tried with two strips of vaselined celluloid paper during the last winter.

Toy balloons were tied to the kites in order to make their flight possible even when winds were unfavourable. The result of this device is very encouraging as it keeps the kite in the air for nearly two hours at an height of nearly 1,500 ft. above ground.

During 1931-32 slides were exposed in aeroscopes in the Punjab, U. P., Bihar, C. P., Rajputana and Bombay-Deccan 16 stations in all.

The dates of first spore showers and the dates of appearance of rusts are quoted in Table III.

From some of the stations information about the dates of appearance has not been received. It is necessary for a work of this kind that farm superintendents should carefully record those dates, as required by the instructions which are sent out with each aeroscope. At one of the stations all slides were exposed with the wrong side facing the winds.

It would be clear from a perusal of Tables I—III that rust inoculum is wind-borne, because in every case spores of a rust were caught on slides very much earlier than the appearance of that rust on the crop.

The study of slides exposed in Bombay-Deccan is particularly interesting and has yielded information of great value, in tracing the foci where from the inoculum may be disseminating.

The very first slides exposed at Dharwar, Poona and Niphad on October 15th—22nd caught spores of black rust. By the last week of October there were 10-30—spores over a 22 m. m. area (the size of the coverslip) on the slides exposed at each one of those stations. Spore showers as early as October in Bombay-Deccan clearly suggest, that the inoculum is blown down either from hills in the South, or the ghats or possibly both.

B. Physiological forms of wheat rusts.—This study was commenced in December 1930 primarily, with the object of finding out the parasitic behaviour of random samples from different parts of the country, on the differential hosts that have been used by workers in U. S. A. for their work on black and brown rusts of wheat respectively.

In October 1931 the Council sanctioned a grant of Rs. 6,500, towards the cost of a green house at Agra and other facilities including a temporary assistant and partial relief to the writer from his duties at the Agra College.

It will be clear from the different tables appended herewith, that the work has already passed the preliminary stage, which alone it was intended to cover.

During the short space of 3 months in 1930-31 and 5 months in 1931-32, 33 random samples of black rust, 18 of brown and 19 of yellow have been tested.

These samples were obtained from 16 different stations in the case of black rust and 10 each in the case of brown and yellow rusts.

Besides 14 isolation and 4 single spore cultures of black and 2 single spore cultures of brown have been established and tested.

In March-April all the cultures were transferred to Simla laboratory, where there are as many as 76 cultures at present, including some which were received after tabulation and others that have been isolated since then. In order to save time it is proposed to start another 20 single spore cultures of all the three rusts taken together by July next and test them at Agra during the early part of winter, before rusts appear afresh.

General observations dealing with the results obtained are given under each rust separately.

The results have been very carefully tabulated and compared with dichotomous and analytical keys, prepared by Stakman in the case of black rust and by Johnston and Mains in the case of brown.

The following tables are appended at the end of the report.

Table I.—Rust dissemination—1929-30.

Table II.—Rust dissemination—1930-31.

Table III.—Rust dissemination—1931-32.

Table IV.—Black rust—Average reactions.

Table V.—Black rust—Detailed reactions.

Table V (Cont.).—Black rust—Resemblances in random samples:

Table VI.—Black rust—Isolation and Single spore cultures.

Table VI (Cont.).—Black rust—Resemblances in isolation and single spore tests.

Table VII.—Brown rust—Average reactions.

Table VIII.—Brown rust—Detailed reactions.

Table VIII (Cont.).—Brown rust—Resemblances in random samples and single spore cultures.

Table IX.—Brown rust—Single spore cultures:

Table X.—Yellow rust—Average reactions.

Table XI.—Yellow rust—Detailed reactions showing resemblances.

I.—Black Rust.

Strains infecting	Occur in
Little club	The Punjab, U. P., Bihar, C. P., Rajputana, Bombay-Deccan, Hyderabad and Madras, <i>i.e.</i> , all parts of the country wherefrom samples have been received and tested.
Marquis	Ditto ditto.
Reliance	All provinces excepting Rajputana and Hyderabad.
Kota	Ditto ditto.
Arnautka	} In every part of the country.
Mindum	
Spelmar	
Kubanka	
Acme	
Einkorn	
Vernal	In every province except Rajputana.
Khapli	In U. P., Rajputana, Bombay-Deccan, and Hyderabad.

Ref. :—Table No. IV.

Little club, Arnautka, Kubanka were found resistant only once; Acme, Mindum and Spelmar twice, otherwise these 6 varieties were susceptible to every sample.

This feature connected with samples of black rust in this country is of special interest, because five out of these 6 varieties have been found to be resistant to many physiologic forms in U. S. A., where the number of forms is as large as 100.

This fact suggests, that the number of physiologic forms in India is not likely to be a large one. In this connection, it is remarkable that all the 14 isolation cultures as well as the 4 single spore cultures that have been tested infected the abovementioned 6 varieties.

Samples from Poona and Kotagiri (Nilgiris)—Madras, produced reaction No. 2 on Khapli and the material from Poona was cultivated on Agra—Desi wheat for further experiments.

Random samples of this rust have shown striking resemblances with some of the physiologic forms in their parasitic behaviour, although they differed from the means of infection, characteristic of these forms as indicated in Stakman's analytical key.

The following table shows the regional distribution of such samples :—

Samples resembling.	Occur in
Form No. 9	C. P.
Form No. 15	The Punjab, U. P., Bihar, Bombay-Deccan, and Madras.
Form No. 16	The Punjab, and U. P. (picked up in S. S. culture only).
Form No. 17	C. P.
Form No. 21	The Punjab, and Bombay-Deccan.
Form No. 39	Bihar.
Form No. 40	U. P. and Bombay-Deccan, only in S. S. culture.
Form No. 75	The Punjab, only in S. S. culture.
Form No. 83	Bihar.

Ref. :—Table V—(continued) and Table VI—(continued).

It is significant to note, that random samples from such distant areas as the Punjab U. P., Bihar, Bombay-Deccan and Madras should show striking resemblances.

It will be clear from Table VI—(Cont.) dealing with Isolation cultures that the samples from Poona and Bellary were mixtures of a strain resembling Form 40 and strain or strains infecting Einkorn. Strain resembling Form 17 was obtained as a result of isolation of the Bellary material on Einkorn but it does not necessarily follow that this form should exist in nature in that part of the country. The Poona material may in addition contain a strain producing reaction No. 2 on Khapli.

So far 4 single spore cultures of this rust have been established. One of them corresponds to Form 16 of U. S. A. and occurs here in Kumaon hills, another to Form No. 75 occurring in Simla hills and two tally with Form 40 which occurs in Kumaon as well as Bombay-Deccan. Table VI—(continued).

All the three forms isolated in Single spore cultures show slight differences on some of the differential hosts in their means of infection as compared with Stakman's analytical key.

With regard to Table V—(continued) it may be noted that random samples, more frequently than not, are mixtures. Consequently it is not possible, at this stage, to say how many forms may actually be mixed up in those samples. After further isolations and as a result of new single spore cultures, one may find only 3-4 forms occurring in different combinations, or some forms different from those indicated in the table may be picked up.

For a definite identification of the different physiologic forms, on the basis of means of infection, more random samples, isolation and single spore culture shall have to be tested.

There is a clear indication from the results obtained as far, that on the basis of parasitic behaviour, which as Stakman has pointed out is the main test, the samples of this rust from different parts of India are not widely different. On the contrary there are striking resemblances.

In some previous contributions the writer has already pointed out that in all probability, the inoculum of this rust is blown down as uredospores, from comparatively low altitudes, where its alternate host does not exist. It is very unlikely, therefore, that the number of its physiologic forms should steadily increase by hybridization on *Berberis vulgaris*, as it does in U. S. A., where it may be noted *B. vulgaris* occurs over the greater part of the area under wheat. In this country *B. vulgaris* occurs only in the Himalayas at altitudes of 8,000—12,000 ft. and there is practically no wheat cultivated above 9,000 ft. It is evident therefore that hybridization of physiologic forms on *B. vulgaris* is possible, only over a restricted area in India, if it is established that this host is responsible for outbreaks of black rust on wheat at 8,000—9,000 ft. or so. So far there is no evidence to show that any species of *Berberis* is connected with the black rust of cereals in this country.

Work on this aspect has been in progress for some time and it is hoped that further survey will settle this doubt.

II.—*Brown Rust.*

Strains infecting.	Occur in
Malakoff	The Punjab, U. P., and Bihar.
Carina	The Punjab, U. P., Bihar, and C. P.
Brevit	The Punjab, U. P., Bihar, and C. P.
Webster	The Punjab, U. P., and Bihar.
Loros	The Punjab, U. P., Bihar, and C. P.
Mediterranean	The Punjab, U. P., and Bihar.
Hussar	The Punjab, U. P., Bihar, and Bombay-Deccan.
Democrat	U. P. only.

Ref. :—Table VII.

Strain infecting Democrat has been found only once so far in U. P. It is rather interesting, because in U. S. A. such strains that infect Democrat, are of common occurrence. So far only one physiologic form has been isolated in two Single spore cultures, which does not tally with any form isolated in U. S. A. by Jackson, Mains and Johnston. Evidently it is a new form and has been isolated from the material occurring both in Kumaon and Simla hills.

Tests made with random sample tally with Form No. 10 in the case of one sample from Agra and Form No. 11 in the case of the sample from Lucknow.

A sample from Agra resembled one from Gorakhpur in its parasitic behaviour and so did samples from Pusa, Jubbulpore and Simla. Another sample from Simla resembled closely with the sample from Chandausi (U. P.)—Tables VIII—(cont.) and IX.

III.—*Yellow Rust.*

Work on Physiologic forms of yellow rust has not been developed to the same extent as in the case of the other two. For our work some varieties of wheat received from Germany were used and attempts have been made to find out independently a set of suitable differential hosts, for work on this rust. There is no work on Physiologic forms of this rust recorded in U. S. A. or Canada. In Germany four Physiologic forms have been isolated, but the set of differential hosts which was sent to us is different from the one, on which isolations were made in that country. Under the circumstances all that is possible is to make some general observations, with regard to the resemblances or differences found in the samples tested on German varieties, as well as on a parallel set of Indian and Canadian varieties.

Out of the ten German varieties, six were found to be resistant to all samples.

Four varieties were found to be susceptible to the material from Simla. Samples of this rust from the cultures established in 1929-30, 1930-31 and 1931-32 were tested and produced identical reactions.

One variety was found susceptible to the material from Lypallpur, two to the material from Gurdaspur, three to the materials from Agra and Almora and two to the material from Muktesar—Table X.

It is worthy of note that material from Gorakhpur, Tansing (Nepal), Pusa and Saugor (C. P.) resembled one another in their parasitic behaviour—Table XI.

With regard to tests made with Indian and Canadian varieties it may be noted that Potia (*Triticum vulgare*) and Bansi (*Triticum durum*) were found to be susceptible to every sample.

Sample from Tansing (Nepal), one from Gorakhpur and the Agra sample resembled one another in their parasitic behaviour.

Judging from the reactions produced on other seven varieties it is clear that samples from some of the stations show striking resemblances but are not identical thereby indicating that in the case of this rust also there are more physiologic forms than one occurring in this country.—Table XI.

C.—*Acknowledgment of co-operation from workers outside India, officers of the Department of Agriculture in different provinces and others.*

The writer is very grateful to the following workers for their kind help and co-operation in the investigations in hand:—

- (i) Drs. E. C. Stakman, C. O. Johnston and W. M. Bever of the U. S. Department of Agriculture.
- (ii) Drs. Th. Roemer, C. C. Allison and K. Isenbeck of the University of Halle, Germany.
- (iii) Drs. H. T. Gussow and M. Newton of the Department of Agriculture, Canada.
- (iv) Mr. J. McDonald of Kenya.
- (v) Dr. W. L. Waterhouse, University of Sydney, Australia.
- (vi) Dr. E. J. Butler of the Imperial Mycological Institute, London, Prof. Sir R. H. Biffen, Prof. F. L. Engledow and Mr. F. T. Brooks, of the University of Cambridge.
- (vii) Agricultural Officer, N.-W. F. Province, Rai Sahib J. C. Luthra, Agricultural College, Lyallpur; M. O. Varkey, Esq., St. Andrew's College, Gorakhpur; P. K. Dey, Esq., Agricultural College, Cawnpore; The Imperial Mycologist, Pusa; Deputy Directors of Agriculture, Jubbulpore and Hoshangabad, C. P.; J. F. Dastur, Esq., Agricultural Institute, Nagpur; Kanhaya Lal, Esq., Government College, Ajmer; Dr. B. N. Uppal, Agricultural College, Poona; Economic Botanist, H. E. H. Nizam's Agricultural Department; Meteorologist in charge of the Upper Air Observatory at Agra.

The writer is very grateful to the Directors of Agriculture in the different provinces of India for making arrangements with their officers for the supply of rust samples and exposure of slides on aeroscopes.

There is need for greater co-operation from the superintendents of the various farms where aeroscopes are exposed and wherefrom samples are despatched.

The officers of the Imperial Council of Agricultural Research have always been very kind and accommodating and the writer wishes to express his warmest thanks for facilitating the work in every way.

D.—*General conclusions.*

1. *Rust dissemination.*—Study of aeroscope slides exposed in the Punjab, United Provinces, Bihar, Rajputana, Central Provinces and Bombay-Deccan has clearly indicated that rust inoculum is wind-borne. Tests with kites flown at Agra have yielded similar results. Spores of each rust were caught on slides, long before that rust appeared on the crop at that locality. This study has given information of great value with regard to Bombay-Deccan, where spore showers occurred as early as October, indicating thereby that there are foci of infection in hills in the South or the Ghats.

Arrangements have been made for the exposure of slides, in aeroscopes at suitable places in Mysore state, Madras and Hyderabad and it should be possible to throw further light on this point by December next.

It is proposed to extend the scope of this study, by exposing aeroscope slides at suitable places in Sind, Bengal, Assam and Central India during the next cold weather.

It is necessary therefore to continue this work, till we have obtained full information about the directions along which rust inoculum spreads, from different foci, through intermediate stations, to the interior of the country.

The writer has already recorded, that year after year rusts outbreak at the foot of the hills, long before they appear at places farther off on the plains.

It should also be possible, from a study of this nature to locate new regions wherefrom the inoculum may be blown down.

It may be pointed out, that such a study has yielded information of the greatest value, in the understanding of epidemiology of black rust in U. S. A. and Canada and there seems to be no reason why it should not give the information desired, in this country.

2. *Physiologic forms of wheat rusts.*—Tests with random samples from several stations in the case of all the three rusts have revealed striking resemblances.

(a) *Black rust.*—Judging from the parasitic behaviour of different samples, which at Stakman has pointed out is the main test, samples from different parts of India are not widely different. On the contrary there is a remarkable similarity as shown by the samples from Simla, Agra, Almora, Pusa, Poona, Bellary and Kotagiri (Madras).

So far 4 single spore cultures have been established. One of them corresponds to Form 16 of U. S. A. and occurs in Kumaon hills. Another tallies with Form 75 occurring in Simla hills and two of them correspond to Form 40 which occurs in Kumaon and Bombay-Deccan.

Fifteen random samples have shown parasitic behaviour characteristic of 7 physiologic forms, out of which 8 resembled one form, 2 another and the remaining 5 resembled one form each.

For a definite identification of the different physiologic forms, on the basis of means of infection, more random samples, isolation cultures, and single spore cultures shall have to be tested.

(b) *Brown rust.*—Only two random samples have shown parasitic behaviour characteristic of Form 10 and Form 11 respectively.

The two single spore cultures do not correspond to any physiologic form isolated in U. S. A. so far, evidently a new form. The two cultures resemble each other in their parasitic behaviour. One of them was picked up from the Simla material and the other from material in Kumaon.

Random samples from Agra and Gorakhpur resembled each other, one sample from Simla resembled that from Chandausi and another sample from Simla resembled those from Pusa and Jubbulpore.

(c) *Yellow rust.*—It is interesting to note that random samples from Tansing (Nepal), Gorakhpur (near the foot of Nepal hills), Pusa and Saugor (C. P.) resembled in their parasitic behaviour.

On the Indian and Canadian set of differential hosts samples from Tansing (Nepal), Gorakhpur and Agra showed resemblances in their parasitic behaviour.

If rusts are to be controlled by the cultivation of resistant varieties only in the hills where the foci lie, the study of physiologic forms has to be continued till we know the different forms of all the three rusts that may be occurring in the country.

Data obtained so far do not call for the distribution of this work on a provincial basis at this stage and in the interest of a comparative study and economy it would be best to continue this study at Agra for another 2-3 years. Fullest advantage should be taken of the laboratory at Simla, where unlike the plains, all the three rusts flourish throughout summer and new cultures can be established and tested during that period. Between the laboratories at Agra and Simla therefore work on physiologic forms can be carried out throughout the year.

By the end of March 1935 if we found, that the number of physiologic forms of all the three rusts taken together is too large to handle at one station, which can not be said at present, a separate station for work on black rust may be opened in the South.

With regard to centralization it may be mentioned that in U. S. A. all work on rust dissemination and physiologic forms of black rust has been done at Minnesota for over 12 years now, in spite of the fact that there are as many as 100 physiologic forms of that rust there. At Minnesota as many as 500 samples are tested each year.

Similarly work on rusts is centralized in Canada at the Winnipeg laboratory, Manitoba.

Work on rust dissemination and physiologic forms should go hand in hand on basis of centralization, in order to get a connected account of the distribution of physiologic forms in the hills, where rusts are known definitely to oversummer, and their regional distribution on the plains, whereto they are blown down, evidently over long distances, from foci in different parts of the country.

In this country work on these two important aspects of the problem was started only recently and what is most desirable is the provision of adequate facilities first at one station. For a satisfactory progress of these investigations it is also necessary that officers in charge of all such stations, where aeroscope slides are exposed and wherefrom samples of rusts are despatched, should extend a whole-hearted co-operation.

In conclusion, the writer wishes to state that he has had the advantage of a personal discussion on programme of further work, with Prof. Stakman, the greatest living authority on rusts, Dr. Butler of the Imperial Mycological Institute, Dr. Newton of Canada and other overseas workers.

The above recommendations are made exactly in accordance with the requirements of the problem at this stage.

Both Prof. Stakman and Dr. Butler have written un-solicited letters on the subject, expressing their views on the work that has been done by the writer so far and have made very useful suggestions, on the different topics that have been discussed by the writer, in this report and the one (Enclosure V) that was submitted a few days ago, on other work done in 1931-32.

SIMLA,
The 30th May, 1932.

K. C. MEHTA, M.Sc., Ph.D. (Cantab.),
Professor of Botany, Agra College, Agra.

TABLE I.

PRELIMINARY STUDY OF " RUST DISSEMINATION " IN RELATION TO FIRST APPEARANCE ON PLAINS.

Data obtained with the help of slides exposed on hydrogen balloons and aeroscopes.
1929-30.

Station.	Date of first spore shower.	Date of appearance.	Remarks.
<i>Brown Rust.</i>			
Lyallpur	4-1-30	3rd week of January 1930.	
Allahabad	26-12-29	4-2-30	
<i>Black Rust.</i>			
Agra (Bichpuri)	25-2-30	9-3-30	
Lyallpur	1-3-30	Last week of March 1930.	
<i>Balloon Slides.</i>			
Agra	11-2-30	9-3-30	

TABLE II.

PRELIMINARY STUDY OF " RUST DISSEMINATION " IN RELATION TO FIRST APPEARANCE ON PLAINS.

Data obtained with the help of slides exposed on hydrogen balloons and aeroscopes.
1930-31.

Station.	Date of first spore shower.	Date of appearance.	Remarks.
<i>Yellow Rust.</i>			
Lyallpur	17-1-31	9-2-31	
Gorakhpur	26-12-30	31-12-30	
Cawnpore	28-1-31	2nd week of February 1931.	
<i>Brown Rust.</i>			
Gorakhpur	1-12-30	31-12-30	
Cawnpore	17-1-31	2nd week of February 1931.	
<i>Black Rust.</i>			
Lyallpur	14-1-31	14-3-31	
Agra (Bichpuri)	21-1-31	22-2-31	
Gorakhpur	1-12-30	30-12-30	
Cawnpore	17-1-31	2nd week of February 1931.	
Nagpur	3-1-31	21-2-31	
<i>Balloon Slides.</i>			
Agra	20-12-30	22-2-31	

TABLE III.

PRELIMINARY STUDY OF " RUST DISSEMINATION " IN RELATION TO FIRST APPEARANCE ON PLAINS.

Data obtained with the help of slides exposed on aeroscopes and kites.

1931-32.

Station.	Date of first spore shower.	Date of appearance.	Remarks.
<i>Yellow Rust.</i>			
Lyallpur	9-1-32	22-1-32	
Gurdaspur	24-12-31	15-1-32	
Rupar (Shiampur) ..	30-12-31	15-1-32	
Agra (Bichpuri)	30-1-32	2nd week of February 1932.	
Gorakhpur	18-12-31	1st week of January 1932.	
Pusa	20-12-31	23-1-32	
<i>Kite slides.</i>			
Agra	24-12-31	2nd week of February 1932.	
<i>Brown Rust.</i>			
Agra (Bichpuri)	20-1-32	2nd week of February 1932.	
Pusa	24-12-31	23-1-32	
Ajmer	18-11-31	26-2-32	
Nagpur	22-1-32	6-3-32	Material was collected by our assistant on that date.
<i>Kite Slides.</i>			
Agra	11-1-32	2nd week of February 1932.	
<i>Black Rust.</i>			
Agra (Bichpuri)	27-1-32	3rd week of February 1932.	
Pusa	13-12-31	22-2-32	
Ajmer	14-11-31	26-2-32	
Nagpur	14-12-31	6-3-32	Material was collected by our assistant on that date.
Jubbulpore	19-1-32	3-3-32	Ditto.
Dharwar	22-10-31	26-11-31	} Very early spore shower. The very first slides exposed caught spores.
Poona	15-10-31	2nd week of November 1931.	
Niphad	22-10-31	1st week of January 1932.		Crop sown very late.
<i>Kite slides.</i>			
Agra	2-1-32	3rd week of February 1932.	

TABLE IV.
BLACK RUST.
(Average Reactions.)

Year.	No. of tests made.	Sample from.	Little otub.	Marquis.	Reiance or Kared.	Kota.	Arnautka.	Mindum.	Spelmar.	Kubanka.	Aome.	Einkorn.	Vernal.	Khapli.	Local.	Hope. (a)	Remarks.
1930-32	4	Simla	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Simla-Single Spore P ¹ Pot b	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant; 2* Twice resistant; *3 Thrice resistant.
1930-32	3	Lyallpur	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1930-31	1	Gorakhpur	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant; *2 Twice resistant.
1930-32	2	Agra	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1930-31	3	Almora	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant; *2 Twice resistant.
1931-32	2	Muktesar-Almora	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant; *2 Twice resistant.
1931-32	1	Muktesar-Almora-S. S. P ²	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant.
1931-32	1	Muktesar-Almora-S. S. P ³	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant.
1930-31	2	Pusa	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Pusa (P. 101)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1930-32	2	Saugor	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant.
1931-32	1	Nagpur	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Jubbulpore	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant.
1931-32	1	Ajmer	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1930-31	2	Poona	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once resistant.
1931-32	1	Poona-(Bansi)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	2	Poona-(Pusa)-S. S. P ¹ Pot a	z	z	z	z	z	z	z	z	z	z	z	z	z	z	*1 Once no reaction, seed lings too old.
1931-32	1	Poona-(Pusa 4)-Little club	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Marquis	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Kota	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Arnautka	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Spelmar	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Kubanka	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Aome	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Einkorn	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Vernal	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Poona-(Pusa 4)-Khapli	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Dharwar-(Pusa 4)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Dharwar-(Pusa 4)-Kota	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Dharwar-(Bansi)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Niphad-(Bansi)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Hyderabad-(140 C. P.)	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Bellary	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Bellary-Mindum	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Bellary-Einkorn	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Bellary-Vernal	z	z	z	z	z	z	z	z	z	z	z	z	z	z	
1931-32	1	Kotagiri	z	z	z	z	z	z	z	z	z	z	z	z	z	z	

(a) Hope was tested only in 1931-32.

TABLE V.
BLACK RUST.
(Detailed Reactions).

trial No.	Year.	Tested at Station.	Sample from.	Little club.	Mar- quis.	Reliance or Kan- red.	Kota.	Ar- naut- ka.	Min- dum.	Spel- mar.	Ku- banka.	Aome.	Ein- korn.	Vernal.	Khapli.	Local.	Hope.	Remarks.
1	1930-31	Simla	*Simla ..	4 S	4 S	4 S	3 S	3 S	4 + S	3 S	4 S	4 S	3 S	3 S	1 R	4 S	..	* From crop 1930-1931.
2	1930-31	Agra	†Simla ..	4 S	1 R	0 R	2 R	4 S	4 - S	4 + S	3 S	4 S	0; R	0; R	1 R	4 S	..	† From culture established in April 1930 with rust on crop, 1929-30.
3	1930-31	Agra	‡Simla ..	4++S	4 S	0; R	4 - S	4+S	4 + S	4 + S	4 + S	4 + S	1 R	0; R	1 R	4++S	..	‡ From culture established in April 1930, with rust on crop 1929-30.
4	1931-32	Agra	§ Simla ..	4 S	4 - S	0 R	0 R	3 S	3 + S	3 S	3 S	3 S	On; R	On; R	1 R	4++S	..	§ From miniature plot started in June 1931, with rust on crop 1930-1931.
5	1930-31	Simla	Lyalpur ..	2 R	In R	On; R	On; R	3+S	4 - S	3 S	4 S	4 S	1+nR	4++S	1+nR	3 - S	..	¶ From culture started in April 1930 with rust on crop, 1929-30.
6	1930-31	Simla	Lyalpur ..	3 S	1 R	On; R	0; R	3+S	4 S	3 - S	4 S	4 S	1 R	4 S	2 R	4 S	..	¶ From culture started in April 1930 with rust on crop, 1929-30.
7	1931-32	Agra	Lyalpur	4 S	4 S	0 R	0 R	4 S	4 S	4 S	4 S	4 S	3 + S	0 R	1 R	4 S	3+S	*0,8 4L-On; R.
8	1930-31	Simla	Gorakhpur	4 - S	1 R	*0 R	1 R	3+S	2 R	3 S	4 - S	4 - S	1 R	4 S	0 R	3 S	4 S	..
9	1930-31	Agra	Agra ..	3 S	3 S	4 S	4 S	4 S	0 R	3 S	4 + S	3 - S	4 - S	0 R	3 S	4 S	..	¶ From culture started in April 1930 with rust on crop, 1929-30.
10	1931-32	Agra	Agra ..	4 S	3 S	4 S	3 S	4 S	4 S	4 S	4 S	4 S	3 S	3 S	1 R	4 S	..	¶ From culture started in April 1930 with rust on crop, 1929-30.
11	1930-31	Agra	|| Almora	4 S	3 - S	0 R	0 R	2+R	3 + S	4 + S	3 S	4 S	1 R	0; R	0 R	3 S	0;R	¶ From culture started in April 1930 with rust on crop, 1929-30.
12	1931-32	Agra	¶ Almora..	4 S	3 - S	2 R	On; R	4 S	3 + S	4 - S	4 S	4 S	2 + R	On; R	2 + R	4 + S	..	¶ From miniature plot Muktesar-Almora.
13	1931-32	Agra	+ Almora	4 S	3 S	3 S	3 S	3 S	4 S	4 S	4 S	4 S	3 S	3 S	1 R	4 S	2 R	x Fresh sample miniature plot, Muktesar-Almora.
14	1930-31	Almora	** Almora	4 S	2 R	0 R	2 - R	4 - S	3 + S	2 + R	2 + S	2 + R	0 R	0 R	1 - R	4 - S	..	° From crop 1930-1931.
15	1930-31	Almora	% Almora	4 S	2 + R	0 R	0 R	3 S	4 - S	0 R	1 R	0 R	0 R	0 R	0 R	4 S	..	° From crop 1930-1931.

16	1930-31	Agra..	Pusa ..	4 + S	2	R	4	S	3	S	4+S	3 + S	4 + S	4 + S	4	S	2	R	1	R	4	S	...	@From crop 1930-31.		
17	1930-31	Simla	Pusa ..	4 + S	1	R	3	- S	On; R	4-S	4	S	4	S	4	- S	4	S	1	R	4	+ S	3	S		
18	1931-32	Agra	Pusa-(P. 101).	3 + S	4	S	4	S	4	S	3+S	4	S	3	- S	4	S	3	- S	On; R	4	S	4	S		
19	1930-31	Agra	Saugor ..	4 + S	4	S	0	R	4 + S	4-S	4++S	4 + S	3 + S	3 + S	4	S	4	S	1	R	4	S	4	S		
20	1931-32	Agra	Saugor ..	4	S	0	R	3 - S	0	R	4	S	4	S	3	- S	0	R	0	R	4	S	4	S		
21	1931-32	Agra	Nagpur ..	4 - S	4	S	†3 - S	On; R	4	S	4	S	3 + S	3	S	4	S	3	S	0	R	*2+R	4	S		
22	1931-32	Agra	Jubbulpore	4	S	4	S	0	R	@3-S	4	S	4	S	4	S	4	S	1	R	2	R	4	S		
23	1931-32	Agra	Ajmer ..	4	S	4 - S	Oc; R	1 + R	4	S	4	S	4	S	4	S	4	S	0	R	3 - S	4	S	...		
24	1930-31	Agra	Poona ..	3 + S	4	S	3	S	4	S	4	S	0; R	4	S	4	S	3 + S	1	R	4	+ S	...			
25	1930-31	Agra	Poona ..	3	S	3	S	4	S	4	S	4	S	4	S	4	S	4	S	4	+ S	2	R	4	S	
26	1931-32	Agra	Poona— (Pusa 4)	4	S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	*3	S	4	S	2†	R	4	+ S	
27	1931-32	Agra	Poona— (Bansi).	4	S	4	S	Oc; R	Oc; R	4	S	4 + S	4	S	4	S	4	S	0	R	On; R	4	S	4	S	
28	1931-32	Agra	Dharwar— (Pusa 4).	4	S	4	S	3 + S	3 + S	4	S	4	S	4	S	4	S	4	S	2	R	3 - S	4	S		
29	1931-32	Agra	Dharwar— (Bansi).	4	S	3	S	On; R	1	R	4	R	4 - S	4	S	4	S	4	S	2	R	On; R	On; R	4 - S	3	S
30	1931-32	Agra	Niphad— (Bansi).	4	S	4	S	0	R	3	S	4	S	4	S	3 + S	4	S	2	R	On; R	On; R	4 - S	3	S	
31	1931-32	Agra	Hyderabad (140-C. P.).	4	S	3	S	0	R	1	R	4	S	4	S	4	S	3	S	3	S	3	S	4	S	
32	1931-32	Agra	Bellary ..	4 + S	4	S	4	S	4	S	4+S	4 + S	4 + S	4	S	4	S	3	S	*1	R	4++S	4	S		
33	1931-32	Agra	Kotagiri ..	3 + S	4	S	4	S	4	S	3+S	4	S	4	S	4	S	3	+ S	3	S	2	R	4 + S		
																								*0/7 3L=Oc, 4L = no reaction. 3/9 3L=3-S. *3/8 3L-3.S. 5L= 2; R. 5L=2R. *2/8 4L=Oc, R. 2L=3-S. *7/9 6L=3 S. 1L= 2 R. %3/11 8L= 2 R. 3L=O R. *To be repeated. To be repeated. *4/8 4L=O. R. 3L-1 R. 1L= 2R		

Explanation of Symbols.

Reaction class R embraces infection types—

O, either no infection whatever or pronounced necrotic flecks or islands = virtual immunity;

1, minute uredinia within solid necrotic lesions extreme resistance: and

2, small pustules in green islands surrounded by necrotic halos = moderate resistance.

Reaction class S embraces infection types—

3, medium sized uredinia accompanied by slight chlorosis but no necrosis = moderate susceptibility;

4, very heavy infection with large confluent uredinia = complete susceptibility.

Reaction class I consists of a single infection type;

X, infection, heterogeneous and ill-defined = indeterminate reaction.

General chlorosis is indicated by a c, necrosis by an n; necrotic flecks are designated by a (:), necrotic islands by a (·).

Plus and minus signs indicate a slightly greater or smaller amount of rust than the nearest figure representing the infection types.

TABLE V—contd.
Showing striking resemblances between random samples from different stations.

Serial No. from the last page.	Sample from	Little olub.	Marqula.	Rellance or Kanred.	Kota.	Arnaut-ka.	Mindum.	Spelmer.	Kuban-ka.	Aome.	Einkorn.	Vernal.	Khapl.	Remarks.
1	Simla ..	4 S	4 S	4 S	3 S	3 S	4 + S	3 S	4 S	4 S	3 S	3 S	1 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
10	Agra ..	4 S	3 S	4 S	3 S	4 S	4 S	4 S	4 S	3 S	3 S	3 S	1 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
13	Almora—Muktesar-Almora).	4 S	3 S	3 S	3 S	3 S	4 S	4 S	4 S	4 S	3 S	3 S	1 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
22	Bellary ..	4 + S	4 S	4 S	4 S	4 + S	4 + S	4 + S	4 S	4 S	3 S	3 S	1 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key. [Evidently a mixture. Ref. Table VI (Cont.).]
18	Pusa (P. 101)	3 + S	4 S	4 S	4 S	3 + S	4 S	3 - S	4 S	4 S	4 - S	3 - S	0; R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
25	Poona ..	3 S	3 S	4 S	4 S	4 + S	4 + S	4 + S	4 + S	4 S	4 - S	4 + S	2 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
26	Poona (Pusa 4).	4 S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	4 + S	3 S	4 S	2 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key. [Evidently a mixture. Ref. Table VI (Cont.).]
33	Kotagiri ..	3 + S	4 S	4 S	4 S	4 + S	4 S	4 S	4 S	4 S	3 + S	3 S	2 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
2	Simla ..	4 S	1 R	0; R	2 R	4 S	4 - S	4 + S	3 S	4 S	0; R	0; R	1 R	Resembling Form 15 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.

3 Simla ..	4++S	4	S	0;	R	4-S	4+S	4++S	4++S	4+S	4+S	1	R	0;	R	1	R	Resembling Form 21 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.							
30 Niphad (Bansi).	4	S	4	S	0	R	3	S	4	S	4	S	3+S	4	S	4	S	2	R	0u;	R	0n;	R	Resembling Form 21 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.	
16 Pusa ..	4++S	2	R	4	S	3	S	4+S	4+S	3+S	4++S	4+S	4	S	2	R	1	R	Resembling Form 39 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.						
22 Jubbulpore	4	S	4	S	0	R	3-	S	4	S	4	S	4	S	4	S	4	S	4	S	1	R	2	R	Resembling Form 17 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.
17 Pusa ..	4	S	1	R	3-S	0n;	R	4-S	4	S	4	S	4	S	4-S	4	S	4	S	4	S	1	R	Resembling Form 83 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.	
19 Sangor ..	4+S	4	S	0	R	4-S	4-S	4++S	4+S	3+S	3+S	4	S	4	S	4	S	1	R	Resembling Form 9 in its parasitic behaviour but differs from the means of infection on several varieties as indicated in Stakman's analytical key.					

From Stakman's analytical key for comparison with the above reaction.

Means of infection of Form 9.	4	4-	0	3++	4-	4-	4=	4=	3++	3+	4-	1-
Means of infection of Form 15.	4	4-	4=	3++	4=	4=	4=	3++	3++	3++	4-	1=
Means of infection of Form 16.	4-	2=	0	1	3++	3+	3++	3+	3+	1=	1=	1
Means of infection of Form 17.	4	4-	0	3+	4+	4=	4=	3++	3++	3	1=	1=
Means of infection of Form 21.	4	4	0	3++	4-	4-	4-	4=	3++	1=	0	1=
Means of infection of Form 39.	4-	2=	4=	3+	4+	3+	4-	4=	3++	4=	1=	1=
Means of infection of Form 83.	4	1+	3-	1-	3+	3+	3+	3+	3+	3+	3+	1

Obtained in Single spore culture from material in Kumaon hills.

TABLE VI.
BLACK RUST.
(Single Spores and Isolations.)

Year.	Tested at station.	Sample from	Little chb.	Marquis.	Reliance or Kanred.	Kota.	Arantka.	Mindum.	Spelman.	Kubanka.	Aome.	Einkorn.	Vernal.	Khapli.	Local.	Hope.	Remarks.
1930-31 .. 1931-32(15)	Simla, Agra	*Simla .. †Simla—Single Spore P1 pot b.	4 S 4 S	4 S 4 S	4 S 0 R	3 S 0 R	4 S 4 S	4+ S 4 S	3 S 4 S	4 S 4 S	4 S 4 S	3 S 0;	3 S R	1 R 1 R	4 S 4+ S	0 R	*From crop 1930-31. †Rust on crop 1930-31. Test to be repeated with culture 1929-30 with material on miniature plot at Simla and rust on crop 1931-32.
1931-32 ..	Do.	Muktesar—Almora ..	4 S	3 S	3 S	3 S	4 S	4 S	4 S	4 S	4 S	3 S	3 S	2+ R	4 S	..	
1931-32 (16)	Do.	‡Almora—S. S. P2 ..	3 S	3 S	4-S	4-S	4 S	4 S	4 S	4-S	4 S	0;	R	3-S	4+ S	4-S	‡Miniature plot material. Muktesar, Almora. *† 4/9 6L-2 —R, 4-L-0R.
1931-32 (17)	Do.	§Almora—S. S. P3 ..	3+ S	0 R	0;	0 R	3 S	4 S	4 S	4 S	3 S	0 R	0 R	0;	4+ S	4 S	§Fresh sample miniature plot. Muktesar-Almora.
1931-32 ..	Agra	Poona (Pusa 4) ..	4 S	4+ S	4+ S	4+ S	4+ S	4+ S	4+ S	4+ S	4+ S	1/53 S	4 S	2 R	4+ S	4 S	||7/9 6L-3 S. 1L-2 R. * 8/11 8L-2 R. 3L-0 R.
1931-32 (18)	Do.	Poona (Pusa 4)—S. S. P1 pot a.	4 S	4 S	4 S	†0 S	4 S	4 S	4 S	4 S	4 S	0;	R	3 S	0 R	4 S	‡No reaction. Seedling old to be repeated.
1931-32 (18a)	Do.	Poona (Pusa 4)—S. S. P1 pot a.	3 S	4 S	4-S	4 S	4 S	4 S	4-S	4+ S	4 S	0;	R	3 S	0 R	4 S	Repeated Reference above.
1931-32 (1)	Do.	Poona (Pusa 4)—Little club.	4 S	4+ S	4+ S	4 S	4+ S	4 S	4 S	4 S	4 S	3 S	3 S	1- R	4 S	3 S	
1931-32 (2)	Do.	Poona (Pusa 4)—Marquis.	4 S	4 S	3+ S	3 S	4 S	4 S	4 S	4 S	4-S	0;	R	3+ S	0;	4-S	3+ S
1931-32 (3)	Do.	Poona (Pusa 4)—Kota	4 S	4 S	3+ S	4 S	4+ S	4 S	4 S	4 S	4+ S	**1 R	3-S	0 R	4 S	4 S	** 2/62L-1R. 6L-0;

1931-32 (4)	Do.	Poona (Pusa 4)—Ar- nautka.	3 S	3 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0 _n ; R	3-S	0	R	4 S	3-S
1931-32 (5)	Do.	Poona (Pusa 4)—Spl- mar.	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0 _n ; R	3-S	0 _c	R	4 S	4 S
1931-32 (6)	Do.	Poona (Pusa 4)—Ku- banka.	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4-S	4 S	4 S	4 S	0 _n ; R	3 S	0	R	4 S	4 S
1931-32 (7)	Do.	Poona (Pusa 4)— Acme.	4 S	4+S	4 S	0 _n ; R	4 S	4 S	3-S	4 S	4 S	4 S	4 S	0 _n ; R	3 S	0 _c	R	4 S	4 S
1931-32 (8)	Do.	Poona (Pusa 4)—Ein- korn.	3+S	4 S	4 S	0 _n ; R	4+S	4 S	4 S	4 S	4 S	4 S	4 S	4-S	4 S	3-S	0 _n ; R	4 S	..
1931-32 (9)	Do.	Poona (Pusa 4)—Ver- nal.	4 S	4+S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0 _n ; R	3+S	0 _n	R	4 S	4 S
1931-32 (10)	Do.	Poona (Pusa 4)—Khap- li.	3-S	0 _c ; R	0 _c ; R	0 _c ; R	4 S	4 S	3 S	4 S	4 S	4 S	3 S	0 _n ; R	↑↑0	R	4 S	..	
1931-32 ..	Do.	Dharwar (Pusa 4) ..	4 S	4 S	3+S	3+S	4 S	4 S	4 S	4 S	4 S	4+S	2 S	0 _n ; R	0 _n ; R	0 _n ; R	4 S	4-S	
1931-32 (11)	Do.	Dharwar (Pusa 4)— Kota.	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	↑↑3-S	3-S	0	R	4 S	3-S
1931-32 ..	Do.	Bellary ..	4+S	4 S	4 S	4 S	4+S	4+S	4+S	4 S	4 S	4 S	3 S	3 S	§§1	R	4++S	4 S	
1931-32 (12)	Do.	Bellary—Mindum ..	4 S	4 S	4 S	4 S	4 S	4 S	4 S	3+	4 S	4 S	0 _n ; R	3+S	0 _n ; R	0 _n ; R	4 S	0 _n ; R	
1931-32 (13)	Do.	Bellary—Einkorn ..	3 S	4 S	0 _c ; R	4 S	4 S	4 S	3 S	4 S	4 S	4 S	4 S	0 _n ; R	0 _n ; R	0 _n ; R	4+S	4 S	
1931-32 (14)	Do.	Bellary—Vernal ..	4-S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0 _n ; R	3 S	0 _n ; R	0 _n ; R	4+S	0 _n ; R	

↑↑To be repated (sam-
ty material. for
Khapli).

↑↑To be repated.
§ 2/62L=3-S. 4L=0_n;
R.

|||4/3 4L=0 R. 3L=1R.
1L=2 R.

Explanation of Symbols.

Reaction class *R* embraces infection types—

0, either no infection, whatever or pronounced necrotic flecks or is-
lands = virtual immunity;

1, minute uredinia within solid necrotic lesions extreme resistance; and

2, small pustules in green islands surrounded by necrotic halos =
moderate resistance.

Reaction class *S* embraces infection types—

3, medium sized uredinia accompanied by slight chlorosis but no
necrosis = moderate susceptibility;

4; very heavy infection with large confluent uredinia = complete sus-
ceptibility.

Reaction class *I* consists of a single infection type.

X, infection heterogeneous and ill-defined = indeterminate reaction.

General chlorosis is indicated by a *c*, necrosis by an *n*; necrotic flecks
are designated by a (*:*), necrotic islands by a (*:*).

Plus and *minus* signs indicate a slightly greater or smaller amount of rust-
than the nearest figure representing the infection types.

TABLE VI—contd.

Tests with isolation and single spore cultures.

Serial No. from last page.	Sample From	Little club.	Marquis.	Reliance or Kanred.	Kota.	Arnautka.	Mindum.	Spelmar.	Kubanka.	Aome.	Einkorn.	Vernal.	Khapli.	Remarks.
2	Poona—(Pusa 4)—Marquis.	4 S	4 S	3 + S	3 S	4 S	4 S	4 S	4 S	4 — S	0n; R	3 + S	0n; R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
3	Poona—(Pusa 4)—Kota.	4 S	4 S	3 + S	4 S	4 + S	4 S	4 S	4 S	4 + S	1 R	3 — S	0 R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
4	Poona—(Pusa 4)—Arnautka.	3 S	3 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0n; R	3 S	0 R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
5	Poona—(Pusa 4)—Spelmar.	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0n; R	3 — S	0c; R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
6	Poona—(Pusa 4)—Kubacka	4 S	4 S	4 S	4 S	4 S	4 S	4 + S	4 S	4 S	0n; R	3 S	0 R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
9	Poona—(Pusa 4)—Vernal.	4 S	4 + S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0n; R	3 + S	0n; R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
12	Bellary..... Mindum.	4 S	4 S	4 S	4 S	4 S	4 S	4 S	3 + S	4 S	0n; R	3 + S	0n; R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
14	Bellary..... Vernal.	4 — S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	4 S	0n; R	3 S	0n; R	Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
1	Poona—(Pusa 4)—Little club.	4 S	4 + S	4 + S	4 S	4 + S	4 S	4 S	4 S	4 S	3 S	3 S	1 — R	Resembling Form 15 in its parasitic behaviour but showing slight differences from the

11	Dharwar— (Pusa 4)— Kota.	4	S	4	S	4	S	4	S	4	S	4	S	4	S	4	S	4	S	3 — S	3 — S	0	R	Resembling Form 15 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
13	Bellary..... Einkorn.	3	S	4	S	0c; R	4	S	4	S	3	S	4	S	4	S	4	S	4	S	0n; R	0n; R	0n; R	Resembling Form 17 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
17	Almora— Single Spore P	3 +	S	0	R	0n; R	0	R	3	S	4	S	4	S	3	S	3	S	0	R	0	R	0n; R	Resembling Form 16 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.
16	Almora— Single Spore P ²	3	S	3	S	4 — S	4 — S	4	S	4	S	4	S	4 — S	4	S	0n; R	3 — S	2 — R				Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.	
18(a)	Poona—(Pusa 4)—S. S. P, Pot a.	3	S	4	S	4 — S	4	S	4	S	4	S	4 — S	4 ++ S	4	S	0n; R	3	S	0	R		Resembling Form 40 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.	
15	Simla—Single Spore—P Pot b.	4	S	4	S	0	R	0	R	4	S	4	S	4	S	4	S	4	S	0n; R	2 — R	1	R	Resembling Form 75 in its parasitic behaviour but showing slight differences from the means of infection as indicated in Stakman's analytical key.

Mean of infection as given in Stakman's analytical key for comparison with the above reactions.

Means of infection of Form 15.	4	4 —	4 =	3 ++	4 =	4 =	3 + =	4 ++	3 + +	4 =	4 =	1 =	
Means of infection of Form 16.	4 —	2 =	0	1	3 ++	3 +	3 ++	3 +	4 =	1 =	1 =	1	Isolated in Single spore culture from material in Kumaon.
Means of infection of Form 17.	4	4 —	0	3 +	4 =	4 =	4 =	3 ++	3 ++	3	1 =	1 =	
Means of infection of Form 40.	4 +	4 +	4	4 +	4 +	4 +	4	4 =	0;	0;	4 =	1 =	Isolated in Single spore culture from material in Kumaon and Bombay-Deccan.
Means of infection of Form 75.	4	3 +	2 +	0;	3 +	3 +	3 +	4 —	3 +	1	0;	1	Isolated in Single spore culture from material in the Punjab.

TABLE VII.

BROWN RUST.

(Average Reactions.)

Year.	No. of tests made.	Sample from.	Mala-koff.	Michi-gan amber.	Norka.	Carina.	Brevit.	Webster	Similis.	Lorca.	Mediterranean.	Husar.	Democrat.	Local.	Hope (a).	Remarks.
1930-32	4	Simla	R	S *2	R	S *3	S *1	R	S *3	S *1	R	R	R	S	..	*1 Once Resistant. *2 Twice resistant. *3 Thrice resistant.
1931-32	1	Simla—Single Spore— P ^a Potb.	R	R	R	S	R	R	R	R	R	R	R	S	S	* once resistant.
1930-31	2	Rupar	S *1	R	R *1	S *1	S	S *1	S *1	R	S *1	S *1	R	S *1	..	*1 Once resistant. *2 Twice resistant.
1930-32	2	Agra	S	S	S	S	S	S	S	S *1	R	R	R	S *1	S	
1930-32	2	Gorakhpur ..	S *1	S *1	R	S *2	S	S	S *2	S *2	R	S *2	R	S	S	
1930-32	2	Almora	R	S	R	S *1	S	R	S	S *1	S *1	R	S *1	S	..	*1 Once resistant.
1931-32	2	Muktesar—Almora —S.S.—P Potb.	R	S	R	S	R	R	R	R	R	R	R	S	S	
1931-32	1	Lucknow	R	S	R	R	S	R	R	S	R	R	R	S	R	
1931-32	1	Chandauli ..	R	R	R	R	R	R	R	R	R	R	R	S	R	
1930-32	2	Pusa	S *1	R	R	S *1	S	S *1	S *1	S	S *1	S *1	R	S	R	*1 Once resistant.
1931-32	1	Jubbulpore ..	R	R	R	S	S	R	R	S	R	R	R	S	..	
1930-31	1	Poona	R	S	R	R	R	R	S	R	R	S	R	S	..	

(a) Hope was tested only in 1931-22.

TABLE VIII
BROWN RUST.
(Detailed Reactions.)

Year.	Tested at station.	Sample from.	Malakoff.	Michigan Amber.	Norka.	Carina.	Brevit.	Webster.	Similis.	Loros.	Mediter-ranean.	Husaar.	Democrat.	Local.	Hoje.	Remarks.
1. 1930-31	Agra ..	Simla*	0; R	0; R	0; R	3 - S	3 S	0; R	3 - S	3 S	0; R	0; R	0; R	4 + S	..	* From culture with material on crop, 1929-30. † From crop of 1930-31. ‡ From crop of 1930-31. § From miniature plot started in June 1931. Crop 1929-30.
2. 1930-31	Simla ..	Simla†	0c, R	3 S	0n; R	1 R	4 S	0n; R	0c, R	4 S	0n; R	0c, R	0c, R	4 + S	..	
3. 1930-31	Simla ..	Simla‡	0n; R	3 S	1 R	2 R	4 S	0n; R	0n; R	4 + S	0n; R	0c, R	0c, R	4 + S	..	
4. 1931-32	Agra ..	Simla§	0n; R	2 + R	0n; R	0 R	2 + R	0n; R	0 R	1 R	0 R	1 R	1 R	4 + S	..	
5. 1930-31	Agra ..	Rupar	0 R	0 R	0 R	3 S	3 S	0 R	0 R	0 R	3 S	3 S	0 R	0 R	..	
6. 1930-31	Simla ..	Simla	3 - S	1; R	3 S	2 R	4 - S	4 S	3 + S	1 R	1 R	1 R	0n; R	4 - S	..	
7. 1930-31	Agra ..	Agra	3 S	3 + S	4 S	3 S	4 S	3 S	4 S	2 + R	2 R	2 + R	2 + R	2 R	..	
8. 1931-32	Agra ..	Agra	4 S	4 S	3 S	4 S	4 + S	4 S	4 S	3 + S	2 R	2 R	2 R	4 S	3 + S	
9. 1930-31	Agra ..	Gorakhpur	3 S	2 R	1 R	2 R	3 - S	3 - S	3 - S	3 S	2 R	1 R	0; R	4 S	..	
10. 1930-31	Simla ..	Gorakhpur	0n; R	3 S	0n; R	2 R	3 - S	3 - S	2 R	0c, R	0n; R	4 S	1 R	4 - S	..	
11. 1931-32	Agra ..	Gorakhpur	3 + S	4 - S	0n; R	4 S	3 + S	3 - S	2 R	2 R	1 + R	1 R	1 R	3 + S	4 S	
12. 1930-31	Agra ..	Almora	0; R	4 S	0; R	3 S	3 S	0; R	3 - S	3 - S	4 + S	0; R	0; R	4 S	..	
13. 1931-32	Agra ..	Almora	0n; R	4 S	0n; R	2 R	3 S	0n; R	3 + S	2 R	2 - R	0n; R	3 - S	4 S	..	
14. 1931-32	Agra ..	Lucknow	0c, R	3 S	0n; R	2 R	3 S	2 R	1 R	3 - S	1 R	1 + R	1 R	3 + S	0 R	
15. 1931-32	Agra ..	Chandausi	0n; R	2 R	0n; R	2 + R	2 + R	0n; R	0n; R	0n; R	0n; R	0n; R	0 R	3 + S	0 R	
16. 1930-31	Agra ..	Pusa	4 S	4 S	3 + S	3 S	3 + S	3 S	3 S	3 + S	3 + S	3 S	1 R	4 + S	..	
17. 1931-32	Agra ..	Pusa	0n; R	4 - S	1 R	4 S	4 S	0 R	1 + R	3 S	0c, R	0c, R	2 R	4 - S	0 R	
18. 1931-32	Agra ..	Jubbulpore	0c, R	2 R	1 R	3 S	4 S	1 R	1 R	3 - S	0n; R	0n; R	1 + R	4 S	..	
19. 1930-31	Agra ..	Poona	0 R	3 - S	0 R	2 R	0 R	0 R	3 - S	2 R	0 R	3 - S	2 R	3 S	..	

EXPLANATION OF SYMBOLS.

<i>Classes of host reaction.</i>	<i>Types of rust infection.</i>	4, Very susceptible	.. Uredinia abundant, large. No necrosis or chlorosis immediately surrounding the uredinia. Infected area sometimes occurring as green islands surrounded in each case by chlorotic ring.
0, Highly resistant ..	No uredinia formed; small flecks, chlorotic or necrotic areas more or less prevalent.	c, = General chlorosis.	
1, Very resistant ..	Uredinia few, small, always in small necrotic spots. Also more or less necrotic areas produced without development of uredinia.	n, = necrosis,	(;) = necrotic flecks, (:) = necrotic islands.
2, Moderately resistant ..	Uredinia fairly abundant, of moderate size, always in necrotic or very chlorotic spots. Necrotic spots seldom without uredinia.		
3, Moderately susceptible ..	Uredinia fairly abundant, of moderate size. No necrosis produced, but sometimes slight chlorosis immediately surrounding the uredinia.		Plus and minus signs indicate a slightly greater or smaller amount of rust than the nearest figure representing the infection types.

TABLE VIII—*contd.*

Showing the resemblances in random samples and Single spore culture.

Serial No. from last page.	Samples from	Malakoff.	Carina.	Brevit.	Webster.	Loros.	Mediterranean.	Hussar.	Democrat.	Remarks.
8	Agra	4 S	4 S	4 + S	4 S	3 + S	2 R	2 R	2 R	Resembling Form 10 in its parasitic behaviour but differs slightly from the means of infection on some varieties as indicated in Johnston-Mains analytical key.
14	Lucknow	0c, R	2 R	3 S	2 R	3 - S	1 R	1 + R	1 R		Resembling Form 11 in its parasitic behaviour but differs slightly from the means of infection of some varieties as indicated in Johnston-Mains analytical key.
	Means of infection of Form 10 ..	4	4	4	4	4	1 - 2	1 - 2	1 - 2	These two samples resemble each other in parasitic behaviour but do not correspond to any Physiologic form. These two samples resemble each other in parasitic behaviour but do not correspond to any Physiologic form. These three samples resemble each other in their parasitic behaviour but do not correspond to any Physiologic form.
	Means of infection of Form 11 ..	0	2 +	3 - 4	1 - 2 +	3 - 4	1 - 2	0 - 2	0 - 2	
7	Agra	3 S	3 S	4 S	3 S	2 + R	2 R	2 + R	2 + R	
11	Gorakhpur	3 + S	4 S	3 + S	2 - S	2 R	1 + R	1 R	1 R	
4	Simla	0n; R	0 R	2 + R	0n; R	1 R	0 R	1 R	1 R	
15	Chandausi	0n; R	2 + R	2 + R	0n; R	0n; R	0n; R	0n; R	0 R	
17	Pusa	0n; R	4 S	4 S	0 R	3 S	0n; R	0c, R	2 R	
18	Jubbulpore	0c, R	3 S	4 S	1 R	3 - S	0n; R	0n; R	1 + R	
1	Simla	0n; R	3 - S	3 S	0; R	3 S	0; R	0; R	0; R	
<i>Tests made with Single Spore culture.</i>										
1	Simla—S. S. P ¹ Pot δ	0c, R	3 - S	2 R	1 + R	1 R	0c, R	0c, R	1 R	Do not correspond in their parasitic behaviour to any form in Johnston and Mains key. Evidently a new form which has not been isolated in U. S. A. so far.
2	Muktesar-Almora. S. S. P pot δ	0 R	3 S	2 R	2 R	2 R	0 R	0 R	0 R	
3	Muktesar-Almora. S. S. P ¹ pot δ	0n; R	3 S	2 R	2 - R	2 R	0 R	0 R	0n; R	

TABLE IX.

BROWN RUST.

(Single Spores.)

Year.	Tested at station.	Sample from	Malakoff.	Michigan amber.	Norka.	Carina.	Brevit.	Webster.	Similis.	Loosa.	Mediterranean.	Hussar.	Democrat.	Local.	Hope.	Remarks.
1930-32	Agra and Simla	Simla (Average reactions) ..	0n; R	3 S	0-1; R	3 S	4 S	0n; R	3-S	4+S	0n; R	1 R	1 R	4 S	..	
1 1931-32	Agra	*Simla—S. S. P2. pot b. ..	0c, R	2+R	0n; R	†3-R	2 R	1+R	1 R	1 R	0c; R	0c; R	1 R	4 S	3+S	
1930-31	Agra	Almora	0; R	4 S	0; R	3 S	3 S	0; R	3-S	3-S	4+S	0; R	0; R	..	4 S	
2 1931-32	Agra	†Muktesar—Almora S. S. P1 pot b.	0 R	3 S	0 R	3 S	2 R	2 R	1 R	2 R	0 R	0 R	0 R	4 S	4 S	
3 1931-32	Agra	‡Muktesar—Almora S. S. P1 pot b.	0n; R	3 S	0 R	3 S	2 R	2-R	1 R	2 R	0 R	3 R	0n; R	4-S	4 S	

* From miniature plot started in June 1931. Crop 1930-31. 2nd trial on 23rd †February 1932 4/9=2-R.
 † Material from miniature plot inoculated with Muktesar material in October 1931.
 ‡ Material from miniature plot inoculated with Muktesar material in October 1931.

TABLE X.
YELLOW RUST.
(Average Reactions).
GERMAN.

Year.	No. of tests made.	Sample from	Riedon Alton.	Carsten V.	Golden Deep.	Geos. Ebn.	Kinsay.	Strube Diakkph.	Svalop Extra Kolben.	Vilmorin 23.	Yanetz-kis Fruhe Kreuzung.	Yaphet.	Remarks.
1931-32	4	Simla ..	S*	R	R	R	S	R	S	R	S	R	* Once resistant.
1931-32	2	Lyallpur ..	R	R	R	R	R	R	S†	R	R	R	† Once resistant—no reaction, to be repeated.
1931-32	1	Gurdaspur ..	R	R	R	R	S	R	S	R	R	R	‡ Once resistant—no reaction to be repeated; § Twice resistant.
1931-32	1	Agra ..	R	R	R	R	S	R	S	R	S	R	
1931-32	3	Almora ..	R	R	R	R	S	R	S†	R	S§	R	
1931-32	1	Muktesar ..	R	R	R	R	S	R	R	R	S	R	
1931-32	3	Gorakhpur ..	R	R	R	R	S	R	S	R	R	R	|| Twice resistant.
1931-32	1	Chandausi ..	R	R	R	R	S	R	S	R	S	R	
1931-32	1	Tansing ..	R	R	R	R	S	R	S	R	R	R	
1931-32	2	Pusa ..	R	R	R	R	S	R	S¶	R	R	R	¶ Once resistant.
1931-32	1	Saugor ..	R	R	R	R	S	R	S	R	R	R	

INDIAN AND CANADIAN.

Year.	No. of tests made.	Sample from.	Marquis.	Little club.	Punjab type No. 7.	Khapli.	Potia.	Bansi.	Einkorn.	Quetta wheat.	Local.	Hope.	Remarks.
1931-32	2	Simla ..	S	R	S*	S†	S	S	S†	S	S	..	* Thrice tested, once resistant;
1931-32	2	Lyallpur ..	R	R	S†	S†	S	S	S†	S	S	S	† Once resistant;
1931-32	1	Gurdaspur ..	S	R	S	R	S	S	R	S	S	..	‡ Once resistant.
1931-32	1	Agra ..	S	R	S	R	S	S	S	S	S	..	
1931-32	3	Almora ..	S	R	S	S§	S	S	R	S	S	S	§ Twice resistant.
1931-32	3	Gorakhpur ..	S	S||	S¶	S||	S	S	S	S	S	S	|| Once resistant ¶ Twice resistant.
1931-32	1	Chandausi ..	S	R	S	S	S	S	S	S	S	..	
1931-32	1	Tansing ..	S	R	S	R	S	S	S	S	S	..	
1931-32	2	Pusa ..	R	S**	R	S**	S	S	S	S**	S	..	** Once resistant.
1931-32	1	Saugor ..	S	S	S	R	S	S	S	R	S	..	

TABLE XI.
YELLOW RUST.
(Detailed reactions showing resemblances).

		German.											Indian and Canadian.																		
Year.	Tested at station.	Sample from	Ble Des Allies.	Carlean V.	Golden Drop.	Gros Bleu.	Kinney.	Strubas Diekkoph.	Svalof's Extra Kolben.	Vilmorin. 23.	Yanez kte Fruhe Kreuzung.	Yaphet.	Marquis.	Little Club.	Punjab Type No. 7.	Khapli.	Potia.	Bansal.	Einkorn.	Quetta wheat.	Local.	Hope.	Remarks.								
1	1931-32	Agra	* Simla ..	2+ R	0	R	3+ S	0	R	3	S	3	0	R	4	S	2- R	4	S	2+ R	4	S	4+ S	0	R	4+ S	4	S	..		
2	1931-32	Simla	† Simla ..	3	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
3	1931-32	Simla	‡ Simla ..	3	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
4	1931-32	Simla	§ Simla ..	3	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	1931-32	Agra	Lyallpur	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
6	1931-32	Simla	Lyallpur	2	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7	1931-32	Simla	Gurdaspur	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
8	1931-32	Simla	¶ Agra ..	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
9	1931-32	Agra	** Almora	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R
10	1931-32	Agra	†† Almora	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R
11	1931-32	Simla	‡‡ Almora	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
12	1931-32	Simla	§§ Muktesar	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
13	1931-32	Agra	Gorakhpur	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
14	1931-32	Agra	Gorakhpur	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
15	1931-32	Simla	Gorakhpur	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
16	1931-21	Simla	Chandaul	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
17	1931-32	Simla	Tansing ..	1	0c, R	0m, R	3	0c, R	0m, R	3	0c, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
18	1931-32	Agra	Pusa ..	0m, R	0	R	0c, R	0	R	0c, R	0	R	0	R	0c, R	0	R	0	R	0c, R	0	R	0	R	0	R	0c, R	0	R	0	R
19	1931-32	Simla	Pusa ..	2	R	0c, R	0m, R	3	S	0c, R	3	S	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0	R	0
20	1931-32	Simla	Saugor ..	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	0m, R	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Samples Nos. 15, 17, 19 and 20 resemble in their parasitic behaviour. Samples Nos. 17, 15 and 8 resemble in their parasitic behaviour.
 No. 15 and 17 are identical.

* From crop 1930-31.
 † From crop 1929-30.
 ‡ From crop 1930-31.
 § From crop 1931-32.
 ¶ No reaction to be repeated.
 ** From crop 1931-32.
 †† No reaction, to be repeated. ** From crop 1930-31.
 ‡‡ From crop 1930-31. Reference above. Repeated.
 §§ From crop 1930-31.
 ¶¶ From crop 1931-32.
 ¶¶ 1/9 8L = 0. R. 1L = 3 S. to be repeated. 1/9 8L = no reaction.
 1L = 2 R. @ 1/8 1L S. 4L = 0m; R. 5/12 10L = no reaction. 2L = 0m; R.

Explanation of Symbols—
 O—Highly resistant.
 1—Very resistant.
 2—Moderately resistant.
 3—Moderately susceptible.

4—Very susceptible.
 n; = Necrosis.
 c = Chlorosis.
 (:) = Necrotic flecks.
 (:) = Necrotic islands.
 Plus and Minus signs indicate a slightly greater or smaller amount of rust than the nearest figure representing the infection types.

ENCLOSURE VIII.

*Annual outbreaks of Rusts on Wheat and Barley in the plains of India** by K. C. Mehta, M.S., Ph.D. (Cantab.), Professor of Botany, Agra College, Agra.

Wheat in India suffers from all the three rusts (*Puccinia glumarum* Eriks. and Henn. *P. triticea* Eriks. and *P. graminis* Pers.) known on that host. The yellow rust (*P. glumarum* Eriks. and Henn.) and the black (*P. graminis* Pers.) are also common on barley but the dwarf rust of barley (*P. simplex*) is very rare. Oats in India are free from rusts.

On an average there are 30,500,000 acres under wheat and 7,000,000 acres under barley in India each year.

The greater part of the area under these crops lies in the Indo-Gangetic plain, Central Provinces, Sind and Deccan.

Both these crops are also cultivated in the hilly tracts of the area mentioned above as well as in the Himalayas up to an altitude of nearly 10,000 ft. above sea-level.

Both wheat and barley are sown in October-November and are harvested in March-April on the plains, whereas the harvesting in the hills is done a couple of months later.

As far as India is concerned the season of the year which is critical for rusts is the intensely hot summer and not winter, as is the case with most of the wheat-growing countries.

For a period of nearly seven years the incidence of all the five rusts under report has been studied by the writer in the plains of the United Provinces as well as in the Kumaon hills.

Casual observations have also been made at suitable periods in the neighbourhood of Simla for purposes of verification of the data obtained.

The present position of the problem of annual outbreaks of rusts in India may be briefly stated as follows:—

A. Incidence of rusts on the plains.

- (1) About the harvest time (March-April) there is very little of the viable material of uredospores on the plains. All attempts to grow rusts, after the end of April, have failed at Agra even in shade, and this is in agreement with previous observations about United Provinces.
- (2) It is almost impossible for the uredospores to survive after the harvest, on the plains of India, where the heat of summer is so intense that the maximum temperature in shade may be well above 110°F for several weeks during May and June, over the greater part of the area under cultivation.

The above statement has been well corroborated by the results of experiments conducted with Hearson's 9 compartment incubator, in order to study the influence of summer temperatures on the viability of fresh uredospores.

- (3) That explains why crops sown on the plains are free from rusts normally up to the middle of January each year, i.e., two to three months from the time they are up. Yet the temperature on the plains is quite favourable for the growth of rusts from the middle of October onwards. Wheat inoculated at Agra with uredospores of brown rust brought down from the hills in specimen tubes in October developed pustules within a week.
- (4) It is right therefore to conclude that, at the time when these crops are sown (October-November), there is no local source of infection on the plains of India. A few self-sown plants that may be present in the fields are invariably free from rusts, besides the alternate hosts are not found on the plains.

* Paper read before the Mycology Section of the international Botanical Congress on August 23, 1930, at Cambridge.

B. Incidence of rusts in the hills.

- (5) Conditions in the hills are different, where on account of a comparatively mild summer, uredospores of rusts survive on self-sown plants and tillers during the critical period. Viable uredospores of rusts of wheat and barley have been found by the writer several times during summer at Muktesar (7,600 ft. above sea-level), where the average temperature during May-August, the hottest part of the year, is 20-30°F. lower than that of Agra.
- (6) The infection of the new crops at such places in the hills, where uredospores are available on volunteers at the time of the sowing, does not need much of an explanation.
- (7) Another fact to bear in mind is, that year after year rusts appear earlier on crops at the foot of the Himalayas than at places farther off. Plant to plant there is a severer attack at the foot of the hills in the month of January, when rusts are either absent, or are just appearing on the plains.
- (8) On account of the obvious survival of uredospores in the hills during the critical period and earlier outbreaks of rusts every year at the foot of the hills, one may rightly conclude that it is a case of dissemination of rusts by wind to crops on the plains of India.

YELLOW RUST (*P. glumarum* Eriks. and Henn.).

It is interesting to note that although there is no alternate host known for this rust, its recurrence is the easiest to explain.

As stated before, this rust survives the summer in the uredo-stage on self-sown plants in the hills at an altitude of nearly 7,000 ft. and above, and there is plenty of this rust at the time of the sowing.

After the infection of the new crop in the hills, the mycelium of this rust seems to grow by fits and starts during November-December, on account of the severely cold winter. Following a comparatively long incubation it breaks out in December-January. At the higher altitude this is the only rust found up to the end of March as it stands cold better than the other two. It is probable that outbreaks of this rust on crops at Muktesar and places similarly situated lead to rust infection on the plains due to wind-blown uredospores.

BROWN RUST OF WHEAT AND THE BLACK RUST OF CEREALS.

A few species of *Thalictrum*, the recently discovered alternate host for *P. triticea* and *Berberis*, the alternate host for *P. graminis*, are found in India in the hills. Aecidia on *Thalictrum* are rather rare and most of the aecidial material occurring on *Berberis* is caused by *Aecidium montanum* showing characteristic "witches-brooms". Barclay has recorded the occurrence of aecidia on *Thalictrum* and *Berberis vulgaris* in India during July and August, but there is no evidence to show that they are connected with brown rust of wheat and the black rust of cereals respectively.

So far the writer has not come across aecidia on either of these hosts in the area that has been under observation in Kumaon and Simla hills.

Inoculations made with aecidiospores from *Berberis aristata* and *Berberis lycium* have given negative results in each case.

Viable uredospores on both these rusts, however, are found in the hills during the critical period.

It is interesting to note that these rusts appear on the plains by the beginning of February, i.e., one-and-a-half to two months earlier than at Simla, or Muktesar, where they have not been found even by the end of March.

It is clear therefore that aecidia found in the hills during March-August have no direct part to play for crops on the plains. The results of observations made so far suggest that the source of infection for crops on the plains in the case of both these rusts spreads from lower altitudes where, on account of a mild winter, uredospores occurring at the time of

sowing may cause outbreaks on the new crops rather early in the season and the infection may then disseminate to plains in January-February.

At the foot of the hills near Nepal both these rusts were observed this year as early as the end of January, and it is proposed to extend the work to that territory soon.

The Imperial Council of Agricultural Research in India have recently accepted a scheme of investigations on cereal rusts, and work on the life-histories of brown rust of wheat and the black rust of cereals is already in progress at two laboratories in the hills.

The Meteorological Department of India and the Royal Air Force at Ambo^{UP} have kindly agreed to help in the study of rust dissemination. A few preliminary tests were made early this year, with slides exposed in aeroscopes and those sent up on hydrogen balloons and the results were promising.* Uredospores of black rust were caught at Agra on a slide sent up on a balloon and on another exposed in an aeroscope three and two weeks respectively before that rust appeared on the crops. One of the slides exposed at Lyalpu caught spores of brown rust two weeks before it was noticed on the wheat crop.

With the facilities that are now available, the writer hopes that further work will fill up the gaps in our knowledge of the recurrence of rusts in India before long.

DAMAGE DONE BY RUSTS AND THE MEANS OF COMBATING THEM.

According to an estimate made nearly 25 years ago, the annual loss in India due to rusts on wheat alone comes to Rs. 40,000,000, i.e., £3,000,000 or so.

The absence of suspected alternate hosts on the plains, and the inability of uredospores to survive the summer over nearly 95 per cent. of the total area under wheat and barley, offer a unique opportunity for measures of control in India.

The data obtained so far clearly indicate that the foci of infection in the case of all the rusts under report lie in the hills.

Destruction of volunteers and tillers after harvest and before sowing in the hills seems to be one effective way of dealing with the situation.

Still more effective should be the suspension of cultivation of wheat and barley for two to three years in the hills which occupy hardly two to three per cent. of the entire area under these crops in the country. This method would be impracticable without the co-operation of the neighbouring States that own a considerable part of the hilly tract.

The only other way of checking the spread of rusts in the hills and thereby saving crops on the plains to a considerable extent, is to cultivate only rust-resistant varieties in the hills.

There is a pressing need therefore for investigations on the "biologic" forms of rusts on cereals and grasses in India. Information on the different forms that may be present in the country and their distribution should be of immense help in the selection and breeding of varieties suitable for cultivation in the hilly tract and at the foot of the hills. At present there is no such information available in India.

*The mechanism of the 'Spore Trap' used for this purpose is explained in a Note, by Mr. G. Chatterjee, Meteorologist in charge of the Upper Air Observatory at Agra, published on p. 306 of this Journal.

APPENDIX XV.

SUBJECT No. 12 (a).

RECOMMENDATIONS OF THE INDIAN OIL CRUSHING INDUSTRY COMMITTEE, 2ND MEETING, DECEMBER 1931.

A) CULTIVATION OF MAHUA; AND INTRODUCTION OF NEW VARIETIES OF OIL-SEEDS AND THE QUESTION OF IMPROVED STORAGE.

Attention is invited to the attached extract from the proceedings of the second meeting of the Indian Oil Crushing Industry Committee appointed by the Imperial Council of Agricultural Research, held in Bombay in December 1931.

The recommendations of the Committee are now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 9th June 1932.

EXTRACT FROM THE PROCEEDINGS OF THE 2ND MEETING OF THE INDIAN OIL-CRUSHING INDUSTRY COMMITTEE, DECEMBER 1931.

Mahua.—Mr. Duke suggested that attention might be given by various Departments—Irrigation Departments, Public Works Department (Roads Branch), Municipal Boards, District Boards and Forest Departments—to the cultivation of *Mahua* in view of the tendency of the Indian soap industry to expand. He pointed out that in Northern India there was no other vegetable oil from which hard soap could be made and that with any increase in the trade, there was likely to be a shortage of suitable oils and that the flowers from the tree would augment the supply of cattle food. Mr. Burt pointed out that *Mahua*-cake was a cheap manurial cake with a low nitrogen content and decomposed very slowly; crushers of *Mahua* seed should not expect much above the fuel value of the cake but larger local supplies would help the agriculturist. The Committee agreed to make general recommendations on the above lines.

In the matter of investigating and developing new varieties of oil-seeds, Mr. Duke suggested that more intensive research should be done in matters regarding diseases and pests of the oil-seed crops. Mr. Burt stated that work on these lines had been proceeding since 1908 and also in the matter of improving the various varieties. A great deal of the fundamental work had already been done at Pusa which was still actively engaged on work on linseed. The Madras, Punjab and United Provinces Agricultural Departments now have botanists giving special attention to oil-seed crops. Mr. Menon referred to his note (not printed) and the work in progress in Madras. Mr. Duke suggested that research work, which would assist both the agriculturist and the oil-miller should be in the direction of producing types of seed yielding more oil; the weight of oil per acre should also be kept in view; such work, if successful, would make Indian oil-seeds more attractive and valuable to the oil-industry of the world and would probably enable a premium to be obtained for Indian oil-seeds. He also mentioned an insect-pest from which the *Sarson* crop of the United Provinces was suffering. Mr. Roberts emphasised the importance of the yield per acre and the financial return to the grower. He also suggested that work should be done on improving the quality of *Toria* seed in the Punjab and on cultivating pure crops of seed, as at present the crop is composed of a number of varieties which even ripen at different periods. Mr. Duke suggested that this work could with advantage be extended to the United Provinces. Mr. Burt referred to the Howards' work on Brassicæ and to the difficulties in improvement which they found but he agreed that the problem should be taken up though difficult. Mr. Roberts said that even admitting the difficulties pointed out by Mr. Burt, he thought that a purity of 90 per cent. would, from an agricultural point of view meet the case, and that separation and testing of varieties for yield should be pro-

ceeded with. The Committee recommended that the matter should be brought to the notice of the Economic Botanists in the various provinces concerned. Mr. Duke also recommended the cultivation of groundnuts and white Til seed in the United Provinces.

The question of improved storage of oil-seeds was considered and the Committee recommended propaganda amongst merchants and dealers urging on them the importance of storing seed under suitable conditions. The Committee also recommended that the attention of Agricultural Departments be drawn to these matters and to the need for improved methods of removing the outer husk from castor seed, so that it does not get over-heated before it reaches the market.

APPENDIX XVI.

SUBJECT No. 12 (b).

RECOMMENDATIONS OF THE INDIAN OIL CRUSHING INDUSTRY COMMITTEE, 2ND MEETING, DECEMBER 1931.

(b) IMPORT DUTY ON OIL-MILL MACHINERY AND SPARE PARTS.

Attention is invited to the attached extract from the proceedings of the second meeting of the Indian Oil Crushing Industry Committee appointed by the Imperial Council of Agricultural Research, held in Bombay in December 1931.

The recommendation of the Committee is for the consideration of the Advisory Board

CHARAN DAS,

Secretary.

The 26th May 1932.

IMPORT DUTY ON OIL MACHINERY AND SPARE PARTS.

Mr. Walker did not think that the existing duty should really affect the industry. It was decided to represent to Government that the Committee realised that the present duty on oil-mill machinery was of a temporary nature but that it tended to hamper the development of the industry and therefore should be removed as soon as possible.

APPENDIX XVII.

SUBJECT No. 12 (c).

RECOMMENDATIONS OF THE INDIA OIL-CRUSHING INDUSTRY COMMITTEE,
2ND MEETING, DECEMBER 1931.*(c) Helping village Presses and Larger Scale Oil Factories.*

Attention is invited to the attached extract from the proceedings of the second meeting of the Indian Oil Crushing Industry Committee appointed of the Imperial Council of Agricultural Research, held in Bombay in December 1931.

The recommendations of the Committee are for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**The 30th May 1932.*EXTRACT FROM THE PROCEEDINGS OF THE SECOND MEETING OF THE INDIA OIL CRUSHING
INDUSTRY COMMITTEE HELD IN DECEMBER 1931.

* * * * *

5. *Helping village presses and larger scale oil-factories.*—Mr. Menon considered that work should be done with the object of assisting the village *telis*. Such assistance should include the devising of improved methods and plant for crushing various oil-seeds, simple and practical methods of refining oil in small quantities and manufacture of soap in villages; the plant and processes should be essentially suitable for village use. The Committee agreed that this work should be undertaken at the various provincial institutions. Mr. Duke suggested that considerable assistance could be given to the small industrialist type of oil-crusher, *viz.*, owners of small oil-mills which did not come under the Factory Act. He was of the opinion that, in order to do this, it is necessary to establish personal contact with the oil-millers. The Committee considered that this contact should be established through the various Departments of Industries, and that the Departments of Industries and Agriculture should co-operate in ascertaining the exact number of these small mills and village *telis* which exist in each province. Mr. Roberts suggested that the Board of Economic Enquiry in the Punjab should be invited to make an enquiry into the economics of the village *telis* and his business. Mr. Duke said that the recently established Board of Economic Enquiry in the United Provinces might also be approached. This was approved.

APPENDIX XVIII.

SUBJECT No. 12 (d).

RECOMMENDATIONS OF THE INDIAN OIL CRUSHING INDUSTRY COMMITTEE,
2ND MEETING, DECEMBER 1931.

d) *Organisation and Development of the Manufacture of Soaps, Candles, lubricants and edible Products, etc., such as Ghee and Vegetable Substitutes for which there is a demand ; also steps to increase the demand for edible oil.*

Attention is invited to the attached extract from the proceedings of the second meeting of the Indian Oil Crushing Industry Committee appointed by the Imperial Council of Agricultural Research held in Bombay in December 1931. The question of levying an export duty on castor-seed referred to therein will be further considered by the Committee at its next meeting. In the meantime the recommendations of the Committee on the other points are for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 30th May 1932.

EXTRACT FROM THE PROCEEDINGS OF THE 2ND MEETING OF INDIAN OIL CRUSHING INDUSTRY
COMMITTEE, HELD IN BOMBAY IN 1931.

* * * * *

4. *Organisation and development of the manufacture of soaps, candles, lubricants and edible products, etc., such as ghee and vegetable substitutes for which there is a demand ; also steps to increase the demand for edible oil.*

Mr. Menon stated that there were many small soap makers all over India who are making very inferior and adulterated soaps which were spoiling the industry. It is necessary first of all to set up standards for both imported and Indian made soaps so as to improve the quality manufactured ; if this is done, it would stimulate the growth of the industry. India at present uses only 4 oz. of soap per head of the population : England 20 lbs., but the habit of using soap was growing rapidly. He said that for a large soap industry, there is not at present a sufficient supply of vegetable oils of the right quality for the manufacture of toilet soaps, i.e., the supply of high melting point vegetable fats was too small but in view of the development of the hydrogenation of oils in India, the supply of suitable material can easily be augmented. The Committee were of opinion that steps should be taken to set up legal standards for soaps and that these standards should apply both to soaps manufactured in India and to imported soaps.

The Committee were further of opinion that research work should be undertaken in order to ascertain methods of manufacturing different kinds of lubricants from vegetable oils and fats, and with a view to improving the trade in castor oil. Steps should be taken by the trade to improve the quality of the oil produced and to make efforts further to develop the export trade in castor-oil. The Committee felt that an increase in castor-oil production in India is necessary in order to make available in the country sufficient quantities of castor-cake for manurial purposes. Mr. Saklatwala pointed out that castor-seed exports were equivalent to about 20 times the castor-oil export. There was no great demand for castor-cake in European countries and an export duty on castor-seed would stand on a different footing to one or other oil-seeds. It was decided to discuss this further under subject 13 of the Agenda (*vide* Enclosure).

Edible Oil-products.

After a full discussion the Committee came to the following conclusions :—

- (1) There is a serious shortage of genuine *ghee* and a real need for vegetable substitutes.
- (2) It would be better to introduce a separate name for "vegetable *ghee*" which would not include the word "*ghee*", if this could be done.

(3) Meantime correct description and labelling is most important.

The Committee consider that there should be standards of quality for all kinds of edible oils and vegetable-oil products and that they should be sold under a proper description both by wholesalers and retailers.

 ENCLOSURE.

* * * * *

6. *Levying an export duty on oil-seeds and oil-cakes as a means of encouraging the oil industry. (Subject 13 of the Agenda.)*

Mr. Saklatwala said that he was only in favour of export duties when a practical monopoly existed of a raw material from which valuable products could be produced. He thought that before anything is done in this matter the trade should be asked if they would be able to crush more seed than at present in the event of the export of seed being restricted by the levying of a duty. As previously mentioned castor-seed seemed to be a special case as India had almost a monopoly of production. Mr. Roberts questioned the effectiveness of an Indian monopoly in castor-seed production and referred to the efforts made by other countries. Mr. Gandhi said that in view of the fact that other countries also are now producing castor-seed in substantial quantities, an export duty is not likely to fall on the foreigner and will therefore be shifted to the producer to some extent. He pointed out that considerable and increasing quantities of castor-seed were being produced in Brazil. The Committee thought that the present was not a good time to consider the levying of a duty on the export of oil-seeds and oil-cakes and that the only seed which might be considered for an export duty was castor-seed. But before they could make any recommendation on this matter, it was necessary to find out the actual production of castor-seed in Brazil, Tanganyika, Australia and America and to ascertain where markets for these exports existed. Mr. Roberts said he was surprised to find that the proposal to levy an export tax was given in the Simla Report as his 'Child'. He was against an export tax on principle, but had suggested maximum rates that may be imposed if such a tax was levied.

Export duty on oil-cakes.—The Committee agreed that such a duty could do no one any good and might do great harm by reducing the production of mills which were now exporting some of their cake.

* * * * *

APPENDIX XIX.

SUBJECT No. 13.

APPLICATION FROM THE ANNAMALAI UNIVERSITY FOR A GRANT TO INVESTIGATE THE MARKETING PROBLEM OF THE GROUNDNUT CROP IN THE SOUTH ARCOT DISTRICT.

Attention is invited to the attached letter (Enclosure I) from the Government of Madras, No. 954-III/31-3, dated the 30th April 1931; recommending *inter alia* an application from the Annamalai University for a grant to investigate the marketing problems of the groundnut crop in the South Arcot District. The scheme was considered by the Advisory Board at its meeting held in June 1931 [*vide* extract from the proceedings (Enclosure III)], and it was decided that the papers should be placed before the Oil-seeds Committee for detailed examination of the question. The scheme was then considered by the Indian Oil-Crushing Industry Committee at its meeting held in December 1931 (Enclosure IV) where it was suggested that a detailed budget should be called for from the University on the lines recommended by the Committee and that the revised scheme should be submitted to the Advisory Board.

The revised scheme (Enclosures V to IX) which is now submitted by the Annamalai University and involves an expenditure of Rs. 970 is for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 25th June 1932.

ENCLOSURE I.

LETTER FROM S. V. RAMAMURTY, Esq., I.C.S., M.L.C., SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, No. 954-III/31-3, DATED THE 30TH APRIL 1931.

SUBJECT:—*Schemes for grant from the Imperial Council of Agricultural Research.*

I am directed to refer to this Government's letters No. 954-III/31-2, dated 21st April 1931 and No. 1223-III/31, dated 26th April 1931 (Not printed), forwarding four schemes for grant from the Imperial Council of Agricultural Research. The Provincial Agricultural Advisory Committee at its meeting held on the 28th April 1931 examined the schemes and their recommendations are noted below:—

Scheme 2.—Application of the Annamalai University for a grant of Rs. 2,000 for the investigation of the problems of marketing of the groundnut crop in the South Arcot District.

The Committee recommends the application.

ENCLOSURE II.

LETTER FROM THE REGISTRAR, ANNAMALAI UNIVERSITY, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, DATED THE 21ST NOVEMBER 1930.

I have the honour, by direction of the Syndicate, to submit the following proposal of the Board of Studies in Economics, for a grant of not less than Rs. 2,000 for the favourable consideration of the Advisory Board.

It is proposed to depute one or two members of the Economics Department of this University to investigate the problems of "the marketing of the groundnut crop of the South Arcot district". It is hoped that the final report of the research work done will be made at the end of one year. In this connexion, it is needless to mention that the South Arcot district produces more groundnut than any other district in this Presidency and since it is a very important commercial crop, the investigation is bound to be of considerable interest and importance.

I have to request you to be so good as to place the matter before the Advisory Board for its favourable consideration and decision.

ANNAMALAI UNIVERSITY.

Extract from the note of the Reader in Economics regarding the directions in which expenditure will have to be incurred in connection with the investigation (marketing of groundnut in South Arcot).

- (1) Travelling to typical villages in different taluks of the South Arcot district to investigate the existing conditions of production, and the factors which affect quantity and quality of production—Indebtedness of the ryot, its influence on the quality and quantity of crops studied. The storage facilities of the poor ryot studied.
- (2) Investigation with the present methods of financing the production of groundnut. Interviews with money-lenders and agents of banks.
- (3) Acquisition of data representative of marketing facilities existing at present by visits to local markets. Interviews with groundnut merchants and commission agents to ascertain whether the rates charged by commission agents are fair.
- (4) *Groundnut markets*.—Adulteration, prevalence of fraudulent measures or practices studied. Existing facilities for warehouse studied.
- (5) Comparison of marketing conditions for internal consumption in South Arcot compared with conditions in Godavari, Coimbatore and other districts. Travelling to market centres in those districts.
- (6) Interviews with (i) Railway Administration, (ii) exporting firms, (iii) groundnut merchants for comparing the freights on sea, rail and road.
- (7) Export facilities provided by foreign firms, inspection of their godowns, and interviewing with agents, Volkart Bros., Dreyfus Co., etc.
- (8) Co-operative societies for the sale of groundnut. Possibility investigated.
- (9) Travelling to places where groundnut oil is manufactured on a large scale to ascertain if the facilities for wet decortication in the Madras Presidency as a whole are satisfactory.
- (10) Purchasing of bulletins and reports issued by such bodies as (i) the Imperial Institute, London, (ii) the Indian Central Cotton Committee, (iii) the Federal Farm Board.
- (11) Cost of stationery and typing charges in connexion with submitting the report.
- (12) Subsistence and other miscellaneous allowance during the period when the investigators are travelling.

ENCLOSURE III

EXTRACT FROM THE PROCEEDINGS OF THE ADVISORY BOARD, HELD AT SIMLA IN JUNE 1931.

Application from the Annamalai University for a grant of Rs. 2,000 to investigate the problems of the marketing of the groundnut crop of the South Arcot District.

Dr. Hyder said that he did not consider the scheme important enough for a grant. The evidence taken by Provincial Banking Enquiry Committees and their reports would be found to cover all the ground which it was proposed to do under the present scheme. He suggested that in the matter of agricultural economic enquiries the Board should set definite problems which he was sure the Indian Economic Association would be glad to take up, provided the necessary assistance was given to it. The Chairman said that Dr. Hyder's suggestion was a valuable one and that instead of rejecting the scheme out of hand it would be as well to place the papers before the Oil Seeds Committee at its next meeting some time in December. The Committee would then be able to indicate problems in connection with the marketing of oil seed crops which were of importance to the country and the agency which should be approached to tackle them.

The Board accepted the Chairman's suggestions.

ENCLOSURE IV.

EXTRACT FROM THE PROCEEDINGS OF THE INDIAN OIL CRUSHING INDUSTRY COMMITTEE;
HELD IN BOMBAY, DECEMBER 1931.

Application from the Annamalai University for a grant of Rs. 2,000 to investigate the problems of the marketing of the groundnut crop of the South Arcot District.

The Committee considered that the scheme was too wide and as it stood much too superficial. They recommended that the Annamalai University Economics Department might undertake a thorough investigation into items 3 and 5 of the scheme (Enclosure II) modified to read :—

(3) Acquisition of data regarding marketing facilities at present existing market charges, common rates, etc., by detailed investigation in local markets on the lines of the Indian Central Cotton Committee enquiries into cotton marketing.*

(5) Comparison of marketing conditions for internal consumption in South Arcot, North Arcot, Coimbatore and Salem districts.

It was suggested that a detailed budget should be called for on these lines and the revised scheme submitted to the Advisory Board.

ENCLOSURE V.

COPY OF LETTER FROM DR. B. V. NARAYANASWAMI, M.A., PH.D., B.COM., BAR.-AT-LAW,
HEAD OF THE DEPARTMENT OF ECONOMICS, ANNAMALAI UNIVERSITY, TO THE SECRETARY,
IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, DATED THE 2ND
MARCH 1932.

In continuation of my letter dated 19th January 1932 (not printed), and in the light of the note (not printed) sent by the Agricultural Expert, Imperial Council of Agricultural Research, I have the honour to submit my revised and detailed working scheme as well as the Budget in connection with the marketing investigation of the 'Groundnut Crop' of the four Districts of South Arcot, North Arcot, Salem and Coimbatore in the Madras Presidency.

It may be pointed out in this connection that my first application (Enclosure II) was for Rs. 2,000 but as the original scheme of investigation was narrowed down to specific points by the Indian Oil-Crushing Industry Committee (Enclosure IV), the revised bare minimum estimates were submitted only in the hope that this University will get an opportunity to work out the scheme even if it might entail some additional private expenses on the part of the investigators. But in the light of the note of the Agricultural Expert (not printed), I find that we have to undertake a thorough investigation which might take a longer time and would further necessarily involve the employment of a number of investigators to take records in all the markets and special provision has therefore to be made for these additional items.

I have therefore the honour to submit the final detailed working scheme and the Budget for your kind approval.

ENCLOSURE VI.

WORKING SCHEME.

The objects of the Scheme are :—

- (i) Acquisition of data regarding marketing facilities at present, existing market charges, common rates, etc., by detailed investigation in local markets on the lines of the Indian Central Cotton Committee enquiries into cotton markets.
- (ii) Comparison of marketing conditions for internal consumption in South Arcot, North Arcot, Salem and Coimbatore Districts. The investigation will be conducted according to a detailed questionnaire on the lines of the Indian Central Cotton Committee. It will comprise preliminary investigation of the crop—

* Copy of questionnaire and instructions to investigators arranged for.

- (i) before the harvest,
 (ii) during the harvest and after.

It will include the full history of every cart-load brought to market, *viz.*, by whom brought in (cultivator, or petty trader), to whom sold, when sold, prevailing rates, actual rates, allowances, delays, difficulties, disputes, *etc.*, *etc.*

A copy of the questionnaire (Enclosure VIII) will be submitted shortly for approval.

ENCLOSURE VII.

	Estimated expenditure.
I. Travelling Expenses—Railway, bus, and other conveyances in the four Districts of North Arcot, South Arcot, Salem and Coimbatore for—	Ra.
(i) Two investigators (including nominal allowances for them) ..	300
(ii) Expenses for the two members of the Economics Department of the University, who also will undertake to investigate ..	300
II. Purchase of Bulletins and reports of the Indian Central Cotton Committee and Federal Farm Board	20
III. Cost of Stationery —printing of questionnaire, and typing charges in connection with submitting the Report	50
IV. Subsistence and other miscellaneous items of Expenditure for the Economics Department staff of the University and the investigators (<i>viz.</i> , Boarding and Lodging)	300
Total ..	970

Rupees nine hundred and seventy only.

ENCLOSURE VIII

GENERAL FOR EACH VILLAGE.

(To be ascertained at the commencement of the Inquiry.)

1. Name of village.
2. Total cultivated area.
3. Area under ground-nut this year—
 - (a) irrigated from canal,
 - (b) irrigated from other sources,
 - (c) unirrigated.
4. Area under ground-nut last year—
 - (a) irrigated from canal,
 - (b) irrigated from other sources,
 - (c) unirrigated.
5. How does this year's crop compare with last year's.
6. Is the crop this year earlier or later this year and by how much.
7. What is (are) the nearest ground-nut market (markets) ?
 What is the distance ?
 Is the road good, fair or bad ?

8. Is there any storage accommodation for ground-nuts in the village ?
9. What is (are) the common system (systems) or weights in use in the village for cart-loads ?

ENCLOSURE IX.

The questionnaire will be somewhat on this model.

Information obtained from each individual bringing cart-loads (Ground-nuts) to market for sale.

1. Date.
2. Was the cart-load grown by you ?
Or, have you bought it ?
3. From what village brought ?
Distance in miles.
Road metalled or not.
4. What weight of cart-loads have you brought ?
5. What is the rate which you have accepted ?
6. What money have you received ?
7. To what deductions have you agreed ?
8. Have you taken any advance ?
And if so, of what amount ?
And from whom (Sowcar, dalal, ground-nut trader, etc., etc.) ?

APPENDIX XX.

SUBJECT No. 14.

APPLICATION FROM PROFESSOR J. C. GHOSH, D.Sc., CHEMISTRY DEPARTMENT, DACCA UNIVERSITY, DACCA, FOR A GRANT OF Rs. 11,200 SPREAD OVER A PERIOD OF FIVE YEARS FOR THE INVESTIGATION OF THE ORGANIC CONSTITUENTS OF INDIAN SOILS.

Attention is invited to the attached letter from the Government of Bengal, No. 246-T.A.I., dated the 8th June 1932 forwarding *inter alia* a revised scheme of work for investigation of the organic constituents of Indian soils. The scheme which has been approved by the Bengal Provincial Agricultural Research Committee, and which is for a period of five years, involves a non-recurring expenditure of Rs. 1,000 and a recurring expenditure of Rs. 10,200 or a total expenditure of Rs. 11,200 spread over a period of five years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS

Secretary.

The 22nd June 1932.

COPY OF LETTER FROM THE SECRETARY TO THE GOVERNMENT OF BENGAL, AGRICULTURE AND INDUSTRIES DEPARTMENT, No. 246-T.A.I., DATED THE 8TH JUNE 1932.

With reference to your letter No. 873/G1., dated the 13th May 1932 (not printed) I am directed by the Government of Bengal (Ministry of Agriculture) to forward herewith, for inclusion in the agenda of the meeting of the Advisory Board to be held in July next the schemes noted below :—

* * * * *

(2) Revised scheme of work for investigation of the organic constituents of Indian soils (enclosure to Appendix),

which has been approved by the Provincial Agricultural Research Committee, Bengal, and to say that Local Government recommend the same subject to the condition that no financial liability devolves on them.

One hundred spare copies each of the schemes will be forwarded to you direct by the Director of Agriculture, Bengal.

ENCLOSURE I.

Prof. J. C. Ghosh, D.Sc.

DACCA UNIVERSITY,
CHEMICAL LABORATORY,
The 2nd March 1932.

To

The Secretary to the Imperial Council of Agricultural Research, New Delhi.

Through the Provincial Agricultural Research Committee, Government of Bengal.

Sir,

have the honour to invite reference to an extract from the proceedings of the meeting of the Advisory Board of your Council held at Pusa on the 4th December 1929, referred to in your letter No. 507-R.C.S., dated 5th March 1930, which runs as follows :—

“The Board does not consider the estimation of the organic matter in soils to be as important as an investigation of the organic constituents of the soils. The Board hopes that Prof. Ghosh will find it possible to modify and extend his proposals for soil research in this direction.”

In response to this I addressed a letter outlining a scheme of work for investigating this problem, on the 6th of May 1931, to Mr. B. C. Burt, the Agricultural Expert of your

Council, for his consideration and opinion. Unfortunately Mr. Burt was away on leave then, but he has now written to me to say that he agrees with the scheme personally (*vide* copies of correspondence attached—Enclosure III).

I, therefore, beg to enclose a revised scheme of work (Enclosure II) for the investigation of the organic constituents of India soils and request you to be so good as to place it before the next meeting of the Advisory Board of your Council for consideration.

I have the honour to be,

Sir,

Your most obedient servant,

(Sd.) J. C. GHOSH,

Prof. of Chemistry.

ENCLOSURE II.

SCHEME OF WORK FOR INVESTIGATION OF THE ORGANIC CONSTITUENTS OF INDIAN SOILS.

A. Requirements :—

- (i) One Research Assistant who must be a first class M.Sc., with Organic Chemistry as his special subject, on Rs. 150—10—200 per month, for a period of five years.

NOTE.—The two research assistants who have already been appointed out of the grant sanctioned by the Imperial Council of Agricultural Research for investigating the problems of (1) nutrition of rice plants and (2) mechanical analysis of lateritic soils are so busily engaged in the above works that it will not be possible to start the present investigation with their aid.

- (ii) A capital grant of Rs. 1,000 for purchase of apparatus as per list attached.

B. Scheme of work :—

A quantitative estimation will be made of the following variables in the soil samples by standard methods :—

- (a) Moisture, (b) Combined CO_2 , (c) Soluble nitrate and nitrite, (d) Total C, (e) Total N, (f) Ash or inorganic residue.

There are several methods described in the literature for the estimation of the total C in the soil and of these the modern ones are those of Schollenger, Degtjareff, Waksman, Page, and A. O. A. C. It will be necessary to compare the merits of these methods before it is possible to hit upon the method which would give a fairly accurate estimate of the organic C, without consuming undue amount of time, labour and trouble. It is presumed that either Schollenberger's or Degtjareff's method may be found convenient. These consist in oxidising the organic matter with a standard solution of CrO_3 in Conc. H_2SO_4 , with or without H_2O_2 , and after dilution, titrating the unused CrO_3 , with ferrous ammonium sulphate, using diphenyl amine as indicator. These methods have been shown in this laboratory to give satisfactory end point and to require only a short time for completion.

After determining the total C, it will be necessary to estimate the components of the organic matter,—soluble carbo-hydrates, fats, gums and resins, etc., cellulose, hemicellulose, humic matter and crude protein. For the estimation of these the methods described by Waksman (*Soil Science*, 1930, 113 ; 1931, 483), or by Page (*J. Agri. Sc.*, xx, 473), will be followed after it has been found out by actual comparison which method is the most convenient. Attempts will also be made to evolve new methods.

The C/N ratio for each soil will be noted. It may be helpful to know the actual figures for soil temperatures, rainfall and a rough estimate of the amount

of sun light, at various times of the year, of the places from which the soils are collected. After some data have been collected under these heads it may become possible to decide (a) whether there is any correlation between the C/N ratio and the soil fertility, (b) the source of the organic matter and the transformations undergone by the various constituents of the added organic matter, (c) the influence of temperature, insolation, bacterial action and superficial tillage in bringing about depletion of the organic matter.

Apparatus of work on the Organic Constituents of the soil.

Cat. No.	Description.	Quantity.	Appr. price.
			Rs. s. p.
B. C. P. W.	A1 Beakers 500 cc	1 Doz.	7 8 0
	" " 300 cc	1 "	6 0 0
	A4 F. B. Flasks 500 cc	6 only	2 1 0
	" " 750 cc	3 "	1 6 0
	" " 1000 cc	3 "	1 14 0
	A6 Conical Flasks 500 cc	1 Doz.	2 1 0
	A8 Distilling Flasks 500 cc	1 "	5 8 0
	B2 Porc. basin 3000 cc	2 only	33 8 0
	B10 Crucible with lids 10 cc	6 "	2 12 0
	B14 Gooch crucibles 10 cc	3 "	4 0 0
	C13 Bunsen burners	1 Doz.	20 0 0
	C36 Sand baths 15 cm	1 "	3 8 0
	C48 Water bath with 6 openings	1 only	24 0 0
	E57 Measuring cylinders 500 cc	2 "	3 8 0
	" " 1000 cc	1 "	3 0 0
	E63 Measuring flasks 1000 cc	3 only	3 8 0
	" " 500 cc	2 only	7 6 0
	" " 2000 cc	1 only	6 6 0
	Clamps, stands and bossheads .. .. .	..	50 0 0
(Local Purchase)	Soil sample jars	6 doz.	27 0 0
	14 I. R. Stoppers 40 mm	1 "	11 0 0
	K85 Vacuum desiccators 20 cm	1 only	17 0 0
	Desiccator 20 cm	2 only	15 0 0
	K146 Gas wash bottles 100 cc	6 only	12 0 0
	K199 Soxlet app. complete	6 only	56 0 0
	Sulphuric acid E. Merck 1.84	50 lbs.	58 0 0
	Caustic soda flakes	50 "	33 0 0
Pyrex	Kjeldahl flasks 500 cc	18 only	30 0 0
	F. B. Flasks 1000 cc	6 only	11 9 "
	Conical Flasks 500 cc	1 Doz.	16 0 0
	Beakers 500 cc	1 Doz.	14 0 0
Baird and Tatlock	A5167 Ball copper condenser 4 x 1'	1 only	11 0 0
	Aspirator bottles 10 litres	1 only	12 6 0
B. C. P. W.	K13 Aspirator bottles 3 litres	2 only	12 0 0
	Total .. .. .	..	525 9 0
	Air oven	1 only	60 0 0
	Surcharge on account of enhanced price and duty (approximate) .. .. .	..	400 0 0
	Total .. .. .	..	985 9 0

ENCLOSURE III.

D. O. No. 607/Agri.

New Delhi, the 13th March 1931.

Dear Prof. Ghosh,

The Imperial Council of Agricultural Research in sanctioning a grant to the Dacca University for work on soils, emphasised the importance of an investigation of the organic constituents of the soils. I do not know whether you have seen the American work on thi

subject but you will find papers of interest in the Journal "Soil Science", 1926, by S. A. Waksman. There are several other papers by the same author and doubtless this reference will enable you to follow the matter up.

Yours sincerely,
(Sd.) B. C. BURT.

Prof. J. C. Ghosh, D.Sc.,
Chemistry Department,
Dacca University, Dacca (Bengal).

Prof. J. C. Ghosh, D.Sc.

DACCA UNIVERSITY,
CHEMICAL LABORATORY,
The 6th May 1931.

Dear Dr. Burt,

I am glad to receive your D. O. No. 607 Agric., dated the 13th March, 1931. The two research Assistants who have been appointed with the aid of the grant sanctioned by the Imperial Council of Agricultural Research have been busily engaged in investigating the problems of (1) Nutrition of rice plants and (2) mechanical analysis of laterite soils. The work they are already doing is so heavy that it is not possible to start an investigation of the Organic Constituents of the soil in tropical countries with their aid. We have been however thinking over the matter for a long time and a scheme for investigating this problem is herewith submitted to you for consideration and opinion. It will be possible to start this investigation if the Imperial Council be pleased to sanction the appointment of an additional research Assistant on Rs. 150 per month for a period of 5 years. I shall be glad to place this scheme officially before the Imperial Council through the Provincial Council of Agricultural Research if it has your approval.

Yours sincerely,
(Sd.) J. C. GHOSH,
Prof. of Chemistry.

B. C. Burt, Esq., D.Sc.,
Imperial Council of Agricultural Research, Simla.

A SCHEME FOR THE INVESTIGATION OF THE ORGANIC CONSTITUENTS OF SOILS IN TROPICAL COUNTRIES.

- | | | |
|---|---|---|
| 1. Estimation of C and N in untreated soil dried at 100° C. | | Estimate C: N ratio. |
| 2. Ether soluble portion. | Oils, fats, waxes, resins, etc. | Estimate total C. |
| 3. Portion soluble in cold and hot water. | Sugars, sol. proteins, organic acids, inorganic nitrates and nitrites, etc. | (a) Estimation of total C and N.
(b) Estimation of nitrate and nitrite.
(c) Estimation of ammonia and amido N. |
| 4. Alcohol extract (boiling). | Waxes, resins, bitters, pigments, tannins terpenes, etc. | Estimate total C. |
| 5. 2% HCL extract (boiling). | Hemi celluloses, pentosans, Hexosans, etc. | (a) Estimate total C.
(b) Estimate furfurals by distilling pentosans Portion with 12% HCL and ppting with phloroglucinol.
(c) Protein nitrogen. |

6. 2-5% alkali under pressure, (a) *Lignin, Aumin, ulmia* (a) Weight, total C, methoxy
or by Grandeau method ppt. aliquot portion with conc (portion).
(first dil. HCl and then dil. HCl. (b) Weight total C, methoxyl
ammonia). (b) ppt. another portion at ash (AL₂O₃)—portion.
pH 4-6 to 5-0. (c) Also C. N. ratio.
(c) Grandeau method—Am- (d) G' Extract, weight C, N,
OH extract evaporate to methoxyl, C, N, ratio.
dryness.
7. 72% H₂SO₄ or 42% HCl. Loss of weight represents Estimate sugar if possible or
cellulose. total carbon.
8. Extra with hot conc. HCl. Humin N Estimate C & N and C, N, ratio.
9. Ash. Ignition at a low red heat
and finding loss of weight.
10. Estimation of free and combined CO₂ At various times of the year
under field conditions.
Also of Methane.
11. Record of soil temp., amount At various times of the year under field con-
of sun light and rainfall. ditions.
12. Estimation of various constituents 1-9 After harvest and after various periods under
over-leaf, in rice straw immediately. field conditions and also in the laboratory
both under anaerobic and aerobic condi-
tions.
13. Parallelism, if any, between humus and N.
compounds at various times of the year.
14. Comparison of cellulose and lignin from
rice straw with those from other sources.
15. Physical properties (porosity, density,
power of absorbing CO₂, H₂O, NH₃ etc.),
of lignin and humin from rice straw.

Is the low organic content of laterites due to (a) rapid photochemical decomposition, (b) increased fungoid and bacterial activity (c) clayer and impervious nature of the soil, with no power of conserving it, (d) absence of green manuring and therefore gradual depletion, (e) continuous superficial cultivations ?

A Recurring Grant for a period of five years of Rs. 1,800 per year will be necessary for the appointment of a Research Assistant who will carry on this investigation in the Chemical Laboratory of the Dacca University.

DACCA UNIVERSITY,
CHEMICAL LABORATORY,

The 19th January, 1932.

My dear Mr. Burt,

I enclose herewith a copy of a letter which I wrote to you on the 6th of May 1931. I wonder if the letter reached you at all. I am going to Delhi on the 25th of January to attend the meeting of the Advisory Board of the Imperial Council of Agricultural Research. I shall be glad to discuss this matter with you at Delhi.

With kind regards,

I am,
Yours sincerely,
(Sd.) J. C. GHOSH,
Prof. of Chemistry.

B. C. Burt, Esq., D.Sc.,

Imperial Council of Agricultural Research, Delhi.

No. 382/AGRI.
IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH,
New Delhi, the 10th February 1932.

Dear Prof. Ghosh,

Please excuse delay in replying to your letter of January the 19th as you know I have been laid up with influenza and this prevented our discussing the matter whilst you were at Delhi.

I have looked into the matter and find that, through a misunderstanding during my absence on leave, it was not realised that your letter of the 6th of May 1931 contained proposals for meeting the suggestion of the Research Council that the nature of the organic constituents of the soil should be studied. I agree with your scheme of work personally and would suggest that you now put it forward officially through the Provincial Research Committee and the Government of Bengal, as your response to the suggestions made by the Advisory Board and conveyed in our letter No. 507 of March the 5th, 1930, to the Government of Bengal. If you take immediate steps in this direction, the proposal could come before the next meeting of the Advisory Board.

If I may make a further suggestion, I would have the technical details of your programme re-examined, before final submission, in the light of the most recent work which I think is all summarised in the technical communications and abstracts of the Imperial Bureau of Soil Science which you receive. This I suggest as a precaution against the mentioning in the scheme of any method which has become out of date and which in actual fact would be replaced by the modern one when work actually commences.

I am sorry that owing to my illness, I could not get this matter cleared up during the Advisory Board meeting.

Yours sincerely,
(Sd.) B. C. BURT,

Prof. J. C. Ghosh, D.Sc.,
Chemical Department,
Dacca University, Dacca.

APPENDIX XXI.

SUBJECT No. 22.

APPLICATION FROM Dr. B. K. SINGH, PROFESSOR OF CHEMISTRY, RAVENSHAW COLLEGE, CUTTACK, FOR A GRANT OF Rs. 8,260 SPREAD OVER THREE YEARS FOR RESEARCH WORK ON THE NATURE OF ORGANIC COMPOUNDS PRESENT IN THE RICE SOILS OF INDIA AND THE FACTORS INFLUENCING THEIR DECOMPOSITION WITH SPECIAL REFERENCE TO BIHAR AND ORISSA SOILS.

Attention is invited to the attached letter from the Government of Bihar and Orissa, No. 229-D. R., dated the 27th June 1932 (Enclosure), forwarding an application from Dr. B. K. Singh for a grant for research work on the nature of organic compounds present in the rice soils of India and the factors influencing their decomposition with special reference to Bihar and Orissa soils. The scheme which is explained in Dr. Singh's note, dated the 27th April 1932 (Annexure), involves a non-recurring expenditure of Rs. 1,000 and a recurring expenditure of Rs. 7,260 or a total expenditure of Rs. 8,260 spread over a period of three years.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 2nd July 1932.

ENCLOSURE.

LETTER FROM B. K. GOKHALE, Esq., I.C.S., SECRETARY TO GOVERNMENT OF BIHAR AND ORISSA, EDUCATION AND DEVELOPMENT DEPARTMENT, TO THE SECRETARY TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 229-D. R., DATED RANCHI, THE 27TH JUNE 1932.

I am directed by the Government of Bihar and Orissa in the Ministry of Education to submit for the consideration of your Council, a copy of an application (Annexure) from Dr. B. K. Singh, Professor of Chemistry at the Ravenshaw College, Cuttack, for a grant for research work on the nature of organic compounds present in the rice soils of India and the factors influencing their decomposition with special reference to Bihar and Orissa soils and to say that the scheme has the support of the majority of the members of the Bihar and Orissa Agricultural Research Committee. The local Government consider that the scheme might be sanctioned for a period of 3 years with a possibility of extension for another two years if the results justify such extension.

2. I am to request that your Council may be pleased to approve the scheme and take necessary steps to allot funds. The local Government would particularly request for the scheme to be considered by the Advisory Board in July, if possible, the delay in submission beyond the 18th June being overlooked.

ANNEXURE.

Application for a grant for research work on the nature of organic compounds present in the rice soils of India and the factors influencing their decomposition with special reference to Bihar and Orissa soils.

A. A knowledge of the formation, nature and decomposition of the soil organic matter is the most important and most outstanding need of the soil science to-day. It is well known that organic matter (or Humus) exerts an important influence on the physical properties of the soils such as, tilth moisture temperature and the nature of the soil solution. Physico-chemically on account of its colloidal nature and buffering properties it acts as nature's automatic control on the re-action of the soil. No less important from the point of view of soil economy are biological properties of organic matter in offering

a medium for the growth of various micro-organisms which exert a profound influence on soil fertility.

B. Indian soils are generally deficient in this important constituent and this is one of the most potent causes of their low fertility as compared to soils in other countries.

In the field there is always a sort of equilibrium established between the rate of addition of organic matter and the rate of its disappearance. In tropical countries the decomposition and disappearance of organic matter is very much quicker than in colder regions and a lower balance of organic matter for the improvement of soils is available. But it is not known what happens to the green manure and other plant residues when they are left in the soil for any length of time. It is, however, clear that the correct solution of this problem must form the very basis of our agricultural practice and soil treatment.

A knowledge of the nature of soil organic constituents and the factors governing their decomposition in the soil is of prime importance for offering practical suggestions as to the conservation of these materials in Indian soils.

C. Several theories have been suggested to explain the origin of soil 'humus' by chemical processes, either as a result of oxidation of benzene ring compounds, or interaction of carbohydrates with aminoacids or polymerization of furfural. There is a complete lack of uniformity concerning the very usage of the term 'humus'. Some investigators (largely European) use the term 'humus' to designate the total organic matter in the soil. The term 'humus' and 'Humic substances' are often used to designate the dark coloured materials formed from plant and animal tissues, after these have become decomposed (the exact nature of the process of decomposition remaining practically unknown) and incorporated into the soil. Some investigators (largely American workers) apply the term 'humus' to that part of the soil organic matter which is soluble in alkalis. Still others limit the use of this term to that part of the alkaline extract which is precipitated by acids.

By treating the soil with various reagents usually acids and alkalis, alcohols, ether, pyridine and other solvents chemists have succeeded in isolating various complex bodies from the soil organic matter.

The various constituents of the plant and animal tissues introduced into the soil, including fat and waxes simple and complex carbohydrates, lignins, glucosides, pigments, tannins, phenol derivatives, and resins are decomposed partly or completely, yielding a complex mass of dark coloured substances in which the identity of most of the original material is lost.

Practically nothing is known regarding the nature of these complex compounds in Indian soils. The need for such knowledge is imperative because the soil organic matter contains the essential element nitrogen, and some of the minerals (phosphorus and potassium) that contribute so largely to the fertility of the soil.

The results of the special investigation of the organic constituents of the Indian soils will enable us to compare these soils with those of other countries as regards their 'humus' content. The further study of the factors influencing the chemical course and the rate of decomposition of organic constituents in the soil, will be the logical corollary of this investigation. The combined results of these two investigations should enable us to formulate the best methods of supplying the general deficiency in organic matter in Indian soils.

D. *The general outline of the proposed investigation.*—For the first two years exhaustive analysis of the organic constituents of some of the typical Orissa soils will be undertaken to ascertain the nature and occurrence of such compounds.

Programme of research in the last three years of the scheme will largely depend upon the results obtained in the early stages of the work. Briefly: A small area at the agricultural farm at Cuttack will be earmarked and divided into plots which will receive different cultural treatments and organic matter will be added to them. Soil samples will be taken at suitable intervals of time and analysed for ascertaining the extent of decomposition and the nature of materials produced thereby.

The results of this investigation will be of great practical importance on account of their direct application to field practices. Knowledge gained from the research work proposed above would not only lead to a better understanding of the effect of organic manures on the fertility of the soil, but it will help us in formulating practical suggestions as to how to get the best out of them.

E. Financial aspects.—Adequate laboratory facilities are available at the Ravenshaw College, Cuttack, but I have no assistant to carry out the routine work involving in the present investigation. I request that the Imperial Council of Agricultural Research may be pleased to sanction a grant of Rs. 8,260 spread over a period of three years as follows :—

	Rs.
1. One Research Assistant at Rs. 150—10—200 for three years ..	5,760
2. One field man at Rs. 25 p. m. for three years	900
3. A recurring grant of Rs. 200 p. a. for contingency and chemicals for 3 years	600
4. A non-recurring grant of Rs. 1,000 for special apparatus to be utilized at any time during the three years	1,000
Total ..	8,260

Considering the importance of this research and the general applicability to agricultural development of the country it is hoped that the Imperial Council of Agricultural Research will consider the scheme favourably. The request for the grant is a most modest one and in addition to the actual research work it aims at training up a qualified young man in this special branch of chemical investigation. It is therefore hoped that the scheme will be sanctioned.

BAWA KARTAR SINGH.

The 27th April 1932.

APPENDIX XXII

SUBJECT No. 15.

APPLICATION FROM THE DACCA UNIVERSITY FOR A GRANT OF RS. 2,000 ON ACCOUNT OF APPARATUS, ETC., FOR THE YEAR 1932-33 IN CONNECTION WITH THE SCHEME FOR AGRICULTURAL RESEARCH ALREADY SANCTIONED BY THE COUNCIL.

Attention is invited to the attached letter from the Government of Bengal No. 246-T.A.I., dated the 8th June 1932, on the subject of a grant for apparatus, etc., to the University of Dacca for the year 1932-33. In 1929 the Advisory Board recommended *inter alia* that the Governing Body sanction a grant for the purchase of apparatus subject to a list of the apparatus required being furnished and approved by the Advisory Board, the intention being that each year's requirements under the head 'Apparatus' should be examined on their merits on receipt of detailed estimates from the University before any amount is sanctioned. The University at first estimated that a sum of Rs. 2,000 per annum would be required for apparatus. The recommendations of the Board were accepted by the Governing Body.

2. The Advisory Board in response to this Department memorandum No. 2194/Agri., dated the 10th October 1930 (not printed) recommended a grant of Rs. 6,518 for apparatus, etc., in 1930-31 which was made. At its meeting held in June 1931 the Board recommended a grant of Rs. 2,021 for the purchase of glass apparatus and chemicals (Rs. 983) and of a potentiometric outfit (Rs. 1,038) for the year 1931-32. As the University agreed to meet the cost on account of chemicals from its departmental budget the amount actually required was only Rs. 1,806 which was sanctioned by the Governing Body.

∴ The application of the University for a grant for 1932-33 is now for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**The 23rd June 1932.*

LETTER FROM L. R. FAWCUS, Esq., I.C.S., SECRETARY TO THE GOVERNMENT OF BENGAL, AGRICULTURE AND INDUSTRIES DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 246-T.A.I., DATED DARJEELING, THE 8TH JUNE 1932.

With reference to your letter No. 873/Gl., dated the 19th May 1932 (not printed), I am directed by the Government of Bengal (Ministry of Agriculture) to forward herewith, for inclusion in the agenda of the meeting of the Advisory Board to be held in July next the two schemes noted below :—

(1) the continuance of grant to Dacca University for the session 1932-33 for researches into

(a) method of mechanical analysis of laterite soils, and

(b) the nutrition of rice plants.

* * * * *

which have been approved by the Provincial Agricultural Research Committee, Bengal, and to say that local Government recommend the same subject to the condition that no financial liability devolves on them.

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ENCLOSURE I.

LETTER FROM PROFESSOR J. C. GHOSH, D. SC., DACCA UNIVERSITY, CHEMICAL LABORATORY, TO THE DIRECTOR OF AGRICULTURE, BENGAL, DATED THE 8TH MARCH 1932.

I enclose herewith a note (Enclosure II) regarding Capital and Recurring grants to the Dacca University for the session 1932-33, from the Imperial Council of Agricultural Research for continuing searches into (a) method of mechanical analysis of lateritic soils and (b) the nutrition of rice plants.

I shall be glad if this request for grant be submitted to the Imperial Council of Agricultural Research through the Provincial Agricultural Research Council at an early date.

ENCLOSURE II.

Note regarding Grant to Dacca University for researches into:—

- (a) method of mechanical analysis of lateritic soils, and
- (b) the nutrition of the rice plant.

REQUIREMENTS FOR THE SESSION 1932-33.

Capital Grant for the purchase of a Sharples Laboratory Super Centrifuge complete with electric motor by Arthur H. Thomas and Co. Cat. No. 3185, Price Rs. 1,450.

The work on the mechanical analysis of lateritic soils in this laboratory has shown that a considerable portion of the soil comes into the finest fraction (as much as 40—45 per cent. in a number of cases) and is estimated as clay. At the same time these soils could be cultivated in such a high state of moisture as would ruin their texture for a considerable period if they contained anything like such large percentages of clay. Consequently it is of importance to distinguish between colloidal clay, i.e., hydrated silicate of alumina and the finest fractions obtained in the case of lateritic soils. An extensive study has therefore been undertaken on the colloidal behaviour of lateritic clays and the above centrifuge is urgently required in this connection. Further, apparatus has been set up in the Dacca University Laboratory for the X-Ray analysis of various clay fractions of lateritic soils.

Recurring Grant:—

Item. Catalogue No.	Description.	Price.
		Rs. s. p.
1. Arthur H. Thomas & Co. 6958-A.	One Zeiss incandescent Micro lamp with flask condenser	55 0 0
2. B. T./L. C. 4062 size 3.	Two platinum crucibles 15 cc. capacity each	300 0 0
3.	One Thermostat 2' x 1½' x 8" on iron stand with thermo-regulator to be made to order	25 0 0
4.	Glass apparatus such as tall form beakers, petri dishes, kjeldahl flasks, conical flasks, bact. test tubes, bottles for water culture expts. and for storing soil samples, etc., etc.	170 0 0
		550 0 0
	Capital Grant	1,450 0 0
	Total	2,000 0 0

Item No. 1 is required in connection with the measurement of cataphoretic velocity of lateritic clays, the main apparatus for which is being bought at our request by the Chemistry Department from its own fund at a cost of about R. 200.

Item No. 2 is required in connection with the analysis of lateritic soils, especially for determining the silica sesquioxide ratio of their clays.

Item No. 4.—These apparatus are either not available in the Chemistry Department or are required in large quantities. Ordinary glass apparatus and all chemicals that may be required during the session will be supplied by the Chemistry Department from its own fund.

(Sd.) J. C. GHOSH

The 7th March 1932.

APPENDIX XXIII.

SUBJECT No. 16.

APPLICATION FROM THE MADRAS UNIVERSITY FOR A GRANT OF RS. 25,830 SPREAD OVER THREE YEARS FOR A SCHEME OF RESEARCH IN THE CYTOLOGICAL STUDY OF INDIAN CROP PLANTS.

Attention is invited to the attached letter from the Government of Madras, No. 3500-III/31-7, dated the 20th June 1932 (Encl. I) forwarding a revised scheme of research in the cytological study of Indian crop plants prepared by the University of Madras. In this connection it may be stated that the original scheme (Encl. II) was considered (Encl. III) by the Advisory Board at its meeting held in June 1931: it was however decided that the substance of the observations made at the Board should be communicated to the University with a view to the latter submitting if it so desired a definite scheme in the light of the views expressed.

2. The University has now submitted a revised scheme (Enclosure I) which involves non-recurring expenditure of Rs. 6,000 and a recurring expenditure of Rs. 19,830 or a total expenditure of Rs. 25,830 spread over a period of three years.

The revised scheme (Enclosure I) is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

Dated the 1st July 1932.

ENCLOSURE I.

LETTER FROM S. H. SLATER, ESQ., C.M.G., C.I.E., I.C.S., M.L.C., SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA, NO. 3500-III/31-7, DATED STONEHOUSE HILL, THE NILGIRIS, THE 20TH JUNE 1932.

Crop Cytology Scheme—Correspondence ending with Diwan Bahadur Sir T. Vijayaraghavacharya's letter No. 2054-Agri., dated 26th August 1931 (not printed).

I am directed to forward a revised scheme of research in the cytological study of Indian crop plants prepared by the University of Madras. As the original scheme (Encl. II) was considered and recommended by the Provincial Agricultural Advisory Committee, this has not again been placed before the Provincial Research Committee.

Crop Cytology Scheme of the University of Madras.

The Syndicate has again considered the scheme of research, submitted by it in 1930, in the light of the remarks made by the members of the Advisory Board (Encl. III) and now submits the same scheme of work but on a reduced scale of expenditure.

The Syndicate does not accept the view that in a vast country like India, research of the kind contemplated in the scheme, involving, it is true, the study of fundamental problems, but based almost exclusively on provincial materials, could or should be confined to a Central Institute. The study of problems that have an immediate or indirect bearing on provincial crops can, it is thought, be most conveniently undertaken at provincial centres, if the necessary facilities exist there. The Syndicate is convinced that Indian Universities should play a very important part in the Agricultural development of

the country and whole-heartedly endorses the following remarks of the Royal Commission on agriculture :—

The importance of carrying out Agricultural Research in the closest touch with other branches of scientific research can hardly be exaggerated. The advantages of mutual intercourse between Research workers in different fields have been demonstrated in many countries, and Indian Universities and Agricultural Colleges can no longer afford to work in isolation. We look forward to a state of affairs in which the Universities will not only initiate Agricultural Research but will also undertake schemes of research, the importance of which is brought to their notice by the Agricultural departments (paragraph 62, page 60 of the report).

The Madras University can give practical effect to the views enunciated above, if it can only secure the co-operation and help of the I. C. A. R.

There is a botanical research laboratory in the University under an Honorary Director. The present Honorary Director is a Graduate of Cambridge University and is now acting as additional Professor of Botany in the Presidency College, Madras. There are University Research students working under him in the laboratory. All the research work done in the laboratory is done under the auspices of the University and is financed by it.

It is now proposed to take up an extensive Cytological study of Indian Crop plants with special reference to genetic problems. Very little has been done in this line of research in India, though its importance has often been pointed out.

The scheme of research proposed by the University has in view :—

- (1) The comparative chromosome studies of different varieties of crop plants and related wild species with a view (a) to determining whether chromosome variations, numerical or otherwise can be correlated with varietal variations, (b) to gathering the necessary Cytological data for providing a basis for genetic analysis of crop plants such as is in progress in the United States of America, and (c) to studying linkage groups.
2. A study of the different phases of meiosis particularly of synapsis in view of its importance in understanding linkage and recombination of characters.

The above are the more important lines of present day work in Cytological research in crop plants.

It is impossible to prescribe at this stage the number or the nature of the plants which will be investigated, except that they will be mainly or entirely plants of economic value, such as paddy, other cereals, tobacco. The particular plant selected will depend to a large extent upon the previous work of the Research worker who will be appointed. No attempt should be made now to restrict the choice of the particular plant or plants for research.

With regard to the research itself, it is not difficult to give an assurance that appreciable results will be obtained in the course of three years. But that the results will be *immediately* applicable to practical agricultural problems cannot be guaranteed.

The work will be carried on at the Agricultural College and Research Institute, Coimbatore, under the general supervision of the Honorary Director of the University Research Laboratory as a transitional measure pending the construction of the permanent Botanical laboratory of the University of Madras which is expected to be completed within two years. There will be the closest co-operation between the University Cytologist and the crop specialists at Coimbatore.

The estimated cost of the scheme is detailed below. As the equipment of the University Laboratory will not be available at Coimbatore, special provision will have to be made for apparatus, chemicals, etc. Provision will also be required on account of travelling

Allowance for visits of Inspection and supervision by the Director of the University Botanical Laboratory.

Recurring.	Per mensem.	Per annum.
One Research Worker	250	3,000
One Research Assistant	100	1,200
Two Gardeners	40	480
One peon	15	180
	405	4,860
Contingencies		1,000
Travelling allowance for visits by the Director of the University Research Laboratory		750
Total per annum		6,610
For three years		19,830
Non-recurring—Equipment		6,000
Total—Recurring and non-recurring for 3 years		25,830

ENCLOSURE II

LETTER FROM THE VICE-CHANCELLOR, UNIVERSITY OF MADRAS, TO THE SECRETARY IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI (THROUGH THE SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT), No. 25114 DATED MADRAS, THE 1ST DECEMBER 1930.

On behalf of the Syndicate of the Madras University, I have the honour to apply to the Imperial Council of Agricultural Research for a grant of Rs. 50,000 for a scheme of botanical research, of which details are given below.

There is a Research Laboratory in Botany in the University under the direction of a Honorary Director. The present Honorary Director is a graduate of Cambridge and is now acting as Additional Professor of Botany in the Presidency College, Madras. There are University research students working under him in the Laboratory. All the research work done in the Laboratory is done under the auspices of the University and is financed by it.

It is now proposed to take up an extensive cytological study of Indian crop-plants with special reference to genetic problems. Very little has been done in this line of research in India, though its importance has often been pointed out. For the purpose of this research, use would be made of isolated strains obtained from Coimbatore and others obtained from the fields in Madras. Good land is available in the vicinity of the University Research Laboratory for breeding experiments. It is proposed to appoint for this investigation Mr. N. Subba Rao, M.A., of the Madras University, who has already published certain papers on cytological subjects* and who is particularly competent

*Papers already published by Mr. N. S. Rao, all in the Journal of the Indian Botanic Society—

- (i) On the chromosome numbers of some cultivated plants of South India, and Note on the use of vacuum flask in Paraffin imbedding.
- (ii) Further contributions to the Cytology of some crop-plants of South India.
- (iii) On reduction division in the pollen-mother-cells of *Cyanotis Cristata*.

carry on this kind of work. The work will be done in the University Research Laboratory and will be carried out under the general supervision of the Honorary Director. Advice and guidance, whenever necessary, can also be obtained from the Professor of Botany in the Presidency College, Madras. The Syndicate will be prepared to furnish the Council with half-yearly reports on the research work. As at present planned, the investigations will be spread over a period of five years.

The expenses of the research above proposed have been estimated at Rs. 50,000. The details are as follow :—

	Amount required for five years.
	Rs.
1. Research worker on Rs. 300 to Rs. 350 per mensem ..	20,000
2. Assistants trained in breeding experiments	8,000
3. Two gardeners	2,400
4. Apparatus and contingencies	19,600
Total	50,000

Though the University is willing to undertake the work, it cannot spare the necessary funds for it. I, therefore, request that the Council may be pleased to make a grant of Rs. 50,000 to it. The amount may be spread over five years, beginning with an initial allotment of Rs. 20,000 in the first year.

If the Council requires any further information before this application can be disposed of, I shall be glad to furnish it.

ENCLOSURE III.

EXTRACT FROM THE PROCEEDINGS OF THE ADVISORY BOARD, JUNE 1931.

Application from the Madras University for a grant of Rs. 50,000 for a scheme of botanical research.—Rao Bahadur Ananda Rao explained the scheme. Mr. Milne said the scheme covered a very wide field and enquired whether it was intended that, Madras should be selected as the place in India where cytological work could best be done. In his opinion the Institute of Agricultural Research at Pusa was a more suitable place for dealing with the bulk of such long range research, because there a research worker on cytology would have beside him plant-breeders with lands and facilities for growing this plant and workers on other phases of the agricultural research who could help him with advice and facilities for work in many situations that might arise. Professor Ganguli objected to the application in which there was no reference to any definite scheme of research. He also pointed out that the local Government had placed this application third in the order of priority among the four schemes sent from Madras. Dr. Mehta said that the field of cytological investigation was so vast that one isolated worker would not be able to cope with the work. He was in favour of a Central Institute to do this work or in the alternative Pusa or an Agricultural College in the provinces. Mr. Sethi agreed with Dr. Mehta. Dr. Agharkar, on the other hand, was against the centralization of research. He favoured a centre being established in each province where work on the cytology of crops of importance to that province could be carried on. He would have the Provincial University as the centre. While therefore he was not against the scheme he would restrict its scope. Professor Dastur also agreed with this view. Professor Ganguli desired that existing facili-

ties like the Agricultural Colleges at Coimbatore, Cawnpore, Lyallpur and Institutes like the one at Pusa should be utilised to the full before the Council began starting new ones. It was absolutely necessary that a Cytologist should work in close co-operation with a practical plant breeder. That he could only do if the former's work was located in proximity to a farm. He also referred to cytological investigations that are being conducted in various institutes in India. Dr. Keen was of opinion that the Council should only sanction such schemes as were the natural outgrowth of work already being done at the Institution applying for the grant. If Madras could show that, the grant would be justified. Mr. Milne suggested that the University should put up a more limited scheme of research, show its bearing on practical Agriculture and the likelihood of getting results say within 3 years. The Board might then consider the advisability of recommending a research scholarship of about Rs. 150—10—170 for three years subject to the University providing the other facilities required.

In the result the Board decided that the substance of the above observations should be communicated to the University with a view to the latter submitting if it so desired a definite scheme in the light of the views expressed.

APPENDIX XXIV:

SUBJECT No. 17.

RECOMMENDATIONS OF THE COMMITTEE APPOINTED TO EXAMINE THE REPORT ON HEMP MARKETING IN INDIA PREPARED BY MR. T. S. SABNIS.

At its meeting held in January 1932, the Advisory Board recommended *inter-alia* that a Committee of about nine members representative of all the interests concerned should be appointed by the Chairman of the Advisory Board with a view to recommending such action thereon as the Committee might consider necessary. The Chairman of the Board accordingly appointed the undermentioned Committee for the purpose.

1. Sir T. Vijayaraghavacharya, K.B.E., *Chairman*.
2. Agricultural Expert, Imperial Council of Agricultural Research.
3. Dr. L. K. Hyder.
4. Director of Agriculture, Bombay.
5. Director of Agriculture, Central Provinces.
6. Director of Agriculture, United Provinces.
7. Director of Agriculture, Bengal.
8. Director of Agriculture, Madras.
9. Director of Agriculture, Bihar and Orissa.

Secretary.—Rai Sahib Malik Charan Das.

The Committee met at Rock House, Simla, on Friday the 15th July 1932 and a copy of its report is attached (Enclosure I).

2. An addition to page 56 of the Report on Hemp Marketing in India, copies of which have already been circulated is also enclosed (Enclosure II).

3. The subject is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 18th July 1932.

ENCLOSURE I.

PROCEEDINGS OF THE COMMITTEE APPOINTED BY THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH TO EXAMINE THE REPORT ON HEMP MARKETING IN INDIA.

The Committee sat at Rock House from 11 A.M. to 1 P.M. on Friday, the 15th July 1932.

2. The following were present :—

1. Diwan Bahadur Sir T. Vijayaraghavacharya, *Chairman*.
2. Dr. W. McRae.
3. Mr. R. G. Allan.
4. Dr. L. K. Hyder.
5. Mr. T. F. Main.
6. Mr. D. R. Sethi.

Rai Sahib Malik Charan Das, *Secretary*.

3. The Chairman at the outset drew attention to the letter from the Indian Trade Commissioner, London, dated the 25th May 1932 (Enclosure III) which stated that the Hemp Marketing Report was being considered by the Imperial Institute's Advisory Committee on Vegetable Fibres and that the considered opinion of the Committee would be

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communicated to the Council in due course. The question was raised whether the report of the Imperial Institute's Committee should be awaited before considering the Hemp Marketing Report or whether the Committee should proceed with the consideration of the latter Report. Dr. Hyder thought that the Institute's Committee would naturally consider the Report from the point of view of the finished article but as the Report dealt with many other points, such as, improvement of methods of cultivation, harvesting, retting, etc., he suggested that the Committee might proceed with the consideration of the recommendations. The Committee agreed.

4. The Committee thought that the recommendations in the Hemp Marketing Report, a summary of which is given in Chapter IX (Enclosure V), fell under two broad groups, namely, (1) cultivation, treatment, etc., of the crop (recommendations Nos. 1—9 and 10—12) and (2) marketing of the crop for export, etc. (recommendations Nos. 13—27). The Committee decided to deal with the recommendations *seriatim* in each group.

5. *Recommendation 1.*—No action is necessary as what is stated therein is a well known fact.

Recommendations 2 and 3.—It was considered that these were part of the routine work of the Provincial agricultural departments and that their attention might be drawn to these points.

Recommendations 4, 5, 6, 7, 8, 9 and 12.—It was considered that before any action could be taken on the above recommendations, investigations would be necessary in the Provinces concerned.

Recommendation 10.—The Director of Agriculture, United Provinces, undertook to inspect and report on the work so far done at the Harcourt Butler Technological Institute by Mr. Mullani and to give his opinion about its continuance and development.

Recommendation 11.—Mr. Allan stated that a good deal of work in connection with breaking and scutching by hand machines had been going on for some considerable time under Mr. Churchill, Deputy Director of Agriculture, Northern Circle, Central Provinces. The Committee therefore considered that the Director of Agriculture, Central Provinces, should be asked for a report on the subject pending the possibility of arranging for a more intensive investigation of these problems at the Centre.

In connexion with the investigations of the matters covered by recommendations 4 to 9 and 12 the question of having the work carried out at some central station was raised by Mr. Main and discussed and the possibilities of the Harcourt Butler Technological Institute at Cawnpore were considered. The advantage claimed for a central station was that accurately controlled experiments could be conducted under the supervision of a skilled technologist who could also be employed to carry out tests on strength and quality of fibre. The results obtained at the Central Station would then be applied in the Provinces with suitable modifications for local conditions. Dr. Hyder considered that in present financial circumstances an ambitious scheme of research at a Central Station was out of the question and that the investigations should be limited to the removal of the specific defects pointed out by Mr. Sabnis in the matter of growing, harvesting and retting of the crop. He suggested that the Directors of Agriculture should conduct experiments in their areas [as had been done in the Central Provinces, see (Enclosure IV)] with the object of obtaining results quickly which would help the growers to produce fibre, cleaner and more suitable for the ultimate use to which fibre would be put. At this stage, the Chairman suggested that the Provinces concerned might be offered a small grant of, say, Rs. 500 each for a maximum period of three years for carrying out the necessary investigations in regard to the recommendations in Group I. This was agreed to by the Committee. If any tests were necessary in the United Kingdom the cost of these should be met by the Council.

Recommendation 13.—It was decided that no action need be taken on this recommendation as the question was a general one and was being considered separately in connexion with the recommendations of the Royal Commission on Agriculture and of the Indian Central Banking Enquiry Committee on the subject of marketing of crops.

Recommendation 14.—No action is practicable on the part of the Council.

Recommendation 15.—This was considered unnecessary.

Recommendations 16—24.—The Committee consider that these recommendations, should be examined in consultation with businessmen bodies, Chambers of Commerce, etc., whose views should be invited as to whether they could without legislation organise their section of the trade relating to hemp with a view to carry out the improvements suggested.

Recommendation 25.—The Indian Trade Commissioner has already taken up this question and information received should be circulated to Directors of Agriculture and the Trade.

Recommendation 26.—The Committee were of the view that the crop was too small to permit of a central organisation being created to deal with it alone but if and when a Central Jute Committee is formed it might be considered whether that Committee should also deal with this subject.

Recommendation 27.—The Committee recommended that the attention of the Provincial Departments of Industries should be drawn to this recommendation with a promise that, if necessary, the Imperial Council of Agricultural Research would be prepared to consider applications for grants for research in this connexion.

The meeting then terminated.

CHARAN DAS,

Secretary.

Simla, the 15th July 1932.

ENCLOSURE II.

ADDITION TO PAGE 56 OF THE REPORT ON HEMP MARKETING IN INDIA BY MR. T. S. SARNIS.

Years.	Bengal.	Bombay..	Madras.	Total.
1930-31	Cwts. 225,325 Rs. 29,05,315	62,544 9,55,697	5,282 69,332	293,151 39,30,344
1931-32	Cwts. 158,111 Rs. 19,21,696	62,495 (+ Sind 75). 7,34,082 (+ Sind 1,200).	3,313 32,594	223,994 26,89,572

ENCLOSURE III.

COPY OF LETTER FROM H. S. MALIK, ESQ., TO DIWAN BAHADUR SIR T. VIJAYARAGHAVACHARYA, NO. 78548, DATED THE 25TH MAY 1932.

You will probably like to know what has been done at this end with Sarnis's Report on Hemp Marketing in India, twenty-one copies of which were sent to us with letter No. 727-Agri., dated 12th March 1932, from the Secretary, Imperial Council of Agricultural Research.

We sent copies to the Imperial Economic Committee, the Admiralty, the Imperial Institute, the Empire Marketing Board, the London Chamber of Commerce, the Indian Chamber of Commerce, and also to some of the leading firms in the city. With the number at our disposal it was not possible to supply each member of the Imperial Institute's Advisory Committee on Vegetable Fibres with a copy, although the Secretary of the Committee was anxious that this should be done in view of the great interest taken in Indian Sann Hemp by the Members of the Committee. However, I wrote to Hydari for twenty-four copies of the Report for this purpose and we are very glad to know that these have now been sent to the Imperial Institute.

At the last meeting of the Committee the summary of recommendations contained in Chapter IX of the Report was laid before it for consideration. The Chairman, Mr. Wigglesworth, went through the various recommendations, criticising some of them, but as the members had not been able to read the Report, there was very little discussion. It has been decided now that the Report together with the Chairman's criticisms made at the last meeting should be brought up for further discussion at the next meeting of the Committee. I shall let you know in due course what the considered opinion of the Committee on Mr. Sabnis's report is, as no doubt you would like to have this in considering the action to be taken on the Report.

ENCLOSURE IV.

A RESUME OF THE EXPERIMENTS CARRIED OUT IN THE CENTRAL PROVINCES WITH A VIEW TO IMPROVING THE QUALITY OF SANN HEMP FIBRE.

I.—Introduction.

In the past only medium qualities of sannhemp were exported from India and even with those there have been constant complaints regarding the amount of dirt in the samples. On going through the literature on this subject it was found that the following four factors affect profoundly the quality and cleanliness of the fibre :—

- (1) seed rate, (2) stage at which the crop is cut for retting, and (3) temperature and quality of the water and (4) the length of time of retting.

The usual practice with the cultivators is to start the retting of sannhemp in the slack season *i.e.*, some time from February onwards. At the beginning of the hot weather, the water supply is deficient and any stagnant pools are employed for purposes of retting, with the result that the fibre thus produced gets very dirty, possibly more so in areas where the retting water flows over black soil and thus accumulates a lot of clay material in contradistinction to one which flows over crystalline rocks and sandy soils. In this connection it has been suggested that the sannhemp stalks may be stored till the rains and retted when a plentiful supply of clear running water is available.

II.—Scheme of experiments.

In view of the above remarks a scheme of experiments was drawn by the Director of Agriculture, Central Provinces and the Agricultural Chemist, Central Provinces was asked to conduct the experiments on the Nagpur farm in conjunction with the Principal, Agricultural College, Nagpur, and the Deputy Director of Agriculture, Northern Circle, Jabhulpore was asked to conduct them on some of the farms in his own circle. The scheme of experiments was as follows :—

- (1) Duplicate plots 1/10th acre each were sown with sannhemp seed the seed rate being 40, 60, 90 and 120 lbs. per acre. There were two sets of duplicate plots, one having been sown early and the other a little later in the season. The plants were cut when the seeds were sufficiently ripe to be fit for subsequent sowing. Germination tests of the seed from each plot were carried out.
- (2) A representative sample of stalks from each of the 16 plots mentioned under (1) above was retted in the months of December, February, and April representing conditions of low, medium and high temperatures, and one more retting of the stored straw was carried out in the month of July, when clean running water was available in the *nullah*.

The straw was retted in small tanks and also in running water in the *nullah* whenever this was possible, for a period of 3, 4, 5, 8 and 10 days as suggested by the Advisory Committee on vegetable fibres of the Imperial Institute, London. Fibre from the retted straw was removed by hand in the usual way and all the samples were forwarded to the Imperial Institute for examination and valuation.

The range of minimum and maximum temperatures prevailing during the various retting periods was as follows:—

Month.	Range of maximum temperature of water during the period of retting.	Range of minimum temperature of water during the period of retting.	Average range of water temperature during the period of retting.
December 1929 ..	61·0—75·0°F	56·0—87·0°F.	60·0—66·5°F.
March 1930 ..	72·0—78·0°F.	63·0—69·0°F.	66·0—74·5°F.
April—May 1930 ..	80·0—92·0°F.	73·0—81·0°F.	76·0—83·5°F.
August 1930 ..	77·0—85·0°F.	72·0—79·0°F.	75·0—79·0°F.

III.—Results of examination of the fibre samples.

(a) Samples retted in December 1929.

Chemical and physical examination and the trade valuation figures showed the following:—

- (1) With the low temperature prevailing during the month of December the retting period of 4 to 5 days gives a satisfactory fibre.
- (2) The tank water is preferable to running water.
- (3) Seed rate of 60 to 90 lbs. per acre, is better than the seed rate of 40 or 120 lbs.
- (4) In running water a longer retting period is necessary, as the retting organisms in this case are being constantly washed and have not therefore the same facility for attacking the fibre as in the case of the tank water.

(b) Samples retted in March 1930.

- (1) Samples of this series were better than those retted in the month of December 1929.
- (2) Contrary to the expectation, fibre obtained from straw retted in *nullah* for 5 days was superior to that obtained from the straw retted for a period of 5 and 8 days in the tank. This may have been due to the increased temperature of the *nullah* water as compared to that of the tank water, and also possibly due to the fact that at this time the *nullah* water being fairly stagnant the retting organisms are not constantly washed, and thus get a fair chance of attacking the straw.
- (3) Chemical examination shows that a seed rate of 60 to 90 lbs. per acre is suitable but the trade examination indicates that 60 lbs. seed rate yields the most satisfactory type of fibre.
- (4) Trade examination also indicated that a period of 8 days retting in *nullah* gave better results than a period of 10 days or a period of 4 to 5 days in tank water.

(c) Samples retted in May 1930.

- (1) Due to want of water in the *nullah*, retting in the tank could only be carried out.
- (2) On the whole the fibre was sufficiently retted in 4 to 5 days, retting for a period of 8 days at a somewhat higher temperature showing no particular improvement. A seed rate of 60 lbs. per acre generally furnished the best results. These samples were considered to be of a good standard of "Fine" from the C. P. market.

(d) Samples retted in July 1930.

- (1) The straw was not stored in sheds and was thus exposed to rain and got black in colour and the resulting fibre was found to be very weak and had a dirty black colour. The samples were sent to England for examination but the results have not yet been received. The samples as indicated above were however of a very poor quality and normally such type of fibre is never produced by the cultivators. Subsequent experiments carried out in

the year 1932 have however shown that fibre of good colour and quality can be produced by retting the straw in the month of July, if the same has been stored in sheds.

(e) Samples retted in January 1930 and March 1930 at Chhindwara.

(1) The difference in the temperature of the water employed for retting in the months of January and March had no noticeable effect on the analytical figures of the two samples.

(2) Seed rate of 100 lbs. and a period of retting equal to 3 to 5 days in January and a seed rate of 60 lbs. and a period of retting equal to 6 days in March gave very good samples of fibre.

IV.—Trade valuation of the various samples.

The market prices of the average Indian hemp and the valuation of some of the good samples obtained from our experiments at the time of examination of the "C" series from Nagpur and the Chhindwara samples were as follows:—

	Market quotation at the time of examination of "C" series samples from Nagpur.	Market quotation at the time of examination of Chhindwara samples.
Fine Jubbulpore	£13-10 per ton	£15 per ton.
Fine Sawnee	£14-10 per ton	£16 per ton.
Fine Itarsi	£15-10 per ton	£18-10 per ton.
Valuation of the best samples	£15-0 to 16-0 per ton	£18-0 to 19-0 per ton.

V.—Germination tests.

Germination tests of seeds obtained from the various plots at Nagpur showed on an average 80 to 90 % germination capacity of the seeds, showing thereby that the sann hemp crop can be harvested just when the pods are nearly mature and before the crop is completely dry, without deteriorating the germination capacity of the seeds.

VI.—Percentage and amount of fibre obtained.

On an average with 40, 60, 90 and 120 lbs. seeds rate the straw yielded 14 to 15% of fibre giving 750 to 800, 800 to 870, 860—930 and 900 to 975 lbs. of fibre per acre, respectively, the average valuation of the respective fibres from the 'C' series being £ 14-0, £ 15-0 to 16-0, and £ 14-0 to 15-0 per ton. These figures indicate that the slight increase in the outturn of fibre in the case of 120 lbs. seed rate per acre, does not give any increased money return, but on the other hand the cultivator will have to spend an additional amount on account of the increased seed rate. A seed rate of 60 to 90 lbs. seems therefore to be more economical than the 40 or 120 lbs. seed rate per acre.

VII.—Effect of early and late sowing.

Sowing the sann seed either immediately after the break of the monsoon, or 15 days later did not affect the quality or outturn of the fibre to any appreciable extent.

REPORT ON SAMPLES OF SANN HEMP FIBRE AND TOW PREPARED BY MESSRS. MARSHALL, SONS AND CO., LTD., GAINSBOROUGH, FROM A CONSIGNMENT OF RETTED SANN STALKS SENT FROM CENTRAL PROVINCES.

Messrs. Marshall stated that after carrying out trials with various machines they had found that the best results were obtained by treating the dry straw with their 6 Pair Breaker and an Irish Scutch Wheel. The breaker removed 75 per cent. of shieve quite free from fibre or two; the shieve remaining on the fibre after this operation was removed by treatment over the scutch wheel.

The best yields obtained from the original dry straw were 18½ per cent. of finished fibre and 5½ per cent of tow. The firm expressed the opinion that for practical operation in India a drum dresser would be preferable to the scutch wheel, as it would not necessitate any skilled labour and would furnish a larger output per hour.

Trade opinion by Messrs. Wigglesworth and Co., Ltd., on the above samples.

"The results of the present experiment may be considered satisfactory. We consider the fibre an improvement on even the best of the hand-prepared fibre shipped from India".
 "The tow produced is clean and fairly long, and would compare favourably with Russian or Hungarian tow, although rather more brittle, as is usual with Indian Grotalaria fibre."
 "We value the long fibre at £ 22.0 and the two at £ 16.0 per ton. Fine Jubbulpore selling at £ 13.10 and Fine Dewghuddy, which is regarded as the best type of the Indian hemp at £ 19.0 per ton. It can be seen therefore that this experiment is of considerable interest, and we would recommend a continuation in India, on the spot where the material is produced, by the shipping of a unit of machinery as offered by Messrs. Marshall. It would however be advisable before sending the drum machine that some fibre should be passed through it in order to see if the result is satisfactory".

It would therefore appear desirable for the firm to be supplied with a further consignment of the retted straw in order to carry out their suggested treatment with a drum dresser. The Imperial Institute will be glad to receive for examination samples of any fibres which may be produced in the course of such trials.

(Sd.) D. V. BALL,

*Offg. Agricultural Chemist to Government,
Central Provinces, Nagpur.*

ENCLOSURE V.

Summary of recommendations.

1. Sann hemp should be grown on light well-drained soils (paragraph 79).
2. There is considerable scope for improvement in the existing strains. Improved strains with higher yield and better quality fibre can and should be evolved by 'selection' (paragraphs 8, 80).
3. The need for ensuring supplies of pure good seed with instructions about the seed rate for each tract has been clearly established (paragraph 79).
4. Cultivators in Bengal should be educated to cut off the root and top portions from the plants before retting; similarly cultivators in Ratnagiri district (Bombay Presidency) should be advised to cut the root portions of the plants before retting (paragraphs 45, 71 and 83).
5. The advantages of drying the harvested crops as practised in Ratnagiri district (Bombay Presidency) should be investigated (paragraphs 71 and 82).
6. Instructions should be given to cultivators regarding the proper time and method of harvesting, retting and extraction of fibre and efforts should be made to improve facilities for washing the fibre where these are deficient (paragraphs 11, 15, 29, 36, 45, 53, 71, 83 and 85).
7. The vertical and twisting actions of the retted bundles during washing as practised in the United Provinces (paragraph 15) and beating of the retted material during extraction as practised in some parts of Bengal (paragraph 45) are undesirable (paragraph 83).
8. The practicability of improving the quality of sann hemp fibre by 'sweating' should be investigated (paragraph 84).
9. The practice of leaving sticks and dirt in the fibre and of twisting it tightly into hanks which serve to hide 'loading' should be discouraged (paragraphs 16, 86).
10. The experiments undertaken at the Technological Institute, Cawnpore, by Mr. Mullani on retting and softening the fibre with cheap chemicals are promising, and the authorities of the Institute might be encouraged to continue them (paragraph 85).
11. The possibilities of breaking and scutching green as well as retted stems, by hand and power machines, should be investigated (paragraph 85).

12. It is desirable to study the effects of the season of growth, and of harvesting and retting practices on the fibre with a view to improvements (paragraph 87).

13. The practicability of regulating up-country markets on the lines of cotton and grain markets in Berar (paragraph 88) and of introducing standard iron weights by legal prescription should be investigated (paragraphs 74 and 88).

14. Co-operative Sale Societies and philanthropic bodies should be encouraged to help in ameliorating the condition of the cultivators (paragraph 89).

15. The practicability of controlling the transport from one growing centre to another through trade organisations should be considered (paragraph 88).

16. The economy and benefit of cleaning and assorting the fibre at the up-country collecting centres before it is made into *kutchas* bales or bundles (paragraph 90) should be brought home to all concerned.

17. Supervision over *kutchas* baling at the up-country markets will help to minimise some of the defects and mal-practices and is not only desirable but necessary (paragraphs 13, 19 and 91).

18. If suitable supervision over the cleaning, grading and packing of the fibre for export could also be provided, it would undoubtedly help to reduce the defects and mal-practices. Shivpur (near Benares) being one of the important centres for baling, experiments should be tried there (paragraphs 92, 93).

19. The Central Provinces which rank next in importance to the United Provinces in sann hemp production should have arrangement for *pucca* baling. Seoni might prove to be a suitable centre for hydraulic pressing (paragraph 93).

20. A reliable and uniform system of grading and specification of the grades is very desirable in the general interests of the trade and efforts should be made to evolve a suitable system through the trade itself (paragraph 94).

21. Bales should bear the name of the grade, the place of production and the name of the press. The shipper's own trade marks may of course continue (paragraph 94).

22. Supervision over cleaning, grading and packing at the presses at the ports through some permanent organization is essential (paragraph 95).

23. Packing of export at the up-country baling centres like Shivpur should be encouraged by giving special transport facilities (paragraph 98).

24. Indian shippers complain that the terms of the form of the contract at present in use when hemp is exported are one-sided and are frequently unfair in their operation. An attempt should be made to bring about their revision (paragraph 96).

25. A study of the foreign centres of production and markets for hemp is desirable before any effective scheme for the improvement of the Indian hemp trade can be evolved (paragraph 97).

26. A permanent central organisation on the lines of the Indian Central Cotton Committee is necessary to effect improvements in the preparation and marketing of sann-hemp and to put the Indian-hemp trade on a sound footing (paragraph 99).

27. The industrial utilisation in India of sann hemp, *e.g.*, the manufacture of ropes, matting, canvas, etc., offers a promising field which should not be left out of the scope of work entrusted to any central organisation which may be set up (paragraph 101).

APPENDIX XXV.

SUBJECT No. 19.

APPLICATION FROM THE GOVERNMENT OF BOMBAY FOR A GRANT OF £500 (RS. 6,667) ON ACCOUNT OF DEPUTATION OF DR. B. N. UPPAL, PLANT PATHOLOGIST TO GOVERNMENT, TO FOREIGN COUNTRIES TO STUDY VIRUS DISEASES OF PLANTS.

Attention is invited to the attached copy of a letter (and enclosure) from the Government of Bombay, No. 9171-A./28, dated the 14th June 1932 on the subject of deputation of Dr. B. N. Uppal outside India to study the latest advances in scientific knowledge pertaining to the virus diseases of plants. The proposal involves an expenditure of £500 or Rs. 6,667 over a period of one year.

The subject is now for the consideration of the Advisory Board.

CHARAN DAS,

The 22nd June 1932.

Secretary.

LETTER FROM R. D. BELL, Esq., C.S.I., C.I.E., I.C.S., CHIEF SECRETARY TO THE GOVERNMENT OF BOMBAY, REVENUE DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 9171-A./28, DATED BOMBAY CASTLE, THE 14TH JUNE 1932.

I am directed by the Government of Bombay (Transferred Departments) to forward an application (Enclosure) in connection with the deputation of Dr. B. N. Uppal, Plant Pathologist, outside India, to study the latest advances in scientific knowledge pertaining to the virus diseases of plants and to state that they recommend it for the favourable consideration of the Imperial Council of Agricultural Research. I am to add that the financial liability of the Local Government in connection with the proposed tour will be limited to the payment to Dr. Uppal of such leave salary as may be due to him.

ENCLOSURE.

Scheme for the deputation of Dr. B. N. Uppal, Overseas, to study the latest advances in scientific knowledge pertaining to the virus disease of plants.

The Imperial Council of Agricultural Research sanctioned a Virus Research Scheme in May 1931 (not printed) to be conducted by the Bombay Department of Agriculture. Preliminary arrangements were taken in hand but in February 1932 the Imperial Council of Agricultural Research addressed a letter No. 410/Agri., dated 12th February 1932 (not printed), to the Government of Bombay in which it was pointed out that owing to severe financial stringency the Government of India had suspended its annual subsidy to the Council. In these circumstances the Imperial Council suggested that the Bombay Government should slow down the research schemes already sanctioned by the Council. The Bombay Government in its reply (not printed) pointed out that the Sugarcane Research Scheme could not easily be curtailed and made the counter proposal to suspend the Virus Research Scheme. This proposal was accepted, and accordingly the Virus Research Scheme has not been launched. During a recent visit to Poona the Agricultural Expert (Mr. Burt) on the Imperial Council of Agricultural Research emphasized the fact that in this branch (Virus diseases) of Plant Pathology very rapid strides were being made by workers in England and other countries, and observed that a great deal of new knowledge was accumulating. The question therefore arises whether advantage should be taken of the postponement of the Bombay Virus Research Scheme to depute abroad, the officer who will be responsible for directing that scheme when it materializes. In view of the newness of this subject and the obscurity which has hitherto enshrouded our knowledge of the nature of this group of diseases and the recent advancements of knowledge thereon, it would appear advisable to take advantage of this postponement to depute, abroad the officer who will control this research.

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An estimate of the cost of this deputation is attached (Annexure) from which it will be seen that the cost will amount to £500 if the officer includes both Europe and America in his itinerary. If America is excluded the reduction will be £200 and the cost £300.

The officer under consideration is Dr. Uppal, Acting Plant Pathologist to the Government of Bombay. This officer has about 5½ years' service and joined his appointment after six years' study in America. As Dr. Uppal is personally acquainted with the leading plant pathologists in America, through long residence there and subsequent professional correspondence, it would seem to be advisable to include America in the itinerary.

This deputation would require about one year, and Dr. Uppal would be granted leave for this period on the usual terms at the cost of Government. The estimates have been kept as low as possible, e.g., the allowance of 12 shillings per day will not be sufficient to meet the daily expenditure at Rothamsted, and the officer will have to supplement this allowance from his private purse as well as incur expenditure on such items as additional clothing.

The appropriate time for commencing this deputation would be April 1933. About eight to nine months would be spent in England and on the Continent and about two months in America.

This scheme is accordingly placed before the Imperial Council of Agricultural Research for favourable consideration, and for making a grant of £500 (Rs. 6,667) if approved, because, in the present position of Provincial finances, it is not possible for the Government of Bombay to make a direct contribution to the cost of the scheme.

T. F. MAIN,
Director of Agriculture,
Bombay Presidency.

ANNEXURE.

Estimated Cost of Deputation, abroad of Dr. B. N. Uppal for 12 months.

	£	s.	d.
(1) Second class fare from Bombay to Genoa, Italy	45	0	0
(2) Second class rail fare from Genoa, Italy, to London (with through booking)	6	0	0
(3) Third class rail fare from London to Rothamsted	0	10	0
(4) Subsistence allowance in England for 8½ months at the rate of 12 shillings per day	155	0	0
	(approximately)		
(5) Six return third class rail journeys from Rothamsted to Cambridge	4	6	0
(6) One return journey from Rothamsted to Dublin (Third class rail from Rothamsted to Liverpool and first class steamer fare; no second class is provided from Liverpool to Dublin)..	5	12	6
(7) One return journey from Rothamsted to Wageningen, Holland [Second class steamer fare from London to Rotterdam (in the absence of second class, first class) and second class rail fare from Rotterdam to Wageningen]	8	0	0
	(rough estimates)		
(8) Second class steamer fare from London to New York	31	0	0
(9) New York to Madison, Wis. Ames, Iowa and back (First class including Pullman, since there is only one class on the American railways)	35	0	0
(10) New York to Maine and Harvard University, and back	10	0	0
	(rough estimates)		

(11) Subsistence allowance in the United States for 2 months at the rate of 30 shillings per day	£	s.	d.
	90	0	0
(12) Second class Steamer from New York to London	31	0	0
(13) Second class fare from London to Bombay (via Italy)	51	0	0
(14) Reserve	27	11	6
	<hr/>		
Total	500	0	0

Explanation of the statement.

(1) Trips to Cambridge, Dublin, Wageningen, Holland, New York, Madison, Wis, etc., will be made to meet the following well-known workers on virus disease and discuss problems with them:—

- (1) Dr. K. M. Smith.
- (2) Dr. P. A. Murphy.
- (3) Dr. H. M. Quanjer.
- (4) Dr. L. O. Kunkel.
- (5) Dr. James Johnson.
- (6) Dr. E. M. Duggar.
- (7) Dr. L. E. Melhus.
- (8) Dr. D. Folsom.

(2) The reserve of £27-11-6 is provided to meet unforeseen expenditure or any extra expenditure due to depreciation in the exchange value of the pound sterling. If a part, or whole, of this amount is not spent during the year it will lapse to the Imperial Council of Agricultural Research.

APPENDIX XXVI.

SUBJECT No. 20.

QUESTION OF COMPILATION BY THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH ANNUALLY FOR CIRCULATION TO ALL CONCERNED, OF A LIST OF RESEARCH WORK COMPLETED OR UNDER INVESTIGATION IN THE AGRICULTURAL AND VETERINARY DEPARTMENTS OR IN THE UNIVERSITIES IN INDIA.

Attention is invited to the attached copy of a letter (Enclosure I) from the Director of Agriculture, United Provinces, No. 10145/1/373-A. (14)-5, dated the 1st December 1931, and of a letter (Enclosure II) from the Secretary, United Provinces, Agricultural Research Committee, No. 1068-80/P.E.C., dated the 2nd December 1931, on the subject mentioned above.

2. Upto 1917, programmes of research work of the Provincial and Imperial Agriculture and Veterinary Departments were submitted to the Board of Agriculture. As a result of the experience gained, however, the Board passed the following resolution at its meeting held in the year 1916.

“That it be recommended to the Government of India that the submission of programmes, both Provincial and Imperial, to the Board be definitely dropped.”

This resolution was not accepted by the Government of India.

3. In 1917, the Board passed the following resolution:—

“That in view of the difficulty of discussing the programmes of the Imperial and Provincial Departments, at the meeting of the Board of Agriculture, programmes should be published annually as a separate compilation and circulated by the Agricultural Adviser to the Government of India to all concerned.”

The Government of India, in consultation with the local Governments accepted this Resolution and decided to discontinue the submission of programmes to the Board of Agriculture and agreed to the publication of all such programmes by the Agricultural Adviser in a separate publication (Enclosure III).

4. In 1922, however, the Agricultural Adviser to the Government of India pointed out that the publication of research programmes of the Imperial and Provincial Departments of Agriculture as a separate compilation was of doubtful utility and in view of this and of the need for economy recommended its discontinuance. The Government of India concurred in the views of the Agricultural Adviser and informed (Enclosure IV) the Local Governments accordingly, leaving them a free hand in regard to the printing of their programmes of research in their Annual Reports of Agricultural and Veterinary Departments. It appears from the Annual Reports that the Madras, Burma and the Bihar and Orissa Departments of Agriculture publish their programmes of research work while others do not.

5. The proposal of the United Provinces Agricultural Research Committee is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

SIMLA,

The 2nd June 1932.

ENCLOSURE I.

COPY OF A LETTER FROM THE DIRECTOR OF AGRICULTURE, UNITED PROVINCES, LUCKNOW, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, No. 10145/1/373-A. (14)-5, DATED THE 1ST DECEMBER 1931.

I have the honour to say that the last meeting of the United Provinces Agricultural Research Committee held at Lucknow on 23rd November recommended that the Imperial Council of Agricultural Research be requested to send to this Committee copies of all research programmes in the various Agriculture Departments in this country. It was also suggested that an annual list of the research work accomplished and the problems under investigation in the country—whether in the departments, or in the Universities—will be very useful, and was an urgent necessity.

ENCLOSURE II.

COPY OF A LETTER FROM THE SECRETARY, UNITED PROVINCES, AGRICULTURAL RESEARCH COMMITTEE, CAWNPORE, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, No. 1068-80/P.R.C., DATED THE 2ND DECEMBER 1931.

I have the honour to forward herewith a copy of resolution No. 1 (printed below) passed on the 5th meeting of the United Provinces, Agricultural Research Committee, held on November 23, in the Council House, Lucknow for your information, with the request that the problems on which research has been or is being carried out in India, may please be intimated to the Provincial Research Committee.

Resolution.—Resolved that the Imperial Council of Agricultural Research be asked to communicate to the Provincial Committee the problems on which research has been or is being carried out in India, so as to avoid duplication.

ENCLOSURE III.

COPY OF A LETTER FROM THE UNDER SECRETARY TO THE GOVERNMENT OF INDIA, DEPARTMENT OF REVENUE AND AGRICULTURE, TO ALL LOCAL GOVERNMENTS AND ADMINISTRATIONS, No. 979, DATED SIMLA, THE 9TH OCTOBER 1919.

I am directed to invite your attention to this Department's circular No. 845-88-5, dated the 31st August 1918 (not printed) and with reference to paragraph 3 thereof to say that after considering the replies received from Local Governments and Administrations, the Government of India have decided to accept Resolution II passed at the tenth meeting of the Board of Agriculture in India which was held in December 1917, regarding the compilation by the Agricultural Adviser to the Government of India and circulation annually to all concerned of the programmes of the Imperial and Provincial Departments of Agriculture and of Provincial Veterinary Department.

ENCLOSURE IV.

COPY OF A CIRCULAR LETTER FROM THE UNDER-SECRETARY TO THE GOVERNMENT OF INDIA, DEPARTMENT OF REVENUE AND AGRICULTURE, TO ALL LOCAL GOVERNMENTS AND ADMINISTRATIONS, No. 593-180, DATED THE 30TH JUNE 1922.

SUBJECT:—Discontinuance of the compilation and circulation by the Agricultural Adviser to the Government of India, of the Programmes of the Imperial and Provincial Departments of Agriculture and of the Provincial Veterinary Departments.

I am directed to refer to Mr. Plowden's letter No. 979, dated the 9th October 1919 (Enclosure III), communicating the decision of the Government of India to accept Resolu-

tion II passed at the tenth meeting of the Board of Agriculture in India, regarding the compilation and circulation by the Agricultural Adviser to the Government of India, annually to all concerned of the programmes of the Imperial and Provincial Departments of Agriculture and of the Provincial Veterinary Departments, and to say that as the circulation of a separate compilation of these programmes is of doubtful utility, the Government of India have decided to discontinue their circulation in future as a separate compilation. So far as the Imperial Department of Agriculture is concerned, the present practice of printing the programmes in the Scientific Reports of the Agricultural Research Institute, Pusa, will be continued, and the Government of India leave it to Local Governments, if they consider it desirable to do so, to arrange for the programmes of Agricultural and Veterinary work in the provinces to be printed in the annual reports of those Departments.

APPENDIX XXVII.

SUBJECT No. 21.

PARTICIPATION IN THE CONGRESS OF THE FAR EASTERN ASSOCIATION OF TROPICAL MEDICINE.

Attention is invited to the attached note (Enclosure I) which gives a brief account of the Far Eastern Association of Tropical Medicine. It will be seen that a representative of India from the medical side has participated in the biennial, now triennial, meetings of the Congress of the Association held so far. The Animal Husbandry Expert to the Council in a note (Enclosure II) proposes that one veterinary representative should also be sent to each Congress from India. The cost in connection with the veterinary representative will fall on the research funds of the Council. The proposal is submitted for the consideration of the Advisory Board. No intimation has yet been received about the next Congress.

CHARAN DAS,
Secretary.

The 28th June 1932.

ENCLOSURE I.

A brief account of the Far Eastern Association of Tropical Medicine.

The Association was formed in 1908 for the promotion of the science of medicine in the East. Its membership consists of representatives of the principal Governments of the Far East, viz., Japan, the Philippines, the Dutch East Indies, the Straits Settlements and Federated Malay States, Ceylon and India. The most important feature of its activities is the holding of meetings at which delegates of the various states belonging to it meet to discuss problems of common interest. Upto 1927 these meetings were held biennially but in 1927 it was decided that the Congress should be held triennially instead of biennially. So far these meetings have been held in the Philippines, Hong-kong, the Straits Settlements, the Dutch East Indies, French Indo-China, Japan, India and Siam, at the invitation of the Governments concerned. The programme at these gatherings consists of a full meeting of the delegates of all the participating countries at which scientific papers are read and of visits of foreign representatives to important educational and research institutions which are organised by the inviting Government.

2. Upto the year 1927 the Government of the country in which the meeting was held used to defray the cost of transport of the foreign delegates inside the country in connection with the visits to various institutions and of their board and lodging. In 1927 it was decided that these expenses should be met either by the delegates themselves or by their own Governments.

3. A representative of India from the medical side has participated in each of the meetings of the Congress held so far. The last Congress was held at Bangkok in December 1930 and Major-General Graham represented India on it.

4. In connection with the 6th Congress of the Association which was held in 1925 in Tokio, Japan, the President of the Association while extending the invitation specially mentioned about the delegation of Veterinary Surgeons as well as of Medical Scientists to represent India at the Congress. The question of sending a Veterinary Officer from India was accordingly considered that year but it was eventually decided that no Veterinary Officer should be sent from India as the advantages that this country could derive would not be commensurate with the expenses incurred.

5. It appears from the transactions of the Congress held in 1923 that there was no special Veterinary Section of the Congress that year but the following subjects which are more or less allied to Veterinary Science were discussed :—

- (i) Has Parasitology a place in the Medical Curriculum ?
- (ii) Recent progress in Parasitology made by Japanese investigators.
- (iii) Application du bacteriophage a la vaccination contre le Barbone.
- (iv) On Pseudo-typhus of Samutra.
- (v) Plague in Wild Rodents.

6. In 1927 there was a regular Veterinary Section of the Congress at which the following papers were read and discussed :—

- (1) Animal Infectious Diseases and their Control in Japan by Dr. Norichika Nakamura.
- (2) Bovine Tuberculosis in India by Mr. J. T. Edwards, I.V.S.
- (3) Virulence of Tubercle Bacilli Isolated from Cattle in India by Dr. M. B. Sporkar.
- (4) An Improved Vaccine for Immunization against Rinderpest by Major R. A. Kelsner, V.C., Drs. Stanton Youngberg and Teodulo Tapacio.
- (5) The treatment of Canine Piroplasmosis by Major R. F. Stirling, I.V.S.
- (6) On the Morphology of the Virus of Contagious Peri-pneumonia of Cattle by Dr. Tenji Paniguchi.
- (7) Generalized infection of *Cænurus serialis* or *Multiceps gaigerii* in Goats by Ra f Saheb Debakar Dey, P.V.S.
- (8) Rhinosporidiosis in Cattle. A case recorded in a Bullock by Mr. V. Krishna-murti Ayyar.
- (9) Gastro-enteritis Hæmorrhagica in the Cattle of Formosan Milkers by Major Tosinobu Miyamoto, Drs. Tosituna Nomura and Siwiti Ono.
- (10) Urocystitis Hæmorrhagica of Native Cattle in Formosa by Major Tosinobu Miyamoto.
- (11) Strongyloidosis Intestinalis in the Farrow of Formosa by Major Tosinobu Miyamoto.
- (12) Rinderpest: Some properties of the Virus and further indications for its employment in the Serum-Simultaneous method of Protective Inoculation by Mr. J. T. Edwards, I.V.S.
- (13) Rinderpest: Some points in Immunity by Mr. J. T. Edwards, I.V.S.

ENCLOSURE II.

Note by the Animal Husbandry Expert to the Council.

Though this congress is essentially a medical one, a considerable proportion of the subjects discussed are also of veterinary interest and there is no doubt that scientific and practical discussions of this nature amongst veterinary and medical workers do a great deal to stimulate research and to help in the elucidation of cognate problems. Apart from purely veterinary subjects the intervention of veterinary workers in discussions on diseases which affect men as well as animals is of mutual benefit and with the large amount of veterinary research which is carried out throughout the far east there should be no difficulty in arranging a good veterinary section wherever such a congress meets, provided that sufficient notice is given.

This would be an inexpensive method of ventilating and discussing veterinary problems, probably more useful and much more feasible than to attempt to hold a purely veterinary congress, continued support for which would be very problematical.

I suggest that one veterinary representative should be sent to each congress from India, and that facilities should be given for workers in India to read papers in the veterinary section. The cost of this would be small compared with that of organizing a separate veterinary congress and great benefit should be derived from the un-official discussions which take place between workers concerned with similar problems in addition to that derived from the official discussions and the preparation of papers suitable for them.

APPENDIX XXVIII.

SUBJECT No. 23.

APPLICATION FROM THE GOVERNMENT OF MADRAS FOR A GRANT FOR RESEARCH WORK ON POTATOES.

At its meeting held in January 1931 the Advisory Board considered an application from the Government of Madras for a grant for research work on potatoes (Enclosure I) which was recommended for sanction (Enclosure II) subject to the proviso that the non-recurring expenditure of Rs. 8,000 for quarters should be met by the Local Government. The Governing Body, however, rejected the application (Enclosure III).

2. The Government of Madras have since represented (Enclosure IV) that the crop is of very appreciable economic importance in the Nilgiris where it forms the main crop raised by the indigenous hill population and that they have no objection to the work proposed being undertaken at Pusa if Pusa is considered to be suitable for varieties for hill tracts not only in the north of India but also the south or to the work being helped in northern provinces as well as in Madras. The Local Government asks that the subject may receive further attention at the hands of the Council.

3. The Government of Madras have also agreed in the course of subsequent correspondence to meet the non-recurring expenditure of Rs. 8,000 for quarters.

4. Mr. B. C. Burt, Agricultural Expert to the Council, now on deputation, has recorded a technical note in this connection which may be of interest (Enclosure V).

The subject is now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

Simla, the 5th July 1932.

ENCLOSURE I.

LETTER FROM THE SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, DELHI, No. 2931-III/30-1, DATED THE 3RD NOVEMBER 1930.

I am directed to address the Council of Research in the matter of a grant for work on potatoes.

2. At present work on potatoes is being done on a restricted scale at Nanjanad on the Nilgiris and is confined to the testing of strains of potatoes, methods of cultivation and manuring for this purpose and the station is under the control of the Curator, Botanical Gardens, Ootacamund, who is also in charge of the fruit stations on the Nilgiris. The staff at present employed on the station is as follows:—

- (1) One Upper Subordinate.
- (2) One Lower Subordinate.
- (3) One Probationer.

And a statement showing the expenditure incurred on the station during the last five years is enclosed.

3. The Director of Agriculture of this Province proposes to take up work on the production of new strains of potatoes and their distribution for seed purposes and is willing also to undertake to supply seed for test to all other Governments in India. As the work on fruits done in this Province is proposed to be expanded, the Curator will have no time to attend to the work on potatoes now proposed to be done and so the Director of Agriculture has proposed the following additional staff:—

- (1) One Gazetted Officer on Rs. 250—25—750 to be in charge of the work.
- (2) Substitution of the existing Lower Subordinate at the station by an Upper Subordinate.
- (3) A fieldman on Rs. 35—1½—50.

Quarters for items 1 and 3 above will also have to be provided at a cost of Rs. 8,000.

4. The scheme is of all-India importance as the Provinces of Bombay, Assam, Central Provinces, Berar, Punjab and United Provinces also are interested in work on potatoes. Barring item (2) specified above in the last paragraph, the expenditure that will have to be incurred on the scheme during the next five years is as follows, assuming that the work can be started on 1st April 1931 :—

	Rs.
1931-32	3,135 plus Rs. 8,000 for quarters.
1932-33	3,738
1933-34	4,056
1934-35	4,374
1935-36	4,692

5. As this Government are already incurring an average annual expenditure of Rs. 15,000 in this connection, while other Provinces also will be benefitted by the scheme and as the recurring expenditure involved is small, I am to request that the Council will be pleased to provide both for the recurring and non-recurring expenditure during the next five years.

Statement showing the amount spent for the Agricultural Research Station, Nanjanad, for the years 1925-26 to 1929-30.

Particulars.	Expenditure during				
	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.
	Rs.	Rs.	Rs.	Rs.	Rs.
Pay of establishment ..	2,577	2,028	2,615	2,746	2,517
Allowances—					
Voted :—					
Travelling allowance ..	264	166	185	76	175
Other compensatory ..	664	504	618	624	536
Honoraria, voted ..	15	..	10	..	5
Miscellaneous ..	116	77	165	36	50
Works—New Works and Petty Construction and Repairs.	9,181	591	83	1,312	698
Capital outlay	861	304	360	227	198
Working expenses	5,925	9,431	9,448	11,095	11,400
Charges payable to Govern- ment departments and others.	300	300	300	300	300
Total ..	19,903	13,401	13,784	16,416	15,879

**BRIEF HISTORY OF THE POTATO EXPERIMENT STATION, NANJANAD,
WITH A SHORT ACCOUNT OF LOCAL AGRICULTURE.**

The Potato Experiment Station was established in 1917 after a good deal of time had been spent in selecting the site. It is situated about half way between the village of Kuruthukulli and Nanjanad. Easy access by motor to the station is now possible by a road constructed to it. This road branches off at Andy's Corner on the Governor's Shola Road. The distance to the Potato Experiment Station from Ootacamund is 10½ miles. The

station was originally scrub jungle and grass land and a portion of it appears to have been cultivated many years ago. The soil is typical of that to be found on the Nilgiris and is therefore somewhat poor. It is all dry land excepting two acres of swamp. The Station is exposed to the south-west monsoon the Winds of which usually damage the haulms of the potatoes. The area of the station is 90.16 acres and the portion at present under cultivation measures approximately 36 acres. The chief crop is potatoes, but korali, samai are grown in rotation and lupins are grown as a green manure crop. The objects of the station are (1) to import and grow disease-free potatoes of good varieties and to distribute them to the ryots for seed purposes at a reasonable price, (2) to experiment with the different kinds of manures to find out which are the best for the district, (3) to carry out various experiments with green manures, rotation of crops, etc., and (4) to encourage the ryots to adopt more up-to-date methods of cultivation and to grow better varieties of potatoes than they usually do. Two crops of potatoes are grown annually, the first being planted in March and the second in August. The best time to see the station is during the months of May and November, the crops then being in full growth.

2. The much needed spring showers usually commence during the first week of April and if the rain is sufficient, the potatoes planted in March soon commence to grow. Everything depends on these early showers, and if they do not occur or if they are light, the period of the crop is shortened; for when the monsoon sets in about the 10th June the high winds which accompany it below the haulms to pieces and growth is slow. Moreover, "Early Blight" (*Alternaria solani*) sets in and destroys the leaves. Towards the end of August a second crop of potatoes is planted, but these do not grow so rapidly as the first crop, the "seed" not having been kept so long, the shoots are therefore weaker; this altogether with the uncertainty of the north-east monsoon and the liability of frosts occurring in November, makes the second crop an uncertain one and it is called a "seed crop", i.e., for use for planting purposes in February and March. With careful storage, however, and an up-to-date storeroom it is possible to keep the crop lifted in July and August until the following March, but such "seed" is more useful for planting in February in drained swamps or where irrigation is possible.

3. The crop grown by the surrounding ryots include potatoes, barley, korali, samai, amaranthus, onions and other vegetables. The ryots' methods of potato cultivation are extremely primitive and it is a common sight to see them planting potatoes little larger than a marble. The "sets" are often planted so close as 6 in. apart in the rows and 15 in. between the rows. Cattle manure is used at the time of planting, but in limited quantities, as it is difficult to obtain. Korali is sown on poor land without any cultivation other than ploughing a few inches deep, no manure being applied as a general rule. After korali has been grown the land is allowed to lie fallow for some years. The cattle kept by villagers are extremely poor and give little milk; the buffaloes are much finer animals, the coarse grass of the Nilgiris apparently suiting them better than it does other cattle. Much of the worn out land around the Badaga villages should be planted with Wattle (*Acacia dealbata*) or other quick growing tree to provide fuel for the villagers as the women have to go miles to collect wood for cooking purposes. Such worn out land if regenerated as described above would provide valuable arable land for future generations. Wild pigs do an incredible amount of damage to the crops, and much expense is incurred in erecting walls and making trenches, etc., around the farms.

4. The ryots practise rotation of crops in a small way and they are beginning to appreciate the value of green manure crops and fertilizers.

Glossary.

English or local names.

Botanical names.

Samai	..	..	..	<i>Panicum miliare.</i>
Korali	..	..	..	<i>Setaria galuca.</i>
Tenai	..	..	..	<i>Setaria italica.</i>
Barley	..	..	..	<i>Hordeum vulgare.</i>
Lupins	..	..	..	<i>Lupinus sp.</i>
Potatoes	..	..	..	<i>Solanum tuberosum.</i>
Kikuyu grass	..	..	..	<i>Pennisetum clandestinum.</i>
Prairie grass	..	..	..	<i>Bromus unioloides.</i>

ENCLOSURE II.

EXTRACT FROM THE PROCEEDINGS OF THE ADVISORY BOARD, JANUARY 1931.

"Mr. Hilson introduced the scheme which Mr. Burt supported subject to the provision of Rs. 8,000 for quarters being borne by the Provincial Government. He said that the potato crop was of great and growing importance. The import of European varieties for sowing was chiefly useful in hill tracts as the selection and breeding of potatoes for cultivation in the plains in India presented distinct problems. He was of opinion that just as in the case of sugarcane cultivation the cultivation of potatoes would not progress in India till the breeding and testing of types suitable for Indian conditions was taken up here. All the Directors of Agriculture present supported the scheme with a proviso that the expenditure of Rs. 8,000 for quarters should be met by the Local Government. The Chairman suggested that it would be as well to pass the scheme with the above proviso rather than to refer it back to the Local Government for an expression of their views in regard to the latter's share of the cost; for if it was approved by the Governing Body the Local Government could be approached with a definite proposal that the Council would be willing to finance the scheme if the Local Government on their part bore their reasonable share.

The Board agreed to recommend the scheme subject to the rider suggested by the Chairman."

* * * * *

ENCLOSURE III.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE GOVERNING BODY, MAY 1931.

Application from the Government of Madras for a grant for research work on potatoes. Cost of the scheme over a period of 5 years : Rs. 20,000.

Messrs. Mehta and Gokhale urged that as the United Provinces and Bihar were also greatly interested in potatoes the scheme should either be located at Pusa or in the alternative that the expenditure on the Madras scheme be reduced to enable the United Provinces and Bihar to submit their own scheme of potato research. The Hon'ble Sir C. P. Ramaswami Ayyar considered such an attitude to be mistaken. The question was whether work already in hand as in Madras should not be encouraged. The Hon'ble Maulvi Abdul Hamid said that they were already doing work on potatoes in Assam. He was in favour of a co-ordinated scheme of potato research for all-India. Mr. Ramamurty said that it was not the case as if Madras was doing nothing. Madras was spending Rs. 15,000 a year on this work and wanted merely an additional Rs. 4,000 a year from the Council to extend the scope of the present work. Mr. Carpenter thought that the potato ranked with barley and was not a crop of primary importance to India.

In the result the Governing Body rejected the application for a grant by 10 votes to 6.

ENCLOSURE IV.

LETTER FROM S. V. RAMAMURTI, Esq., I.C.S., SECRETARY TO THE GOVERNMENT OF MADRAS TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, No. 1425. DATED FORT ST. GEORGE, THE 29TH SEPTEMBER 1931.

Reference your letter No. 1152-Agri., dated 30th May 1931 (not printed).

It is observed from the Proceedings of the meeting of the Governing Body held on 12th May 1931 (Enclosure III) that the objections raised to the scheme for potato research forwarded by this Government were as follows :—

- (1) The scheme should be located at a central place like Pusa so as to serve the needs of all Provinces or help should be given for such research not only in Madras but also in other provinces such as the United Provinces and Bihar.
- (2) The crop is not of primary importance to India.

2. I am to state that the potato crop is of very appreciable economic importance in the Nilgiris where it forms the main crop raised by the indigenous hill population. In 1929-30, the value of the potato crop raised in the Nilgiris was over Rs. 50 lakhs. The crop is

not confined to Madras but is also raised in the United Provinces, Bihar, Assam and perhaps also Bengal. It may be stated for purposes of comparison that the annual value of the coffee produced in this Presidency is about Rs. 45 lakhs. It is hardly correct therefore to consider the crop as not of sufficient importance for being helped by the Imperial Council of Agricultural Research.

3. I am to state that this Government have no objection to the work proposed, viz., the breeding of new varieties of potatoes being undertaken at Pusa if Pusa is considered to be suitable for varieties fit for hill tracts not only in the North of India but also the South or to the work being helped in Northern provinces as well as in Madras. The amount asked for by Madras was only Rs. 4,000 a year and this Government are already spending Rs. 15,000 a year on their potato farm in the Nilgiris. I am to request that the subject may receive further attention at the hands of the Council.

ENCLOSURE V.

COPY OF A NOTE BY MR. B. C. BURT, AGRICULTURAL EXPERT, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

So far as the proceedings of the Governing Body (Enclosure III) show, there was misunderstanding on two points:—

In the first place, Pusa is definitely *not* a suitable place either for breeding new varieties of potatoes or for the acclimatising and first testing of imported potatoes. For several years for example, Mr. Henderson, when Imperial Agriculturist, tried to get facilities for potato work at Shillong because Pusa was unsuitable. A central station is out of the question; the work must be carried out in the hills in some province. The Imperial Department of Agriculture has no hill sub-station.

2. The potato crop is an important one to many provinces, viz. :—

The United Provinces (Hill and Plains).

The Punjab (Hill and Plains).

Bihar and Orissa (Plains and Low Hills). Mainstay of cultivation over a considerable area in South Bihar.

Bengal (Hills locally). Important.

Bombay (Plateau).

Sind (Plains).

Madras (Hills).

Assam (Hills, minor).

In the Advisory Board discussion every Director of Agriculture supported the scheme.

3. The potato crop is essentially the small man's crop—a point which is constantly overlooked. It is a crop increasingly consumed by Indians of all classes in villages as well as in towns, the gross returns per acre are high, it pays for intensive cultivation and it requires a lot of labour. It is a crop which gives the small-holder a big return for his labour and should be encouraged.

4. Like sugarcane potato suffers from mosaic and other diseases and constant replacement of varieties is needed. The present standard is very low.

* * * * *

I see little hope of real progress in potato growing in India unless we have one station in the country for the production of new varieties from seedlings and where imported new

varieties can be acclimatised and tested. This is essentially a case where one province can do work for the whole country.

Acreage under potatoes.

						Acres.
United Provinces	..	..	..	..	..	147,709
Madras	..	..	..	..	..	10,188
Punjab	..	..	..	..	..	9,200
Bihar and Orissa	..	..	..	..	..	60,000
Bengal	..	..	..	..	..	86,500

Imports of potatoes into India.

Bombay.—It has been ascertained that the average annual imports during the three years 1929-30 to 1931-32 of potatoes into Bombay from Italy, Austria (Trieste) and Switzerland (Geneva) amounted to about 3,900 tons and those from Africa to about 375 tons.

Karachi.—

From	Year.		Quantity.	Value.
Italy	..	1929-30	71,965	3,88,334
Italy	..	1930-31	Not available	3,98,213
Malta	..	1930-31	Not available	450
Italy	..	1931-32	Not available	2,86,128

APPENDIX XXIX.

SUBJECT No. 31.

PARTICIPATION OF INDIA IN THE FIFTH WORLD POULTRY CONGRESS,
ROME, 1933.

Attention is invited to the enclosed letter (Enclosure I) from the India Office, No. E. and O. 7823/31, dated 5th November 1931 and enclosures on the subject mentioned above. An *ad interim* reply has been sent to the India Office (Enclosure II) that, in the present financial circumstances, it is not possible to say whether the Government of India will be able to depute any representative to the World's Poultry Congress.

Z. The question whether India should participate in the Congress is now for the consideration of the Advisory Board. If a delegation is sent the cost will fall on the Council.

CHARAN DAS,
Secretary.

The 29th May 1932.

ENCLOSURE I

LETTER FROM THE SECRETARY, ECONOMIC AND OVERSEAS DEPARTMENT, No. E. AND O. 7823/31, DATED THE 5TH NOVEMBER 1931.

With reference to the letter from this Office, No. E. & O. 2741/28, dated 2nd May 1928, I am directed by the Secretary of State for India in Council to forward, for information, copy of the papers noted below, and to enquire what reply the Government of India suggest should be given to the Foreign Office letter:—

From Foreign Office, 31st October (with enclosure).

No. L-6480/137/405.

The Under Secretary of State for Foreign Affairs presents his compliments to the Under Secretary of State for India, and, in transmitting herewith, by direction of the Secretary of State, copy of the undermentioned paper, would be glad to be advised what answer should be returned to M. Bordonaro:—

Foreign Office, October 31, 1931.

Description of Enclosure.

Name and Date.	Subject.
From Italian Ambassador, October 15.	Fifth World's Poultry Congress to be held at Rome in 1933.

Similar letter sent to—

Ministry of Agriculture and Fisheries.

Scottish Office.

Home Office (Irish Branch).

Dominions Office.

Colonial Office.

Department of Overseas Trade (for information).

Copy.
(L. 6480/137/405).

(Translation).

No. 4443.

MY LORD,

ITALIAN EMBASSY,

LONDON,

15th October 1931.

In accordance with the resolution adopted by the Fourth World Poultry Congress (London, July 1930), and in consequence of agreements entered into with the World's Poultry Science Association, a Committee under the high patronage of His Majesty the King of Italy is organising the Fifth World Poultry Congress at Rome, to be convened in September 1933 at the same time as an International Poultry Exhibition.

My Government are well aware of the great interest of the British authorities in questions relating to aviculture and the perfection with which the Fourth World Poultry Congress was organised and directed by the British Ministry of Agriculture and Fisheries.

I have therefore the honour to request that Your Excellency will be so good as to convey to the competent authorities both in the United Kingdom and in the British Dominions, Colonies and Protectorates, the invitation of my Government to take part in the World Congress in question.

I shall communicate to Your Excellency in due course the programmes regarding the Fifth Poultry Congress and the simultaneous International Exhibition.

Thanking Your Excellency for your courteous attention to this matter.

I have, etc.,

(Sd.) A. C. BORDONARO.

The Most Honourable

The Marquess of Reading, G.C.B., G.C.S.I.,

etc., etc., etc.,

ENCLOSURE II.

COPY OF A LETTER FROM THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO HIS MAJESTY'S UNDER SECRETARY OF STATE FOR INDIA, ECONOMIC AND OVERSEAS SECTION, INDIA OFFICE, WHITEHALL, LONDON, S. W. 1, No. 101/VET., DATED THE 17TH MARCH 1932.

SUBJECT:—*World's Poultry Congress, Rome, 1933.*

With reference to the India Office letter No. E. & O. 7823/31, dated the 5th November 1931, on the subject mentioned above, I am directed to say that in present financial circumstances it is not possible to say whether the Government of India, will be able to depute any representative to the World's Poultry Congress to be held in Rome during 1933. A definite reply on the point will be sent by the end of the current year. I am to request that the Italian Government may be informed accordingly.

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APPENDIX XXX.

SUBJECT No. 24.

THE PUNJAB VETERINARY DEPARTMENT SCHEME FOR INVESTIGATION INTO THE MOST SUITABLE AND ECONOMIC METHODS OF COMBATING DIFFERENT TYPES OF PARASITIC INFECTION IN RUMINANTS IN THE FIELD, CONCURRENTLY WITH EXPERIMENTS TO DETERMINE WHETHER CERTAIN MINERAL DEFICIENCIES TEND TO LOWER ANIMAL RESISTANCE TO PARASITIC INFECTION.

Attention is invited to the attached application (Enclosure I) from the Director of Veterinary Services, Punjab, for a grant of Rs. 400 non-recurring and Rs. 19,868 recurring or in all a sum of Rs. 20,128 spread over a period of three years on account of the above scheme. The Punjab Government have permitted the Director to use the buildings and equipment of the Punjab Veterinary College and also agreed to a small expenditure on drugs (Enclosure II). The scheme is submitted for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

SIMLA S. W.,
The 13th July 1932.

ENCLOSURE I.

COPY OF A LETTER FROM THE OFFICIATING DIRECTOR, VETERINARY SERVICES, PUNJAB, CAMP SIMLA, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 8-C., DATED THE 1ST JULY 1932.

I have the honour to forward herewith a proposal for some Parasitological Research to be carried out at the Punjab Veterinary College.

I request that you may kindly submit it to the Council for consideration.

Scheme for investigation into the most suitable and economic methods of combating different types of parasitic infection in ruminants in the field, concurrently with experiments to determine whether certain mineral deficiencies tend to lower animal resistance to parasitic infection.

Part I.—Mention has several times been made in Annual Reports of the steady increase in parasitic infection of domestic animals, chiefly ruminants, in low-lying damp areas, such as riverain districts, and in those areas which are under water for a portion of the year due to water-logging by canals.

Owing to the increase in the canal system in the Punjab diseases of a parasitic nature have become more prevalent.

It is generally recognised that the economic loss occasioned by parasites is enormous almost incalculable, and this scheme is put forward with the express object of attempting to analyse the basal causes of the increased infestation, and find suitable treatment for each type of parasite, having due regard to the cost of the remedy.

It is true that at present there are certain drugs which cope successfully with some types of parasitic infestation, but on account of their cost, they can be utilised only in hospitals and on a comparatively few cases. The use of them on large numbers of animals in the field is definitely prohibited by reason of expense, the result being that practically no organised effort on an extensive scale has been undertaken in India in this direction.

Part II.—It is possible (a) that on account of repeated water-logging, the soil is denuded of, and the fodder grown on those areas consequently lacks, some of the mineral constituents essential for proper animal growth and development, with a consequent deleterious effect on the resistance of the animal organism against parasitic infection. Again (b) this lessening of resistance may be due to the rankness and excess of fibrous constituents in the

fodder of these regions, thus greatly lessening assimilability, with resultant loss of nutrition and the production of a suitable environment for infesting parasites.

It is possible for results to be obtained for Part I and decisions to be made regarding Part II concurrently in one investigation.

2. It is proposed that the experiments should be carried out, in the first instance, at the Punjab Veterinary College, and later in the field in the Punjab, but the problem affects, and the work, if successful, will benefit, the whole of India.

3. Lately, on account of retrenchment, all the larger experimental animals at the above college were disposed of; whilst, were new animals obtained, funds necessary for feeding them cannot be allotted from the college resources.

It will be necessary to entertain an assistant to work with the Parasitologist, and, when necessary, with the officer-in-charge of the dietetic portion of the investigation, but the bulk of his work will be with the former.

4. It is proposed to use twenty calves of six to twelve months of age, twenty lambs and a similar number of goats.

Young animals are chosen, because it is in them that the serious results of parasitic invasion, and the effects of mineral deficiency are evidenced.

At the end of a year or thereabouts, it is proposed that the first lot of animals will be sold, the proceeds being utilised for the purchase of new ones. It is hoped that recurring expenditure under this head, will thus be avoided.

5. The necessity for an assistant requires elaboration. After the animals, cleared of parasites in the first instance, have been re-infested by feeding with ova, larvæ, or hosts, it will be necessary to make daily microscopic examinations of faeces. As he will have to examine several fields of each animal (sixty animals) and distinguish the several kinds of eggs, his time will be fully occupied; indeed, he will have to acquire an expert knowledge and rapidity. For this purpose it will be necessary for him to apply himself to similar work for at least two months, before the infestation of the experimental animals. At a later date, it will probably be found necessary for him to conduct experiments in the field. One of the recent graduates who has shown a special aptitude for the work during his course in Parasitology, will be chosen.

6. The animals will be divided into four batches.

It is intended that fodder for one lot will be procured from the region of the Deg Nullah, for another lot from adjacent areas but not in the water-logged region; for the third from any other area neither water-logged nor adjacent.

The fourth batch of animals will be used as controls and be fed on a balanced ration with an admixture of green food.

7. It is considered that the investigation will cover a period of three years.

The estimated cost will be as follows:—

	Rs.
20 calves at Rs. 15 each	300
20 lambs at Rs. 4 each	80
20 kids at Rs. 4 each	80
	460

The above is a non-recurring charge and will be expended during the first year.

					Per annum. Ra.
6 attendants at Rs. 13 p.m.	..	..	..	--	936
Feed of cattle at 5 annas a day each	..	--	--	--	2,250
Feed of sheep at 2½ annas a day each	..	--	--	..	1,125
Feed of goats at 2½ annas a day each	..	--	..	..	1,125
Cost of grass and carting	..	--	--	--	300
Assistant at Rs. 60 p.m.	..	..	..	..	720
Contingencies, bedding, etc.	..	..	..	..	100
					<u>6,556</u>
Or Rs. 7,016 for the first year and Rs. 6,556 for the two succeeding years.					
				Total	<u>.. 20,128</u>

The buildings, drugs, and equipment will be provided by the Punjab Government.

ENCLOSURE II.

COPY OF A LETTER FROM THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, TO THE DIRECTOR, VETERINARY SERVICES, PUNJAB, NO. 465-D. (3), DATED THE 7TH JULY 1932.

Order of the Ministry of Agriculture.

SUBJECT:—*Scheme for some Parasitological Reserach to be undertaken at the Punjab Veterinary College.*

In reply to your letter without number and date, returned herewith, I am directed to say that the Punjab Government (Ministry of Agriculture) agrees to your using the buildings and equipment of the Punjab Veterinary College, Lahore, for the work in question, and also to the small expenditure on drugs.

APPENDIX XXXI.

SUBJECT No. 25.

SCHEME FOR RESEARCH ON SUGARCANE IN THE MADRAS PRESIDENCY.

Attention is invited to the attached memorandum (and enclosures thereto) addressed to all members of the Sugar Committee in regard to the revised scheme for research on sugarcane in the Madras Presidency. The scheme (Enclosure IV) has received the approval of the Committee, in circulation, six members voting for and none against.

The revised scheme which involves, in so far as the Council is concerned, a total expenditure of Rs. 80,570 spread over a period of five years, is now for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**Dated the 6th July 1932.*

ENCLOSURE I.

MEMORANDUM FROM THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO ALL MEMBERS (INCLUDING CO-OPTED MEMBERS) OF THE SUGAR COMMITTEE, NO. 137/AGRI., DATED SIMLA, S. W., THE 28TH MAY 1932.

In November 1931 the Government of Madras submitted a scheme of research on sugarcane for consideration by the Sugar Committee at its fourth meeting held in December 1931. The scheme involved a total expenditure of Rs. 2,56,900, spread over a period of five years out of which the local Government promised to meet a sum of Rs. 1,06,800, leaving the balance of Rs. 1,50,100 to be met by the Imperial Council of Agricultural Research.

2. The scheme was first considered by a Sub-Committee appointed by the Sugar Committee and their recommendations were accepted by the main Committee at its meeting held on the 8th December 1931. It will be seen from its report and the proceedings of the Committee (Enclosure II) that the Committee were of opinion that the Anakapalle Sugarcane Research Station should be strengthened. They also agreed to the principle that a sub-station should be established in one of the new canal areas, but wished the suitability of Chittoor for this purpose to be further examined. The Committee rather felt that the principal justification of a grant to Madras lay in the possibility of future development and wanted the scheme to be prepared from that standpoint. At the meeting the Agricultural Expert to the Council also gave a verbal promise that either the Vice-Chairman or he would discuss technical details with the Madras authorities in due course.

3. It was subsequently ascertained from the Madras Government that the anticipated receipts from sugarcane and its products amounting to Rs. 13,906 per annum would be made available for the scheme. This would reduce the contribution from the Imperial Council of Agricultural Research from Rs. 1,50,100 to Rs. 80,570 over a period of five years.

4. The scheme was then submitted to the Advisory Board of the Council at its meeting held in January 1932 for (i) any further suggestions that it may have to offer, and (ii) its endorsement of the recommendation of the Sugar Committee. The Advisory Board decided that the scheme after revision by the Madras Government should be reconsidered by the Sugar Committee and should thereafter be referred back to the Board (Enclosure III).

5. The Agricultural Expert to the Council recently discussed the scheme personally with the Director of Agriculture, Madras, and certain amendments have now been carried out therein. The scheme as amended is enclosed (Enclosure IV). As stated above, deducting the value of anticipated receipts, viz., Rs. 69,530, the total expenditure over five years to be met by the Council comes to Rs. 80,570.

6. With reference to the point raised by the Sugar Committee regarding the suitability of Chittoor as a sub-station, the Director of Agriculture, Madras Presidency, has stated

that the chief reason for selecting Chittoor as a sub-station is that conditions are entirely dissimilar there to those at Anakapalle. The Chittoor ryot works under different conditions. Besides, Chittoor is said to be the only district in the Presidency where sugar manufacture under indigenous methods is being attempted, and it is therefore necessary to carry out the experiments there. Further, it has been suggested as a sub-station in order that it may serve the central part of the Presidency where tank water supplemented by well water will have to be used for growing sugarcane—unlike as in the Northern Circars where canal water supplemented by well water, if necessary, is available. Normally Chittoor has 7,200 acres, North Arcot 3,600 acres and South Arcot 7,000 acres of sugarcane.

7. The scheme as revised (Enclosure IV) is now submitted for the consideration of the Sugar Committee. If approved, it will be placed before the Advisory Board at its meeting to be held in July 1932.

It is requested that a reply to this memorandum may kindly be sent so as to reach the undersigned not later than the 19th June 1932.

ENCLOSURE II.

REPORT OF THE SUB-COMMITTEE ON ITEM NOS. 8, 9 AND 10 (a) OF THE AGENDA OF THE 4TH MEETING OF THE SUGAR COMMITTEE HELD AT NEW DELHI ON THE 7TH DECEMBER 1931.

The United Provinces Government have withdrawn their original proposal, Item 10 (not printed), as a comprehensive scheme has now been submitted after full consideration by the Provincial Research Committee.

Item 10 (a) part 1.—Agricultural.

Subject to the following modifications, the Sub-Committee recommend for sanction parts (a) and (b) of this scheme. The Director of Agriculture explained that the Shahjahanpur sugarcane research farm has been placed under the control of Mr. Sethi, Economic Botanist, United Provinces, who will be in charge of both rice and sugarcane research. Statistical assistance will be available from the Bureau of Economics in connection with the planning and interpretation of field experiments. The following reductions are recommended:—

- (1) Omission of the storekeeper's post.
- (2) Substitution of a clerk on Rs. 50—5—75 for a stenographer clerk.
- (3) Reduction of travelling allowances to Rs. 5,000 for the whole period of 5 years.
- (4) Reduction of provision of manures from Rs. 10,000 to Rs. 5,000.

This involves the reduction of the total grant for sections A and B to approximately Rs. 75,000 spread over 5 years.

As regards Agricultural C, physiological and chemical, the Director of Agriculture would like to reconsider the proposal for physiological work. The Sub-Committee emphasised that sub-section (c) (2) was the more important. The question of a further grant for chemical physiological work may be examined a year later.

The Sub-Committee recommend the addition to the United Provinces scheme, as now revised, of provision for an Assistant Entomologist (or a Plant Pathologist) on a scale of Rs. 200—20—300 per mensem for investigation of sugarcane pests under the direction of the Government Entomologist.

Punjab Agricultural scheme (Item 8).

The Sub-Committee are not satisfied that Lyallpur is the best centre for a sugarcane research station in the Punjab. At previous meetings of the Sugar Committee the importance of the central tract has been emphasised and they would like the question of establishing the sugarcane research station on the departmental farm at Jullundur to be re-examined.

Subject to the re-examination of the site, the scheme is recommended for sanction with the following modifications :—

- (1) *Pay of Sugarcane Specialist.*—It is considered that the scale of Rs. 250—25—500 with liberty to pay an initial salary up to Rs. 400 per mensem is adequate.
- (2) The post of Technical Chemist is unnecessary for the programme put forward and should be omitted ; also one post of Chemical Assistant.

This will reduce the expenditure on staff to about Rs. 83,220 spread over five years.

As regards the expenditure shown in statement No. 2, no special grounds have yet been shown for a departure from the Council's principle that buildings should be provided by the local Government. Provision for machinery and implements is excessive ; a sum of Rs. 6,000 would be adequate if the Station is established at Jullundur where water lifting machinery would be needed : otherwise about Rs. 2,000. The recurring grant for machinery and equipment on the manufacturing portion of the scheme should be reduced to Rs. 2,000 per annum for reasons subsequently stated. This reduces the total cost of the scheme to approximately Rs. 1,73,170 or Rs. 1,33,170 net after deducting the 40,000 offered by the Punjab Government.

(3) *Madras Agricultural scheme (Item 9).*

The Sub-Committee felt that they had not sufficient information before them to come to a definite conclusion on the financial details presented. They are agreed that the Anakapello sugarcane research station should be strengthened. They also agree to the principle that a sub-station should be established on one of the new canal areas but they would like the suitability of Chittoor for this purpose to be further examined.

II.—*Technological.*

(1) *United Provinces.*—Mr. Srivastava explained that this was an experiment in the use of hydro-electric power for sugarcane crushing and sugar manufacture and not an experiment with sugarcane crushers or in sugar-boiling. The Sub-Committee enquired why the whole cost should not be met by the Hydro-electric circle of the Irrigation Department ; it was explained that this would lead to indefinite delay and that the main object of the present scheme was the utilisation of electric current for agricultural purposes. The Sub-Committee recommend that the grant be sanctioned on the condition that the United Provinces Government will undertake to purchase the machinery at 75 per cent. of its cost at the end of the first year. The Sub-Committee desire to emphasise that as the object of the experiment is to ascertain the relative cost of electric motors and oil-engines for this class of agricultural operation, full electrical records should be maintained and a report made to the Council on this point at the conclusion of the experiment.

Punjab.—It is recommended that sections 6 and 7 of the proposed programme of work be omitted pending further experience, by the Sugar Technologist, of the problems now under examination has been gained. It is recommended that a grant of Rs. 10,000 spread over the 5 years be provided for the purchase and testing of equipment to enable the Punjab Agricultural Department, to co-operate with the Sugar Technologist and to take advantage of his results and test their applicability to local conditions in the Punjab.

In connection with this report Chowdhry Mukhtar Singh enquired if there was any co-ordination between the research schemes of the various provinces to which Mr. Burt replied that all these schemes were the result of our previous decision to have a chain of research stations in the main sugarcane belt. Rao Bahadur Venkataraman, referred particularly to the United Provinces scheme and the reference therein about Mr. Howards' book and the Indian Sugar Committee's report. He said that in the light of world experience it was not essential that the breeding and the crossing work should be done in the area for which the sugarcane variety was needed, and in support of this he quoted the instance of canes bred in Demerara which were being used in Louisiana and also of cane bred in Java (P. O. J. 213) which was grown in Louisiana and Argentina. Similarly, the canes grown in Japan had been obtained from Java. There was no ground for the view that the actual production of crosses should be effected in the areas where they were to be grown. He added that Coimbatore crossed seeds were being sent to

Hawaii and Australia and the United Provinces in India were nearer to Coimbatore than either Hawaii or Australia. Mr. Noel Deerr endorsed this and said that he agreed with R. B. Venkataraman in every particular. R. B. Venkataraman also mentioned for the information of the Committee that he had been successful at Karnal in getting sugarcane seeds to germinate in sub-tropical India and added that, with proper technique, proper supervision and sowing at the proper time, it was quite possible to get sugarcane seed to germinate in Upper India. This made practically redundant the scheme which had already been sanctioned for Shahjahanpur to transport seedlings at a cost of Rs. 6,000. The 3rd point he mentioned was that he was now investigating the different times of sowing for Sorghum hybrids and the Shahjahanpur scheme will be very useful to him.

In connection with the Punjab scheme Mr. Burt explained that the question of site was very important. The Sugar Committee had all along been of opinion that the sugarcane research station should be located in the Central Punjab. R. B. Venkataraman said in this connection that in Lyallpur cotton was a competitive crop with sugarcane and the area under sugarcane fluctuated very considerably from year to year in that tract depending upon the price of cotton. It was important therefore that our research station should be established in a tract where the area under cane was steady.

As regards Madras, Mr. Burt explained that the Madras Government had now revised their former opinion that there was no scope for the expansion of sugarcane cultivation in that Presidency and the present proposal of the Madras Government was based on that view. The Sub-Committee approved of the expansion of the Anakapalle research station and of the provision of a sub-station but desired the question of site of the latter to be more fully examined. The scheme was complete on the financial side but lacking in technical details.

In connection with the technical side of the Punjab scheme, Mr. Burt explained and the Committee agreed that they should wait till Mr. Srivastava's work progressed a little further, it was on this account that Sub-Committee had reduced the proposed annual grant of Rs. 10,000 for sugar machinery a year to Rs. 2,000 per annum.

Mr. Burt referred to page 4 of the printed papers in connection with item 10(a) and said that in view of the discussion on subject 4 it would seem sufficient to place on record that the agency for carrying out the investigation in connection with the cost of sugarcane cultivation should be the Board of Economic Enquiry in the United Provinces and attached Bureau. This was approved.

ENCLOSURE III.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD AT NEW DELHI ON WEDNESDAY, THE 27TH JANUARY 1932.

* * * * *

ITEM No. 16(A).—*Scheme of research on sugarcane in the Madras Presidency. Scheme submitted by the Madras Agricultural Department.*

Rao Bahadur Ananda Rao introduced the scheme. He considered that necessary details were contained in the scheme and he was therefore not clear as to why it had been referred back by the Sugar Committee. Mr. Mehta intervening stated that the Sub-Committee appointed by the Sugar Committee for considering the Sugar schemes was unable to follow the details of the Madras scheme and had therefore decided that further details should be obtained from the Madras Government and a revised scheme placed before the Committee. The Chairman added that it was suggested in the Sugar Committee that the Vice-Chairman or the Agricultural Expert should meet representatives of the Madras Government and explain to them the lines on which the scheme should be re-drafted.

Professor Gangulee stated that the Sub-Committee's report was not sufficiently precise in stating that "they had not sufficient information before them to come to a definite conclusion on the financial details presented". He considered that the Madras scheme was as good or as bad as the United Provinces and Punjab schemes. Dr. Coleman supported

Professor Gangulee. Professor Gangulee also added that referring to the list of grants given to the various provinces, it was observed that Madras had received inadequate consideration from the Council.

Professor Agharkar suggested that the technical side of the scheme should be amalgamated with the Sugar Technologist's scheme. He also pointed out that according to the Madras scheme, the Madras Government were going to hand over Rs. 14,000 annually to the Research Council, whereas the Government of the United Provinces were not willing to supply cane free of charge from the Shahjahanpur farm.

Dr. Subramanyam pointed out that provision had been made in the scheme for residential buildings, which was contrary to the principle followed by the Council in giving grants. The Chairman explained that when the financial details of the scheme were examined all such items will be scrutinized. Dr. Coleman recommended that the scheme be sent back to the Madras Government for revision and that it should then be placed before the Sugar Committee, after which it should be referred back to the Advisory Board. He particularly desired the Sugar Committee to be informed that their attitude towards this scheme was to be deprecated as the scheme was considered to be as good as the other two provincial schemes. Professor Gangulee moved and Mr. Plymmer seconded that "the Board supports the Madras scheme subject to financial and technical details being presented to the Sugar Committee and that it may be referred to the Governing Body". The resolution was rejected by the Board which decided unanimously that the scheme after revision by the Madras Government should be re-considered by the Sugar Committee and should thereafter be referred back to this Board.

ENCLOSURE IV.

COPY OF A LETTER FROM THE SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 1342-III/31-7, DATED THE 11TH NOVEMBER 1931.

Scheme of research on Sugarcane.

With reference to Mr. Hydari's letter No. 956-Agr., dated the 2nd May 1931 (not printed), I am directed to enclose a Scheme of Research on Sugarcane submitted by the Director of Agriculture, Madras. I am to commend it for the consideration of the Imperial Council of Agricultural Research. It will be observed from the Director of Agriculture's report that the scheme costs Rs. 2,56,900 out of which Rs. 1,06,800 may be accepted as contribution by this Government.

Scheme of the Director of Agriculture.

I have the honour to state that the Government in their letter No. 1153, dated the 9th of July 1929 (not printed) to the Government of India said that "this Government consider that the needs of the Presidency are now adequately provided for as the Imperial Sugarcane breeding station at Coimbatore has been extended to deal with thick canes and a sugarcane testing station has been established at Anakapalle in charge of a gazetted officer where considerable progress has already been made with local problems." Since that statement was made, there has been a happy change in the policy of Government as exemplified in their support for an economic enquiry into the cost of sugarcane cultivation in the Madras Presidency [*vide* No. 158-Ms., dated the 5th February 1931 (not printed)]. The reason for this change was mainly due to having realised the futility of raising paddy in extensive areas with prices at such a low ebb. A change in the local practice was found essential to meet the new situation, and sugarcane offered an excellent substitute giving more handsome returns. In fact, it is a happy augury of the future that the Irrigation Development Board has under its consideration the advisability of utilising the Lower Bhavani irrigation project in the Coimbatore district for the irrigation of dry crops rather than for paddy as had been the policy all along. In these changing circumstances sugarcane will undoubtedly play an important role. However, in view of the financial depression and other causes, there is no likelihood of this and other irrigation schemes of this nature materialising for another ten years. Besides, sugarcane is an important cash crop of the Presidency. It takes a prominent place both in acreage and yield among the main sugar-

cane producing provinces of the country. While several crops have their specialists, sugarcane despite its importance, has had to get on without one due to financial depression.

2. The area under cane in the Presidency during the last decade has had a chequered career. There is no doubt that during the last few years it has gone down as shown below.—

Year.	Acres.
1920-21	103,823
1921-22	119,313
1922-23	131,095
1923-24	121,298
1924-25	110,360
1925-26	112,821
1926-27	114,495
1927-28	105,950
1928-29	89,075
1929-30	98,107

Apart from economic causes which would affect a world crop like sugarcane there are other causes contributing to the restriction in area. Want of initial capital, high cost of production, limitations with regard to soil and water-supply, low prices are some of them. Poor quality canes: periodical visitations of insect pests and diseases, narrow rotations, uneconomic cultural methods, wasteful irrigational practices, crude methods in the manufacture of jaggery and their quota.

3. Although Agricultural Research Station, Anakapalle, has been recognised as the sugarcane research station of the Presidency, research work has not been confined to sugarcane alone: similar work on paddy and ragi has been going on simultaneously. Progress in fundamental and agronomic research has been tangible, but it has been confined to local problems. Besides Anakapalle represents only the district of Vizagapatam with 35,000 acres under sugarcane—the largest in the Presidency. The Central districts in the presidency numbering more than half a dozen, grow sugarcane on about 30,000 acres largely with the help of lift irrigation. This represents over 25 per cent. of the area under sugarcane in the presidency.

4. I, therefore, venture to put forward a scheme of research which would give rapid results during the period of five years to solve some of the problems mentioned above.

Nearly four-fifths of the irrigated area in the Presidency is under flow irrigation; but the needs of the farmer engaged in lift irrigation, situated as he is under most adverse circumstances labouring hard at the mhote or picotah and irrigating but a few cents a day a high cost, have to be considered at the same time. It is, therefore, proposed to have two stations, a larger one to represent flow irrigation and a smaller one for tracts under lift irrigation.

5. Improvement in the economics of the sugarcane cultivator may be effected either by increasing the yields or by reducing the cost of cultivation or by both. The problem to be investigated come under three distinct heads:—

1.—Increase in the yield of sugarcane.

By (a) Varietal test. These will be laid down not only at the Anakapalle and Chittoor Stations but also at the Central farm, Coimbatore, where sugarcane is raised in rotation with paddy. The tests will include thick and medium canes not being grown at the Imperial Cane-breeding Station.

(b) Vigorous seed material obtained by short crop planting. A large measure of success has already been achieved in one or two varieties at the Agricultural Research Station, Anakapalle but this needs augmentation and duplication in tracts different in climatic and soil conditions like the Chittoor district.

- (c) Spacing methods in relation to varieties and source of irrigation, methods in planting, cultural methods, etc.
- (d) Manurial methods. Sufficient information in the manuring of sugarcane has already been gained and therefore no investigation in this direction is proposed except in so far as it affects items 2(a) and 3(a) below.

2.—Reduction in cost of production.

- By (a) A reduction in the manure bill. The investigation aims at finding out the possibility of cutting down the cost of manuring the bulk crop by judiciously manuring the crop intended for seed material. Experiments in plant nutrition have revealed that plants absorb large quantities of nutrients in their very young stages and plants with a good start are better able to withstand adverse conditions in later life. Therefore, seedlings or seed material raised under well manured conditions should, according to this observation, do better after transplanting or sowing than those raised under unmanured or insufficiently manured conditions. Experiments carried out at Coimbatore and Anakapalle have already indicated that this is the case. Further experimental proof is necessary and if this is obtained, we should be giving a distinct stimulus to cane cultivation by considerably reducing the cost under manure.
- (b) A reduction in the cost of irrigation. During the growth of the crop, sugarcane receives a large number of irrigations; in localities under lift irrigation, the area under sugarcane is mainly limited by the amount of irrigation water available. In seasons of deficient rainfall, the area becomes considerably reduced.

Experiments at the Agricultural Research Station, Anakapalle, have revealed that Co. 213 can be grown successfully under the normal rainfall conditions supplemented by about 4 acre-inches of irrigation at the time of planting. If this experiment could be successfully repeated at this place with other varieties; and in localities where irrigation is costly, it will be little short of a revolution in the irrigational practices of the country. This would also tend to increase the area of sugarcane in the Presidency.

- (c) A reduction in the cost of methods in wrapping and propping. On account of cyclonic storms the Province is subject, the practice of wrapping and propping cane is almost universal, entailing a large amount of outlay. The methods employed are capable of improvement in efficiency and of reduction in cost. An investigation into the methods of planting and spacing may even result in the elimination of the operation.
- (d) A reduction in cost of cultural and planting methods. The indigenous practices are laborious, slow and wasteful. Introduction of labour-saving machinery and more efficient methods in planting are indicated.

3.—Improvement in the manufacture of jaggery.

- By (a) An improvement in the colour and keeping qualities of jaggery. The loss of the cultivator consequent on defects in these, our ignorance of the chemistry of jaggery manufacture, and the fact that this aspect has so far remained unexplored by other workers made an investigation into this subject imperative. The enquiry will be to ascertain the factors that affect the colour and keeping quality of jaggery and the effect of manures on its quality. Although a beginning is being made in this investigation at the Agricultural Research Station, Anakapalle, for a thorough and a large scale investigation that this important problem warrants, the laboratory and equipment need immediate extension.
- (b) An improvement in the Mechanical methods employed in the manufacture of jaggery and brown sugar. The manufacture of white sugar suited to ryots conditions is in an undeveloped state practically throughout the country. With the collaboration of the Department of Industries, it is also proposed

to explore the possibility of introducing centrifugal machines so largely employed in the United Provinces.

It will be observed that problems proposed to be tackled are in the main of inter-provincial importance and it is hoped that investigations proposed here will profit also the ryots of other Provinces.

6. Estimates heréin attached are self-explanatory. The object being to make use of materials and resources available at Anakapalle, provision is made there only for bare necessities in equipment. The land proposed for the sub-station will be taken on lease. All buildings proposed for erection will be of a temporary nature, so that at the expiry of the lease they will be worth practically nothing. The experimental area of 50 acres at the Agricultural Research Station, Anakapalle, and the 30 acres of the sub-station at Chittoor, will with a 3-year rotation give about 26 acres of cane, 20 acres of garden crops (two crops) and 35 acres of paddy. Of the staff provided, the following are available at Anakapalle for this scheme :—

(Farm Manager in Madras means an Agricultural Assistant. Superintendent means the Chief Investigation Officer.)

- 1 Superintendent,
- 2 Farm Managers,
- 1 Assistant Farm Manager,
- 1 Chemistry Assistant,
- 1 Laboratory Attender,
- 1 Fieldman, and
- 1 Peon.

The additional staff required is as follows :—

		<i>Anakapalle.</i>				Rs.
1	Farm Manager on .. .. .	..	..	..	..	120—10—170
1	Assistant in Botany on .. .. .	..	..	..	..	85—5—120
1	Field man on .. .. .	..	..	..	..	35—50
		<i>Chittoor.</i>				
1	Farm Manager on .. .. .	..	..	..	..	120—10—170
1	Farm Manager on .. .. .	..	..	..	..	85—5—120
1	Assistant in Botany .. .. .	..	..	..	..	85—5—120
2	Fieldmen on .. .. .	..	..	..	..	35—50
1	Clerk on .. .. .	..	..	..	..	60—4—80
1	Peon on .. .. .	..	..	..	..	12—18

7. The total expenditure of the scheme for 5 years comes to Rs. 2,56,900 of which the contribution of the Government of Madras is as follows :—

		Rs.
Staff .. .. .	.. .. .	56,000
Working Expenses .. .. .	.. .. .	50,800
		1,06,800

8. The following will be the annual receipts from the two stations:—

	Rs.
1. Jaggery from 26 acres at 8,000 lbs. per acre (208,000 lbs. at 15 lb. per rupee)	13,866
2. Paddy from 35 acres yielding 2,500 lbs. per acre (87,500 lbs. at 45 lbs. per rupee)	1,944
3. Garden produce from 40 acres at Rs. 100 per acre	4,000
4. Cane setts, etc.	40
Total	19,850

Proposed Sugarcane Research Stations.

Land required—

Sub-station at Chittoor under irrigated dry conditions	30 acres.
Spare for buildings, sheds, furnace, etc.	3 acres.
	33 acres.

The lease value will be:—

	Rs.
30 acres garden land at Rs. 75 an acre	2,250
3 acres dry land at Rs. 16 per acre or roughly	50
	2,300

Lay out, road, fence, etc.—

	Rs.
Lay out of plots at Chittoor	600
Fencing with barbed wire, 5 strands with angle iron posts inclusive of iron posts, corner posts, gates—2,500 yards at Rupee one a yard	2,500
Wire netting for 10 acres of sugarcane against jackal attack	600
	3,700

*Buildings.—Residential.—Katcha buildings to last for about 5—7 years.
At Chittoor.*

	Rs.
One Manager	3,000
One Assistant Manager	2,000
One fieldman	1,000
Four cooly huts	400
	6,400

Non-residential—

	Rs.
Office room and store 48' × 15' with 8' Verandah in front. Brick in mud with concrete flooring and galvanised iron roofing protected with matting for the office alone at Rs. 1-8-0 a sq. ft.	1,350
Cattle shed for 5 pairs with a feed-room, brick in mud walls, earth flooring and thatched shed 50' × 10', 500 sq. ft. at 0-12-0 a sq. ft.	375
Cart stand and implement shed (thatched) 24' × 15', 12' × 15' 540 sq. ft. at 0-12-0 per sq. foot	405
Drying and threshing floors	150
Furnaces and shed	150
Water meters	500
Water troughs, feed trough, etc.	100
Rain gauge	50
Anemometer and Thermohygraph, etc.	1,000
Miscellaneous	120
	4,200
Total buildings for Chittoor	10,600

Equipment.	Anakapalli. Chittoor.	
	Rs.	Rs.
Live-stock 5 pairs at Rs. 350 each .. .. .	..	1,750
Dead stock—6 cane mills (2 for Anakapalle)	300	600
Jaggery pans, moulds, etc.	300	200
Bins, receptacles, etc. .. .. .	..	200
Two oil engines .. .. .	..	4,000
Chains, ropes, etc. .. .. .	..	150
Field labels .. .. .	..	30
Two carts .. .. .	..	240
Farms tools, crow bars, etc. .. .. .	..	150
Ploughs and field implements .. .. .	..	200
Laboratory materials for chemical and botanical equipment	2,300	1,700
Thermohygraph and other meteorological instruments	1,000	..
Miscellaneous items like reference books, etc.	400	480
	4,300	9,700

Furniture—Chittoor :—

	Rs.
Tables 4	120
Chairs 6	30
Almirahs 2	70
Record racks, shelves, etc.	50
Clocks, coat-rack, wash stand	30
	300

STAFF.

Madras I. C. A. R. contribution.
contribution.

	Anakapalle. Chittoor.		
	Rs.	Rs.	Rs.
Superintendents, Rs. 250—25—750/425)	5,100	..	..
2 Farm Managers, Rs. 120—10—170/(140)	..	1,680	1,680
1 Farm Manager, Rs. 85—5—120/(120) ..	1,440	..	..
1 Farm Manager, Rs. 85—5—120/(120) ..	1,440	..	..
1 Farm Manager, Rs. 85—5—120/(95) ..	..	..	1,140
1 Assistant Farm Manager, Rs. 45—3—75/ (73)	876	..	..
2 Botany Assistants, Rs. 85—5—120/(95)	..	1,140	1,140
1 Chemistry Assistant, Rs. 85—5—120/ (117)	1,404	..	..
1 Fieldman, Rs. 35—50/(41)	492	..	..
3 Fieldmen, Rs. 35—50/(38) .. .. .	..	456	912
1 Clerk, Rs. 60—4—80/(68) .. .. .	..	..	816
1 Laboratory Attendant, Rs. 25—1—35/(27)	324	..	..
1 Peon, Rs. 12—18/(12)	144	..	144
	11,220	3,276	5,832
	or 11,200	or 3,300	or 5,800
		9,108	or 9,100

ABSTRACT.

Particulars.	I year.			II year.			III year.			IV year.			V year.		
	Madras contribution Anaka-palle.	I. C. A. R. contribution.		Madras contribution Anaka-palle.	I. C. A. R. contribution.		Madras contribution Anaka-palle.	I. C. A. R. contribution.		Madras contribution, Anaka-palle.	I. C. A. R. contribution.		Madras contribution, Anaka-palle.	I. C. A. R. contribution.	
		Anaka-palle.	Chittoor.		Anaka-palle.	Chittoor.		Anaka-palle.	Chittoor.		Anaka-palle.	Chittoor.		Anaka-palle.	Chittoor.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1. Lay out .. ..	..	..	3,700	..	..	..	..	..	..	..	..	..	..	..	..
2. Buildings .. ..	..	..	10,600	..	..	..	..	..	..	..	..	..	..	..	..
3. Equipment .. ..	..	4,300	9,700	..	..	..	..	..	..	..	..	..	..	..	..
4. Furniture .. ..	..	..	300	..	..	..	..	..	..	..	..	..	..	..	..
5. Working Expenses ..	11,400	..	16,100	9,600	..	11,000	9,900	..	12,900	10,000	..	13,000	9,900	..	13,000
6. Staff	11,200	3,300	5,800	11,200	3,300	5,800	11,200	3,300	5,800	11,200	3,300	5,800	11,200	3,300	5,800
7. Travelling Allowance ..	..	1,500	..	..	1,500	..	..	1,500	..	..	1,500	..	..	1,500	..
8. Contingencies .. ..	..	500	..	..	500	..	..	500	..	..	500	..	..	500	..
	22,600	9,600	46,200	20,800	5,300	16,800	21,100	5,300	18,700	21,200	5,300	18,800	21,100	5,300	18,800
Total	22,600	55,800		20,800	22,100		21,100	24,000		21,200	24,100		21,100	24,100	
GRAND TOTAL	2,56,800														

APPENDIX XXXII.

SUBJECT No. 26.

- (A) SCHEME FOR THE ESTABLISHMENT OF A SUGARCANE RESEARCH STATION IN THE PUNJAB.
- (B) APPLICATION FROM THE GOVERNMENT OF THE UNITED PROVINCES FOR A GRANT FOR INVESTIGATION INTO VARIOUS PROBLEMS OF SUGAR INDUSTRY IN THE UNITED PROVINCES.
- (C) SCHEME FOR A RESEARCH AND TESTING STATION FOR THE INDIGENOUS SYSTEM OF GUR AND SUGAR MANUFACTURE, DRAWN UP BY THE SUGAR TECHNOLOGIST, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Attention is invited to the attached memorandum (and Enclosures I—X thereto) addressed to all members of the Sugar Committee, No. 1551-A., dated the 23rd June 1932 in regard to the three schemes mentioned above. The schemes have received the approval of a majority of the Sugar Committee, in circulation.

2. Certain members of the Committee have made critical remarks on the schemes. Copies of their letters will be found in Enclosure XI.

The schemes are now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 13th July 1932.

No. 1551-A.

IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, S. W., THE 23RD JUNE 1932.

Memorandum.

At its fourth meeting held in December 1931 the Sugar Committee considered and recommended the following three schemes subject to certain modifications and conditions:—

- (i) Scheme for the establishment of a Sugarcane research station in the Punjab (Enclosure I)—

Grant applied for—Rs. 16,450 non-recurring and
Rs. 2,38,120 recurring during 5 years.

		Rs.
	Total ..	2,55,000
Grant recommended by Sugar Committee—		
		Rs.
Non-recurring		9,650
Recurring in 5 years less Rs. 40,000 to be provided by the Punjab Government		1,63,320
	Total 5 years ..	1,32,970

(ii) Application from the United Provinces Government for a grant for investigation into the problem of sugar industry in the United Provinces (Enclosure II)—

					Rs.
Grant applied for—					
Non-recurring	..	..	..	..	31,930
5 years recurring	..	..	..	..	1,44,880
Total					1,76,810
					Rs.
Grant recommended—					
Non-recurring	..	..	..	..	23,000
5 years recurring	..	..	..	..	94,820
Total 5 years					1,17,820

(iii) Scheme for a Research and Testing Station for the indigenous system of gur and sugar manufacture (Enclosure III)—

					Rs.
Capital expenditure	..	..	..	..	76,000
Recurring expenditure, 5 years	..	..	..	..	91,380
Total					1,67,380

All the three schemes were then placed before the Advisory Board at its meeting held in January 1932. The Board, however, decided that they should be referred back to the Sugar Committee for consideration with special reference to the definition of problems and allotment of work (Enclosure VIII).

2. From the attached extracts from the proceedings of the Advisory Board (Enclosure VIII) it will be seen that the Board, when considering these schemes, gave insufficient attention to the following three very important considerations, *viz.*—

- (i) In administering the special grant of Rs. 10 lakhs for developing the sugar industry the Council should not meticulously enforce some of the considerations which apply to general research schemes;
- (ii) The Imperial Council has already endorsed the policy of the Sugar Committee that a chain of sugarcane research stations should be established throughout the sugarcane belt;
- (iii) Unlike other crops, the greater part of the sugarcane area in India is contained in a definite sugarcane belt stretching from Bengal in the south-east to the central Punjab in the north-west. This belt includes over 2,400,000 acres out of the total Indian sugarcane area of 2,800,000 acres.

3. With reference to the considerations mentioned in the preceding paragraph, it may be explained that the Governing Body at its second meeting accepted the principle that there must be more latitude in the administration of the special grant made by the Government of India for the encouragement of the sugar industry than in regard to other research schemes. Practically all the work on sugarcane in India, except the production of seedling

canes at Coimbatore (and the associated research work at that centre), has been done by provincial governments and it was no doubt the intention of the Government of India that the special grant for sugar should be used to supplement efforts in the best possible way.

The Sugar Committee's general scheme for a chain of sugarcane research stations throughout the main sugarcane belt included one in North Bihar, one in Gorakhpur, the existing provincial station at Shahjahanpur, a station in Meerut, the sub-station (of Coimbatore) at Karnal and the Punjab Station which the Committee recommended should be somewhere in the Central Punjab. The extreme limit was provided by the existing Punjab experimental farm at Gurdaspur.

The primary work which the Committee had in view for this chain of stations was the testing of new varieties of cane, the constant recording of the behaviour of standard varieties of cane, especially of those which have been recently established in cultivation with special reference to their behaviour towards diseases and pests and their suitability to local method of manufacture. As central factories increase, probably changes in the varieties grown will be desirable. The question of testing cannot therefore be divorced from the question of breeding in sugarcane work especially as vegetative reproduction renders unnecessary much of the selection work after a hybrid has been created which is necessary with crops reproduced from seed. Adequate and early testing is second in importance only to the production of improved seedlings. The provision of a sub-station of Coimbatore has enabled a considerable advance to be made and a further refinement of methods which will probably shorten the interval between the production of a batch of seedlings and the introduction of the best in the cultivation. But the need for systematic testing is as great as ever and in the opinion of the Vice-Chairman of the Council the Sugar Committee, far from recommending unrelated schemes, has always taken care to recommend only those which form part of a carefully co-ordinated whole.

The study of cultural methods and manurial requirements, etc., was included in the work of these research stations, because it is not possible to separate these aspects of the problems from the varietal question. Both the manure and water supply must be taken into consideration in deciding on a new variety for introduction.

4. The Punjab scheme (Enclosure I) would appear to fit in well with the Sugar Committee's general scheme for a chain of research stations explained above. Only in regard to its site was there any difficulty and this question the Sugar Committee recommended to be referred back for further examination by the Local Government and the Provincial Department of Agriculture. The proposed agricultural work is quite definite and there is need for such work as part of the Sugar Committee's general scheme. There has been some misunderstanding over the technological proposals as the criticism in the Advisory Board (Enclosure VIII) seems to have been directed less against the Sugar Committee's recommendations than against a portion of the scheme which they did *not* recommend. The original proposals in this respect were rejected by the Sugar Committee and found no support in the Advisory Board. The Sugar Committee recommended a grant of Rs. 10,000 spread over five years (average 2,000 per annum) to enable the Punjab Agricultural Department to co-operate with the Council's Sugar Technologist, whose actual experimental work will be done in the United Provinces and test the applicability of his results to Punjab conditions. That conditions do vary is undoubted and this was put forward as a definite proposal for making the Sugar Technologist's work better available to the Punjab.

In the circumstances the Chairman of the Committee suggests that the Sugar Committee might emphasise the points mentioned above and recommend the grant again.

5. As regards the scheme for investigation into the problem of sugar industry in the United Provinces (Enclosure II), the position was explained to the Local Government in considerable detail (Enclosure IX) so that they may, if necessary, suitably revise the scheme and forward it in time for consideration by the Advisory Board at its forthcoming meeting. It will be seen that special emphasis was laid on the lack of apparent connection between Mr. Clarke's original proposals (not printed) and the scheme (Enclosure II) under consideration and the Local Government were asked to furnish certain particulars for the information of the Committee and the Advisory Board. The Government of the

United Provinces have now explained the position in their letter No. 180-A., dated the 23rd May 1932 (Enclosure X) and have forwarded a revised scheme which is self explanatory. It may however be observed that the proposals under "Section III—Economic" have been merged in the Council's general scheme for an investigation into the cost of production of crops in the principal cotton and sugarcane tracts in India. Omitting the cost on account of this section which is Rs. 16,960 spread over two years, the net cost as at present estimated would be Rs. 33,930 on account of non-recurring expenditure and Rs. 1,32,700 on account of recurring expenditure. If the United Provinces Government purchase the machinery provided for under Item II-Technical, as recommended by the Sugar Committee the net amount asked for from the Council will be Rs. 1,53,880 spread over a period of five years as against the sum of Rs. 1,05,070 originally recommended by the Sugar Committee (Enclosure VI). If the Committee has no objection the Vice-Chairman recommends that the revised scheme may be supported subject to the condition that the financial details should be scrutinised by the Vice-Chairman before sanction is accorded.

6. The scheme of the Sugar Technologist for a Research and Testing Station for the indigenous system of Gur and Sugar manufacture (Enclosure III) was generally supported by the Advisory Board but the criticism turned almost entirely on the question of site and working details. The remarks of the Board were communicated to the United Provinces Government (*vide* paragraphs 7 and 8 of Enclosure IX) and their reply will be found in paragraphs 9 and 10 of Enclosure X. In the circumstances, therefore, the Committee will perhaps be inclined to support the scheme again subject to the original condition that the budget details should be scrutinised by the Vice-Chairman.

7. As the next meeting of the Advisory Board had been fixed for the 18th to the 22nd July 1932 the views of members of the Sugar Committee are now sought by circulation on the three schemes mentioned with special reference to the definition of problems and allotment of work.

It is requested that a reply may kindly be sent, so as to reach the undersigned as soon as possible and in any case not later than the 12th July 1932.

CHARAN DAS,
Secretary.

All members of the Sugar Committee (including co-opted members).

ENCLOSURE I.

COPY OF A LETTER FROM THE SECRETARY TO GOVERNMENT, PUNJAB, REVENUE DEPARTMENT TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCHI HOUSE, SIMLA, S. W., No. 978-D.-(S), DATED THE 1ST AUGUST 1931.

SUBJECT.—*Scheme for the establishment of a Sugarcane Research Station in the Punjab.*

With reference to your letter No. 956/Agri.,* dated the 2nd May 1931, I am directed to forward for consideration by the Council and the Sugar Committee at its forthcoming meeting during the winter of 1931-32, a scheme (Annexure) for the establishment of a Sugarcane Research Station in the Punjab which has obtained the approval of the Punjab Council of Research and of the Punjab Government. Its details are contained in the not attached, 100 copies of which are being sent to you under separate cover.

2. On consideration of the scheme the Punjab Government have decided that they will not ask for a grant to cover either the value of the 100 acres of land which is being set aside for the station and which is valued at Rs. 70,000 or that of the part time services of their experts and of the use of the buildings and laboratories. It will be observed in the foot note to the scheme that the sub-committee of the Punjab Council of Research has suggested that the income derived from the sale of crops, etc., and estimated to amount to about Rs. 12,000 per annum should be credited against the expenditure on the scheme. This proposal clashes with this Government's financial procedure regarding appropriations-in-aid and cannot therefore be accepted. Based on present day prices, moreover:

* Not printed.

the income is not likely to exceed Rs. 8,000 a year. This Government therefore propose to credit the proceeds to their own revenues and in return will contribute an annual grant of Rs. 8,000 towards the scheme. Hence the grant for which the assistance of the Imperial Council of Agricultural Research is now asked is Rs. 2,15,000 round (Rs. 16,450 non-recurring and Rs. 1,98,120 recurring over a period of 5 years).

3. There may possibly be some small saving on the establishment to be employed *vide* statement No. 1, appended to the scheme, but as the decision of this Government on the pay of new entrants to Government service has not been reached the present sanctioned scales have been retained in the scheme.

ANNEXURE.

SCHEME FOR THE ESTABLISHMENT OF A SUGARCANE RESEARCH STATION IN THE PUNJAB.

As a sugarcane growing Province the Punjab ranks second in importance in India. Upwards of half a million acres of sugarcane, representing over 15 per cent. of the total cane crop of India are grown annually. Owing to the prevailing low prices of wheat and cotton little money is to be made at present out of these crops by the cultivator, and it becomes more than ever necessary to stimulate the growing of higher yielding varieties of sugarcane which is now one of the cultivator's principle money-making crops.

Again, with the erection of sugar factories in the Province the manufacture of white sugar has now become a matter of practical interest to the Punjabi. This step forward increases the necessity of paying more attention to the sugarcane crop with a view to replacing by higher yielding varieties of cane the local varieties, still grown on a large scale, to the introduction in particular tracts of those new varieties most suitable for them and to the control of insect pests and fungal diseases to which this crop is subject.

The climate of the Punjab is not suitable for cane-breeding work, and it is necessary to continue to introduce and to test new seeding canes from Coimbatore or elsewhere. During the past few years certain Coimbatore varieties have been introduced into the Province. As a result of their high yielding capacities an area of about 80,000 acres was grown under these improved varieties during the past year. For the benefit of the cultivator it is essential not only to press on with the replacement by these varieties of the indigenous canes, which still form the bulk of the sugarcane crop, but to redouble our efforts to make available to him, after thorough trial, further new varieties still better than those hitherto introduced. This work is being done gradually on several of our Departmental Experimental Stations. But on all these farms the work has to take its place in competition with, and alongside, investigations on all the other crops of the locality. To get the best results and to obtain them most quickly it is desirable to have a separate sugarcane research scheme, under which investigations can be intensified and many more varieties can be tried.

The sugarcane growing tracts in the Punjab may be divided into four broad areas :—

- (i) The sub-montane tract including the districts of Gurdaspur, Hoshiarpur and Sialkot.
- (ii) The tract of the South-Eastern Punjab, which includes the district of Rohtak and Karnal.
- (iii) The Central Districts including Ludhiana, Jullundur, Amritsar, Lahore and Gujranwala.
- (iv) The new Canal Colonies, in which Lyallpur and Sheikhupura are important sugarcane growing districts.

The attached table shows the area of cane grown in 1929 in each of the principal cane-growing districts of the Province. These areas have all been considered carefully, with a view to selecting the best possible site for the present scheme. Ultimately the choice centred round Gurdaspur, Karnal, Jullundur and Lyallpur. Hitherto Gurdaspur has been the main Departmental sugarcane-growing farm. Experience, however, over a number of years has proved that it is not an ideal station for sugarcane work, in that the locality is subject to frosts which at times cause severe damage to the cane crop. The

Coimbatore varieties of sugarcane which have been introduced there are very late in ripening. Probably the period of growth is unduly prolonged by autumn rains. It is, therefore, felt that the present scheme should be carried out elsewhere.

At Karnal the area of land at the disposal of the Department is small and the water supply poor, so much so that at most not more than 3 or 4 acres of irrigated sugarcane can be grown annually on the existing farm. Further, it is understood that the Government of India intend to develop sugarcane work at their own farm at Karnal.

Jullundur suffers from two disadvantages, in that the area of land possessed by the Agricultural Department is small and the water supply from wells is very inadequate.

When Government considered the scheme for a sugarcane Research Station some time ago, the Department was informed that the scheme must be made to fit one or more of the existing Departmental Farms. In view of the considerations given above in connection with Gurdaspur, Karnal and Jullundur, this decision brings the choice down ultimately to Lyallpur.

As a sugarcane growing District, Lyallpur grows from 30 to 50 thousand acres of cane annually. This area represents about 10 per cent. of the sugarcane crop in the Punjab, and, as a District Lyallpur ranks third in importance from the sugarcane-growing aspect. The Agricultural Department has at Risalewala, just outside Lyallpur a farm of some 1,100 acres, of which 220 acres are devoted to the Cotton Research Scheme financed by the Indian Central Cotton Committee. A further 300 acres have been earmarked for the Research Scheme on Water Requirements of Crops now before the Imperial Council of Agricultural Research. It is proposed now to utilize another 100 acres of this farm for the Sugarcane Research Scheme.

The present layout of the Risalewala Farm provides for a four years' rotation whereby crops can be grown in blocks. This layout is suitable for the present scheme and no additional expenditure would be incurred in this connection. There would thus be 25 acres under sugarcane experiments annually. The land is canal irrigated, but to permit of growing sugarcane to the above intensity, an additional supply of canal water for these 100 acres will be required, the addition being probably of the nature of 50 per cent. more than the present supply.

Whilst it is proposed that the main research work under this scheme should be carried out at the Risalewala Farm, it is intended that the present facilities to whatever extent available on other farms at Gurdaspur, Jullundur and Karnal will be utilised for work subsidiary to that done at Lyallpur; this subsidiary work being carried on in the ordinary course of experiments with the sugarcane crop on these farms and being financed from the ordinary farm budgets.

The work which it is proposed to carry out under this scheme includes the following:—

- (1) The growing and testing of new seedling canes obtained from Coimbatore or elsewhere.
- (2) Investigations into cultural methods, the economies of artificial fertilizers and the water requirements of the crop.
- (3) Chemical analysis of the various varieties grown, together with the study of varying sucrose content with age, etc., with a view to possible variation of maturing time so as to make possible the availability of the crop at maximum sucrose content through an extended crushing season.
- (4) Investigations into methods of prevention and the control of entomological and mycological diseases of the sugarcane crop.
- (5) Investigations from an economic standpoint of the present sugar market as to local eating consumption, refiners requirements, and possible export markets to ascertain if possible whether gur, crude sugar as used by the home refiner, or concentrated syrup can most profitably be the primary product to be made by the sugarcane producer.

- (6) Based on the results of No. (5), investigations leading to improved gur production by the introduction of better furnaces, evaporative equipment, and production methods.
- (7) Investigations leading to the design of suitable equipment and methods for the production of crude crystallized sugar either in the village, or in suitable centres, as a possibly more profitable primary product not only from the standpoint of consumption within the Province, but also as a possible export product.

The expenditure proposed under this scheme has been reduced in every direction where reduction was possible by making full use of such facilities as exist or can be made available. Thus, it is not proposed to erect any buildings, but to utilize after repair such katcha quarters and buildings as are available at the Risalewala Farm, together with certain of the stores and other pucca buildings already provided there. Again where elsewhere a field laboratory would have been necessary for the chemical, botanical, entomological and mycological aspects of the scheme, all these problems will be dealt with in the laboratories of the Research Institute and Agricultural College, Lyallpur, with the assistance, when needed, of the University Technical Chemistry Laboratories Lahore.

In view of the importance of the scheme to the province it is proposed to place to Research Station and the work outlined above in this scheme under the charge of a sugarcane Specialist Officer, who would carry out the work under the Director and would be in a position to hand over special branches of the investigation to the control of the various Specialist Officers at present available. Thus he would have the collaboration of the Professor of Agriculture, the Agriculturist Chemist to Government, the Associate Professor of Botany, the entomologist to Government, the Mycologist being appointed at present, and other specialist officers. In addition, with reference to the manufacturing side of the investigation, the collaboration of the University Professor of Technical Chemistry, and the University Technical Chemistry Laboratories at Lahore, are available for help in this undertaking.

It is further to be pointed out that the Mycological Assistant shown in Statement I will be suitable only if the services of the qualified Mycologist who it is understood is to be appointed by the Punjab Government are available for control of this work. Should such an officer not be appointed, the services of a more highly qualified Mycologist than the Assistant described in Statement I will be required for this investigation.

The Supplementary work which will be carried out on the other farms previously referred to, will be devoted mainly to testing the applicability locally of results obtained at the Central Research Station at Risalewala. These investigations will be carried out by the Deputy Directors of Agriculture concerned, such of their staff, equipment, land and other facilities as are required, being made available.

According to the estimate attached the non-recurring expenditure on the scheme amounts to Rs. 16,450, and the recurring expenditure over a period of five years comes to Rs. 2,38,120 totalling Rs. 2,55,000 in round figures. It is proposed that the Imperial Council of Agricultural Research be requested to provide funds to the above extent over a period of five years. The Punjab Government on its part would make available the following:—

- (a) 100 acres of land valued Rs. 70,000.
- (b) The part-time services of the Professor of Agriculture; the Agricultural Chemist; the Associate Professor of Botany; the Entomologist, etc.
- (c) Buildings—some existing and some after repairs.
- (d) Laboratories and laboratory equipment, at the Research Institute, Lyallpur.
- (e) Staff; land; equipment, etc., for supplementary experiments at the Gurdaspur, Jullundur and Karnal Farms.

This scheme is not intended to diminish in any way the experimental work on sugarcane which is being carried out at present by the Punjab Agricultural Department. Its aim is to increase and expand those investigations with a view to the total replacement.

at an early date of the local indigenous canes at present grown in the Province, by the newest and highest yielding varieties of Coimbatore canes. By effecting improvements in the methods of manufacture and quality of Punjab gur it is hoped to create a demand for it on the part of local white sugar factories. Much has been done in the Punjab for the improvement of the wheat and cotton crop. The sugarcane crop of the Province, however, is still capable of very great improvement. In comparison with wheat and cotton the market rate of gur is still high. It is thus more than ever essential that everything possible should be done to help the cultivator to tide over the present difficult times by improving the crop which still leaves him a fair margin of profit.

STATEMENT No. I.

Showing details of staff required for the Sugarcane Research Station at Risalewala.

Post.	Monthly rates of pay.				
	1st year.	2nd year.	3rd year.	4th year.	5th year.
	Rs.	Rs.	Rs.	Rs.	Rs.
1. Sugarcane Specialist with special knowledge of Botany, Rs. 500—50—700.	500	550	600	650	700
2. Farm Manager, Rs. 130—10—170 ..	130	140	150	160	170
3. 1 Agricultural Assistant, Rs. 100—10—140.	100	110	120	130	140
4. 4 Mukaddams, Rs. 25—1—29 ..	100	104	108	112	116
5. 1 Store-keeper on Rs. 50	50	50	50	50	50
6. 1 Chaukidar on Rs. 14	14	14	14	14	14
7. 2 Sweepers on Rs. 13	13	13	13	13	13
'	13	13	13	13	13
8. 1 Technical Chemist, Rs. 250—20—330	250	270	290	310	330
9. 2 Chemical Assistants, Rs. 120—10—160	240	260	280	300	320
10. 1 Entomological Assistant, Rs. 120—10—160.	120	130	140	150	160
11. 1 Mycological Assistant, Rs. 120—10—160	120	130	140	150	160
12. 2 Laboratory Attendants, Rs. 20—1—24	40	42	44	46	48
Total Monthly expenditure ..	1,690	1,826	1,962	2,098	2,234
Total Yearly Expenditure	20,280	21,912	23,544	25,176	26,808
Add—pay of one Engine driver for three months.	180	180	180	180	180
Total ..	20,460	22,092	23,724	25,356	26,988
GRAND TOTAL ..			1,18,620		

STATEMENT No. 2.

Showing details of miscellaneous expenditure required for the Sugarcane Research Station at Resalewala.

	Non-recurring.	Recurring.
	Rs.	Rs.
Buildings	4,000	..
<i>Labour—</i>		
16 Beldars at Rs. 18 .. .. .	..	3,500 (round).
Variable labour .. .. .	..	2,000
<i>Purchase and maintenance of bullocks—</i>		
16 Bullocks at Rs. 200	3,200	..
Maintenance at Rs. 20 per pair per month <i>plus</i> Rs. 250 for replacements.	..	2,200
Machinery and Implements (Agricultural) ..	8,800	1,200
Machinery and equipment to be developed or purchased (manufacturing).	..	10,000
Manure .. .. .	..	1,000
Travelling Allowance .. .. .	..	2,000
Water Rates .. .. .	..	1,000
Apparatus and Chemicals	200	500
Contingencies and other charges	250	500
Total	16,450	23,900
For five years	16,450	1,19,500
Staff for five years .. .. .	..	1,18,620
GRAND TOTAL	16,450	2,38,120

NOTE.—There will be an estimated income from sales of crops, etc., amounting to some Rs. 12,000 per year. It is suggested that this might be applied towards the expense of the scheme.

Table showing the area of cane grown in 1929 in each of the principal cane growing districts of the province.

Serial No.	Name of district.	Irrigated.	Unirrigated.	Total
		Acres.	Acres.	Acres.
1	Gurdaspur	20,383	17,748	38,131
2	Sialkot	26,325	4,662	30,987
3	Lyallpur	30,941	5	30,946
4	Gujranwala	24,386	706	25,092
5	Karnal	19,955	1,903	21,858
6	Jullundur	19,469	490	19,959
7	Amritsar	15,995	1,473	17,468
8	Sheikhpura	17,005	63	17,068
9	Rohtak	15,027	246	15,273
10	Hoshiarpur	4,460	10,149	14,609
11	Ambala	4,669	7,791	12,460
12	Gujrat	10,385	413	10,798

ENCLOSURE II.

Application from the United Provinces Government for a grant of Rs. 1,76,810 (Rs. 1,44,880 recurring and Rs. 31,930 non-recurring) for investigation into the problem of improvement of sugar industry in the United Provinces.

(The scheme has been prepared, with the approval of the Provincial Agricultural Research Committee.)

India occupies one of the foremost positions in the cane-growing countries of the world and over 50 per cent. of the Indian crop is found in the United Provinces. The general facts of distribution, and the present condition of the industry, all point to the United Provinces, as being the centre of the subject, as far as the improvement of sugar-production in India is concerned. The area under cane is already considerable and sugarcane is perhaps the most important money crop cultivated. The importance of the crop is on the increase since the opening of the Sarda Canal and introduction of the improved varieties from Coimbatore; more so, when in these days of slump in prices, sugarcane is one of the very few crops which is paying to the cultivator. A most striking fact brought out by studying the statistics of the sugar industry is the extraordinary low production of sugar in India per acre compared with that of the other main cane-growing countries. The world's cane sugar output is about 14 million tons. India's production in proportion to its area should have been 7 million tons, but it is only 3.5 million tons, inclusive of this province 1.75 million tons or an eighth of the total cane sugar production of the world. The general line of advance, from an agricultural point of view, appears to lie in increasing the production of cane and of juice per unit area, at the same time reducing the cost of each ton of cane grown. This can be achieved by substituting more rapidly growing and early maturing varieties for those now grown and by introducing more intensive methods of cultivation. Such varieties are being evolved at Coimbatore, which is the chief centre of sugarcane breeding, but it is necessary that the first generation trials and subsequent acclimatization and propagation for distribution must be done in the United Provinces itself. According to Howard (Crop Production, page 129) "No effective preliminary selection of the seedlings for Northern India is however possible in South India, so that a mass of material of necessity, mainly unsuited, has to be sent to the plains for trial." The Sugar Committee of 1920 in its report, page 301, also says "the opportunities of deciding at Coimbatore what seedlings are and what seedlings are not likely to prove successful in Northern India are strictly limited, and any attempt to exceed those limits may involve the rejection of seedlings, which would on local trial have proved suitable for introduction. The behaviour of cane on the soil of the cane breeding station is not an index of its behaviour elsewhere, nor is it always possible, even granted the most intimate and scientific knowledge of the local conditions of another tract, to infer from the results at Coimbatore the prospect of a particular cane proving successful in that tract."

Some acclimatization and distribution work of Coimbatore varieties has already been done at the existing Sugarcane Research station at Shahjahanpur, but it is intended now to develop it into a first generation sub-station, where extensive trials will be carried out, and to carry out the seedlings trial at other circle farms under Deputy Directors. Besides there are many important problems—agricultural, technical and economic—the solution of which would be of considerable benefit to the field and the factory, which still remain to be tackled, will also be investigated in these provinces. A few of the important problems are as follows :—

I.—AGRICULTURAL.

(a) *Establishment of first generation sub-station.*—For extensive trials of Coimbatore seedlings at Shahjahanpur and other circle farms under the Deputy Directors such as Parbhargh, Cawnpore, Benares, Gorakhpur, Aligarh, etc.

(b) *Comparative trials of Coimbatore and local canes, and their manurial and water requirements.*—A well-thought out plan of experiments will be laid out on the lines of field experimental technique recently elaborated at Rothamstead, with a view to obtain results capable of correct statistical interpretation, and to find out the best and cheapest combination of organic and artificial manures, and the least quantity of water required by the crop. A thorough study of different times of sowing of various varieties which seems to vary in different parts of the United Provinces will also be made.

(c) *Physiological and chemical—Experimental investigation of some of the external and internal factors controlling the growth and final yield of sugarcane.*—The work under this head will be altogether different from that of a purely academic nature for physiological study of the sugarcane, and will not conflict with any of the scheme, which the Imperial Council might have already sanctioned. It may conveniently be divided into two sections :—

- (1) Researches into the relation of atmospheric and soil humidity to growth ; stomatal opening and transpiration, rate of growth will be determined weekly by rate of increase in dry weight. This aspect of subject is very interesting, because a clear knowledge of the relation of moisture to growth will be very helpful in solving the important problem of optimum water requirements of sugarcane.
- (2) A detailed study of the variations in the composition of sugarcane juice from July to March under different manurial conditions will throw light on the effect of different chemicals on the ripening processes of sugarcane. Chemical constituents of the soil may be responsible for delayed ripening of sugarcane in some districts of the United Provinces.

The present method of carrying on tests of juice in cane has not been standardized owing to which the results are not even comparative. According to Java standard the cane is to be crushed to such an extent as to give at least 72 per cent. juice on its weight either by single or repeated crushings, when the juice is to be polarized, under this condition the juices can be considered as comparative. Inside the cane there are bundles containing sugar-free water. These are harder than the sugar-bearing tubes. Therefore as the pressure is exerted the juice comes out first and water afterwards. Therefore when the canes are crushed not so much the juices are rich in sugar, but when crushed more this juice becomes diluted. Therefore it is essential to fix the condition of extracting the juice on the weight of the cane before it is analysed for its juice contents. The work has never been attempted in a scientific way nor systematized properly.

Note.—Before sending this part of the scheme to the Imperial Council of Agricultural Research for sanction, it was thought fit to get the opinion of sugar experts. A meeting was consequently convened at the Upper India Chamber of Commerce, Cawnpore, on Thursday, October 29th, at 10 A.M. and the following gentlemen were present :—

- (1) Mr. N. C. Mehta, I.C.S., Director, of Agriculture, United Provinces, *Chairman*.
- (2) Mr. J. G. Ryan, Secretary, Upper India Chamber of Commerce, Cawnpore.
- (3) Mr. Noel Deerr, Sugar Expert to Messrs. Begg, Sutherland and Company Cawnpore.
- (4) Mr. L. B. Gray, Director, Messrs. Begg, Sutherland and Company, Cawnpore.
- (5) Mr. R. C. Srivastava, Sugar Technologist, Imperial Council of Agricultural Research, Cawnpore.
- (6) Mr. R. L. Sethi, Economic Botanist to Government, United Provinces, Cawnpore.
- (7) Mr. A. R. Khan, Head of the Sugar Section of the Harcourt Butler Technological Institute, Cawnpore.

The following resolutions were passed :—

(1) In the opinion of the Committee, it is desirable that a research sub-station should be opened in these provinces, preferably at the head-quarters at Shahjahanpur, in charge of an expert officer, where experimental work should be concentrated chiefly on the cane seedlings got from Coimbatore and on the local canes of the United Provinces. The Committee, however, do not desire to exclude any experiments on plant-breeding, if the officer in charge is suitably equipped for the purpose.

(a) The Committee further recommend that the scheme should be taken up as soon as possible by the local Government, and in case there is any difficulty for financing it, the matter may be referred for help to the Imperial Council of Agricultural Research, that it is necessary for the success of the scheme that an expert officer should be posted in charge of the sugarcane farm and the laboratories at Shahjahanpur.

The Government of the United Provinces is already spending a considerable sum annually over the Shahjahanpur Research station, capital about two lakhs and annual revenue expenditure Rs. 17,000. This further work, for which a scheme is now forwarded is the natural outgrowth of the work already in progress. The local Government, being unable to spare money under the present conditions of acute financial stringency, is applying for the help of the Imperial Council of Agricultural Research in this important matter.

II.—TECHNICAL.

Introductory.—The manufacture of sugar by the indigenous methods in the United Provinces is in the hands of *khandalis* who are generally not wealthy enough to instal oil engines or electric motors and most of the crushing is done in bullock-driven mills which never give a yield of juice from the cane of over 60 per cent. and which employ all the available labour and oxen to the detriment of the preparation of fields for the ensuing sugarcane crop. Co-operative societies are developing in various villages and now that hydro-electric power is available, it would be possible to enable these societies to use electrically driven machinery for the manufacture of sugar. *Khandalis* would also profit by the use of such machinery. The margin of profit on sugar manufacture is so small that any more efficient methods would result in a large total return owing to the enormous tonnage of cane produced in the grid area.

Object of the grant.—The purpose for which the present grant is required is to instal a suitable plant in the grid area for demonstrating the advantages of the use of hydro-electric energy and for helping in the introduction of similar plants run either by business firms or by Government.

Details of the scheme.—Mr. Srivastava, the Sugar Technologist, has prepared a specification (Annexure I) for a plant for making sugar or *gur* by the open pan process and having a capacity of 700 maunds of cane per day of ten hours. This quantity of sugarcane of the improved varieties represents the produce of one acre. The plant which will be driven by a 50-horse power motor, will therefore deal with about 50,000 maunds of cane per season and will be of the correct size for working by co-operative societies. The complete plant is estimated to cost about Rs. 17,000. The freight, erection and electric connection on charges and buildings will cost approximately another Rs. 5,000. The present application is for a non-recurring grant from the Imperial Council of Agricultural Research of Rs. 17,000 to cover the cost of the plant. The Irrigation Branch will arrange for the trial to be carried on through the agency of a co-operative society in the grid area in the Bijnor district in collaboration with the Registrar of Co-operative Societies. All cost of erection and running of the plant will be borne by the Irrigation Branch of the United Provinces Government who would recover it from the co-operative society by making a small charge on the electrical units used. At the end of the first season the society will have the option of taking over the plant at a price to be settled with the Imperial Council of Agricultural Research, not exceeding 75 per cent. of the original cost. If the society does not choose to take the plant the Imperial Council of Agricultural Research will dispose it off as it considers best.

Conclusion.—The Irrigation Branch are installing near Moradabad a 15-horse power Massey plant lent by that firm and it will be possible, during the current season, to obtain some data regarding the possibilities of this method of sugar manufacture. A plant of this size is, however, much too small even for one village, and a larger plant, of at least 50 B. H. P. size, is necessary for economical working.

If the experiment is successful, the main items of future plant could be obtained on the hire-purchase system from the manufacturers and the cost recovered from the charges made for units used. It is very difficult to predict whether such a scheme introduced with the closely organized sugar manufacturing industry will be a success or not, but its ultimate success by giving larger yields of sugar per acre of cane is of such importance for the economics of this province that a trial, on the modest lines indicated in this memorandum, appears to be definitely worthwhile.

III.—ECONOMICAL.

The Board of Economic Inquiry considered the scheme of Dr. Radha Kamal Mukerji for the investigation of agricultural marketing methods and practices in the United Pro-

vinces at its first meeting on November 20th, 1931, and approved the scheme. The Board is prepared to undertake a detailed inquiry on the subject with the help of the Bureau of Statistics and Economic Research.

It is proposed to make local investigations in representative districts of the province regarding the cost of production, transit charges, markets, marketing practices, finance, etc., of sugarcane in particular and other agricultural commodities in general. The information thus obtained will be collated and sifted in the office and also thoroughly discussed by a sub-committee of the Board, before formulating definite proposals for submission to the Imperial Council of Agricultural Research and the public.

The United Provinces Government have already established a Bureau of economic research since April 1931, and allotted a sum of Rs. 15,570 per annum. The Bureau is at present in the charge of the Director of Land Records who is also the Director of Statistics and incidentally happens to be the Director of Agriculture as well. A trained Economist is in charge of this Bureau with a staff of investigators. The Economic Bureau has already conducted an inquiry into the visible stocks of wheat and barley in the province and is well adapted by its experience and technical knowledge to undertake an inquiry into the cost of production of sugarcane. The Economic Bureau of the United Provinces Government is in a position to undertake the inquiry immediately which is the subject-matter of item No. 4 of the agenda of the Sugar Committee of the Imperial Council of Agricultural Research. A detailed budget is not appended for this part of the inquiry. It is already shown in appendix 2 of subject No. 4 of the agenda of the Sugar Committee. The inquiry will be conducted under the supervision of the Director of Statistics.

EXPENSES.

I—AGRICULTURAL.

The scheme on agricultural part of the work is expected to be finished within a period of five years, but if however at the end of that period any work remains incomplete, an application for further extension of the period may be submitted. The details of expenses are as under :—

Agricultural A and B (non-recurring).

	Rs.
Apparatus for recording discharge of water	6,000
Total, Agricultural A and B (non-recurring)	6,000

Agricultural A and B (recurring).

Staff and establishment.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One assistant sugarcane expert (Rs. 250—25—750 per mensem), Member of Provincial Service.	3,000	3,300	3,600	3,900	4,200	18,000
Two research assistants (Rs. 110—10—150 each per mensem), one in Botany and other in Agriculture.	2,640	2,880	3,120	3,360	3,600	15,600
One assistant (Rs. 80—5—105 per mensem) will be in charge of drawings required to be made of plant material.	960	1,020	1,080	1,140	1,200	5,400

Agricultural A and B (recurring)—contd.

Staff and establishment.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One store-keeper (Rs. 50—3—65 per mensem).	600	636	672	708	744	3,360
Two laboratory assistants (Rs. 30—3—42 per mensem).	360	396	432	468	504	2,160
Two fieldmen (Rs. 30—3—42 per mensem each).	360	396	432	468	504	2,160
One stenographer clerk (Rs. 75—3—105 per mensem).	900	936	972	1,008	1,044	4,860
Two attendants (Rs. 12—1—16 per mensem each).	288	312	336	360	384	1,680
<i>Allowances.</i>						
Travelling allowance for officers and subordinates (during the first year more travelling will have to be done for collecting varieties).	2,000	1,500	1,500	1,500	1,500	8,000
<i>Contingencies.</i>						
Research farm contingencies ..	3,000	3,000	3,000	3,000	3,000	15,000
Manures—chemical and organic ..	2,000	2,000	2,000	2,000	2,000	10,000
Scientific literature	500	500	500	500	500	2,500
Total, Agricultural A and B (recurring.)	16,608	16,876	17,644	18,412	19,180	88,720

Agricultural C (non-recurring).

	Rs.
Two microscopes	1,800
One microtome	800
Two incubators and thermostate	750
Two thermographs	260
Two hygrographs	320
Blackman's transpirometer	700
Corks, rubber tubes, etc.	400
Analytical balance	800
Glass thermo regulators	100
Miscellaneous	3,000
Total, Agricultural C (non-recurring) ..	8,930

Agricultural C (recurring)—contd.

Staff and establishment.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One research assistant with special knowledge of plant physiology (Rs. 150—25—250 per mensem).	1,800	2,100	2,400	2,700	3,000	12,000
One chemical assistant (Rs. 110—10—150 per mensem).	1,320	1,440	1,560	1,680	1,800	7,800
One trained fieldman (Rs. 65 per mensem).	780	780	780	780	780	3,900
One laboratory assistant (Rs. 30—3—42 per mensem).	360	396	432	468	504	2,160
One attendant (Rs. 12—1—16 per mensem).	144	156	168	180	192	840
<i>Allowances.</i>						
Travelling allowance for visits to sugarcane growing and other research centres.	1,000	1,000	1,000	1,000	1,000	5,000
<i>Contingencies.</i>						
Miscellaneous expenditure on chemicals and glasswares.	1,500	1,500	1,500	1,500	1,500	7,500
Total, Agricultural C (recurring) ..	6,904	7,372	7,840	8,308	8,776	39,200

Note.—The staff demanded above for the agricultural part (A, B and C) of the scheme, is required in addition to those already employed on the farm in charge of general supervision work. No money has been demanded for capital expenditure, as buildings, laboratories, gas plant and other necessary requirements already exist at Shahjahanpur.

II.—TECHNICAL.

Details of expenditure (annexure I).

1. One cane-crushing plant consisting of two three-roller mills arranged in tandem—Size of rollers—12" dia. × 18" long, complete with double reduction compound gearing. Arranged for belt drive.
2. One oil engine, 50 B. H. P. (50-H. P. electric motor).
3. Two *rab* juice-receiving tanks size 3' × 3' × 3' complete with strainer.
4. One belt-driven centrifugal pump for mill juice, capacity 150 gallons per minute complete with piping.
5. Three juice-collecting and measuring tanks—size 3' × 3' × 3' each, in one set.
6. Four sets of juice-boiling batteries, each capable of dealing with 125 maunds of juice per day, complete with fire grate, furnace doors, dampers and two chimneys, 20 feet high.
7. Two batteries of two pans each for reboiling molasses, complete with fire grate.
8. Set of ladles and hand strainers.
9. Eight brass Wiremesh strainers, two for each battery of juice-boiling pans.
10. Guttering for juice from measuring tanks to boiling pans.
11. Two centrifugal machines, size of basket 18" diameter, belt-driven, having a maximum working speed of 2100 B. P. H. each machine to have a separate oil engine, 2½ H. P.
12. 2,000 empty kerosine oil tins for *rab*.
13. Line shafting, plumber blocks, pulleys and belting.

Estimated cost	Rs.	17,000
Total, Technical ..	Rs.	17,000

III.—ECONOMICAL (RECURRING).

Details.—In addition to the present staff of the Bureau, the following additional hands will be required for the investigation of agricultural marketing methods and practices in the United Provinces for a period of two years :—

	First year.	Second year.	Total.
	Rs.	Rs.	Rs.
One research assistant at Rs. 200 per mensem.	2,400	2,400	4,800
Two investigators on Rs. 150 per mensem.	3,600	3,600	7,200
One clerk on Rs. 40 per mensem ..	480	480	960
Total, Staff ..	6,480	6,480	12,960

Besides additional staff the following items will also be required in connection with the above investigation :—

<i>Allowances.</i>			
	Rs.	Rs.	Rs.
Travelling allowance for staff ..	1,500	1,500	3,000
Contingencies	500	500	1,000
Total ..	2,000	2,000	4,000
Total, Economical (recurring) .. ..	..	..	16,960

An abstract of the cost of the complete scheme.

Name of the section.	Non-recurring.	Recurring.	Total.	Remarks.
	Rs.	Rs.	Rs.	
I.—Agricultural, A and B ..	6,000	88,720	94,720	Recurring in five years. Ditto.
C	8,930	39,200	48,130	
II.—Technical	17,000	..	17,000	Recurring in two years.
III.—Economical .. ..	..	16,960	16,960	
Total ..	31,930	1,44,880	1,76,810	

ENCLOSURE III.

Scheme for a Research and Testing Station for the indigenous system of gur and sugar manufacture, by R. C. Srivastava, Sugar Technologist to Imperial Council of Agricultural Research, Cawnpore.

1. *Aims and Objects.*—The present scheme aims at providing an experiment station, properly staffed and equipped, and located in a suitable centre, for the purpose of testing existing processes and machinery used in manufacturing gur, rab and sugar by the indigenous systems, for conducting trials of new plant and processes, and for undertaking research work for introducing improvements.

2. *Importance of the indigenous system of gur and sugar manufacture.*—According to figures given by the Tariff Board* for the 1927-28 crop, out of 35·2 million tons of cane grown in India, approximately 2 per cent. was used for the direct manufacture of white sugar in factories, 11 per cent. for the manufacture of white sugar by the bel process and over 72 per cent. for the manufacture of gur, the balance of about 15 per cent. being used up as sets and for chewing. The indigenous processes therefore accounted for 83 per cent. of the cane as against only 2 per cent. utilised by the factories. From the point of view of the grower of cane the former processes are consequently of far greater importance and any measures adopted for increasing their efficiency will directly benefit the agriculturist.

3. *Necessity for a Research and Testing Station.*—The two sections of the Indian Sugar industry,—the factory industry and the indigenous industry,—differ from one another in one important respect. The plant and process used in the factory industry in India are similar to those used in other cane growing countries. They are the products of generations of research and experience of several countries,—notably Java, Hawaii, the United States of America, and the beet sugar producing countries (particularly Germany). The problems of the factory industry peculiar to India are few and the necessity and urgency for scientific research is correspondingly less.

The case is however, entirely different with the indigenous sugar and gur industry. This has no parallel or counterpart in any other country of the world. The process is unknown in other countries and the technologists there have no interest in studying it. In this branch of the industry therefore India is deprived of the benefit of the researches and accumulated experience of foreign workers which she gets in the factory industry. There is a similar difficulty in regard to machinery for the indigenous industry. The foreign machinery makers have no idea of the special requirements of this industry and consequently the machinery supplied by them is not always quite suitable. What is still more important, they do not know that the people who have to use the machines in this country have very limited means and hence whilst endeavouring to increase the efficiency of the machines they frequently lose sight of the vital importance of low initial cost.

It is obvious therefore that the problems of the indigenous industry have to be solved in India and very little outside help can be counted upon. From the point of view of lowering the initial cost, it is almost certain that the equipment will have to be of Indian make, and of such simple types that the greater part of it can be made and repaired in the villages. To do this a Central Research and Testing Station of the type proposed in this note and located in the centre of the industry is essential.

4. *Lack of fundamental data.*—The most noticeable feature which strikes one when attempting to investigate problems connected with the indigenous processes is the complete absence of fundamental or basic scientific data. A good deal of work has, it is admitted, been done in the past by different workers in this field, but most of it has been of an empirical nature based on a system of trial and error. The first attempt at collecting scientific data was made at Bilari, but as the tests there were being conducted primarily on commercial lines and as the staff and equipment provided were sufficient only for the purpose, the opportunities afforded were necessarily restricted. But what little was done was sufficient to bring into sharp relief the lack of scientific information of even the most essential nature, so much so that it is almost impossible to accurately visualize the problems which await enquiry.

One possible explanation of the haphazard methods of investigation employed in the past is that as the industry is run on crude and antiquated lines, it was felt that it was not

* See "Report of the Indian Tariff Board on the Sugar Industry" 1931, page 44.
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fit subject for exact scientific investigations. The argument is obviously fallacious. The theoretical principles underlying a machine are the same whether it is small in size or large and whether it is intended for use in a cottage industry or in a large organised industry. Thus, for instance, it is just as important to have the stresses in a cane mill correctly balanced whether it is a tiny unit or a large mill. Similarly the conditions for efficient combustion are the same whether bagasse is being burnt in small quantities in a bel furnace or *en masse* in the furnace of a large boiler. To give another example, the juice is susceptible to decomposition precisely in the same manner whether it is treated in the small pans of a bel or in the large tanks of a factory. To understand the defects and to devise methods for rectifying them, there is therefore just as much need for the adoption of precise scientific methods in one case as in the other.

5. *Training of artisans.*—The Bilari experiments have shown that even the existing plant and processes can give better results if the methods employed are carefully controlled by properly trained workmen. A great deal of the higher efficiency of the Bhopal process was due to the skill and long experience of the men employed during the test.

It is therefore necessary to have a supply of properly trained men, if the industry is to develop on efficient lines. The proposed research station should, as part of its normal work, train artisans for this purpose. The training imparted should be of an entirely practical nature. Experience shows that industrial and agricultural schools are not suitable for this purpose as they lack the proper commercial atmosphere and the men coming out of them are apt to consider themselves above doing manual work.

6. *Testing of plant and process.*—There is a large variety of machinery for the indigenous industry on the market. These differ widely in price efficiency, and durability. But apart from the claims made in respect of them by their dealers, the buyer has no means of knowing of their real merits. Very often the buyer fails to get satisfactory results with the machines he has purchased and it is then difficult for him to ascertain whether this is due to defects in the machines themselves or whether the erection and method of operating are at fault. It is not unusual in such cases to put the blame on the machinery maker.

It should be one of the functions of the proposed Research Station to test and report on machines and processes offered to the public. In this way the expert opinion of an impartial body will be available to dealers and users both and will enable them to correctly appraise the merits of the various processes and the different types of plant available to him to choose from.

A certain amount of work of this kind is at present being done by some of the provincial departments, but there is not sufficient collaboration and co-ordination. The Research Station should make full use of this work and should, in fact serve as a clearing house for all the information available.

7. *Devising complete plants.*—The Research Station should also devise complete plant of different capacities, suitable for the indigenous industry. There is no single firm at present which can supply such complete plants and the buyer has to go to different dealers before he can get a complete equipment. Plant purchased in this manner is very often unbalanced, resulting in inefficient and uneconomic working for which none of the suppliers will accept responsibility. If, however, specifications for complete plants are worked out at the Research station and the plants are tested there, it should be easy for engineering firms to take up their manufacture.

8. *Utilization of Electric power from the hydro-electric system.*—There is cheap electric power available now in those parts of the United Provinces where this industry is most established. If suitable arrangements can be made in collaboration with the provincial department concerned, tests can be made to determine the economy which will result from the use of electric power and machinery can be devised for a more extensive utilization of such power.

9. *Demonstration.*—Another important function of the Research Station should be to give demonstrations of new machines and improved processes. The station will have to be located in a suitable centre and should be easily accessible. Arrangements will also have to be made for sending out peripatetic demonstration parties to important centres.

10. *Location of the Research Station.*—The proposed Research station should be started at a suitable centre in the western part of the United Provinces,—Meerut, Muzaffarnagar, Bareilly, Moradabad and Bijnor being the more important places from which a selection may be made. The exact site selected should be on a main road and preferably near a railway station. No enquiries for a site have yet been made, but no difficulty is apprehended in getting a suitable site after the scheme has been sanctioned.

The Imperial Council of Agricultural Research has given a grant to the Government of the United Provinces for an experimental sugar factory at the H. B. Technological Institute, Cawnpore. The advisability of locating the proposed research station at Cawnpore so that it may work in conjunction with the experimental factory was considered, but had to be ruled out for the following reasons :—

- (a) Cawnpore is too far from centres of the Khandsari industry ;
- (b) Cawnpore is not a cane growing centre, and the results obtained with the cane grown near Cawnpore may not always be applicable to the conditions obtaining in places where the Khandsari industry is established ;
- (c) The experimental factory at Cawnpore is intended for research and instructional work in connection with the factory industry and has not very much in common with the plant and processes used in the indigenous methods of sugar manufacture. If any special problems in connection with the latter arise which need to be studied in the experimental factory, there will be no difficulty in doing this as it is one of the conditions of the grant given by the Research Council that the Sugar Technologist will be in charge of the experimental factory and will control the programme of experimental work in it.

11. *Supply of raw material and disposal of finished products.*—An important point to be taken into consideration in selecting a site for the research station will be the facilities available for the supply of raw material and the disposal of finished products. The station will not have its own cane plantation as this is unnecessary for the kind of work it has to do and will add considerably to the cost of the scheme.

The following alternative arrangements are suggested in this connection :—

- (a) Supplies of cane may be obtained from the owner of a private farm and the finished products (gur or rab or sugar and molasses) returned to him, charging for manufacturing expenses at rates previously settled ;
- (b) The cane may be purchased from neighbouring farms or cultivators on payment of price according to contracts previously made, and the finished products sold in the market ;
- (c) The cane may be taken and the finished products given back on a co-operative basis. The Registrar of Co-operative Societies, U. P. is organising such societies in some parts of the province, and it is likely that if he is approached he would be willing to assist in the formation of a society to work in conjunction with the Research Station.

It will not be desirable to arrange for obtaining supplies of cane from an experimental farm of the Department of Agriculture, as these farms are primarily intended for growing cane for distributing seed.

12. *Staff.*—Normally a Research Station of this kind, if it had been an independent institution, would have required a highly qualified technologist at its head. In the present case, however, as the station will be under the direct charge of the Sugar Technologist, it is necessary only to provide suitable assistants to work under him.

Details of the proposed staff are given in Statement II, and full explanatory notes are given later on in connection with the proposed budget estimate. The staff will be partly permanent, employed all the year round, and partly temporary, engaged for the sugar making season of about six months in the year. In the former category are included the technical men (Chemist and engineer), Mistri to look after the machinery, and a clerk to

attend to the office work. The temporary seasonal establishment consists of the operative and supervising staff.

During the off season when cane crushing is stopped, the permanent staff will be engaged in calculating results of experiments conducted during the season, preparing reports overhauling the plant, making changes in the light of the experiments previously conducted and assisting in the designing and erection of improved types of plant. A certain amount of experimental work for which cane juice is not required will also be done during the off season.

13. *Equipment*.—Statement I, gives particulars of the equipment which will be required. This will comprise a laboratory, a repair shop and machinery of different type used in the indigenous process. A detailed description of the equipment required is given in a subsequent paragraph.

14. *Programme of experimental work*.—It is not possible to lay down in advance a complete programme of work because many problems will be discovered only after the work has been commenced. In a general way it may be stated, however, that the plan of work will be at first to collect data, relating to the processes as commonly followed and to investigate the causes of defects so far as are these known at present. Later on such problems will have to be taken up as this preliminary study discloses and finally trials will be made of improved machinery and processes devised as a result of these investigations.

An outline of the preliminary work indicated above, which should take up the first two or three years, is given below. This is, however, subject to amendment in the light of experience gained as the work progresses :—

A.—CANE CRUSHING :

- (i) Testing Cane Mills at present on the market.
- (ii) Designing improved types of cane mills, having 3, 5, 6 and 9 rollers.
- (iii) Trying the effect of different pressures and roller speeds and of different shapes and sizes of grooving on the capacity and extraction of cane mills,
- (iv) Improvements in the methods of feeding cane to secure uniformity,
- (v) Introduction of maceration within the limits of fuel available,
- (vi) Devising simple types of juice pumps,
- (vii) Use of disinfectants in cane mills, juice tanks, pipes, etc.

B.—MOTIVE POWER :

- (i) Hydro-Electric power,
- (ii) Suction gas,
- (iii) Steam from waste heat of bels,
- (iv) Different types of oil engines.

C.—JUICE AND MOLASSES BOILING :

- (i) Obtaining complete technical data regarding the more important types of juice and molasses boiling plants and correlating these with efficiency and economy of working.
- (ii) Testing and perfecting the improved type of bel as recommended in the report on the Bilari experiments.
- (iii) Studying open pan systems of sugar manufacture as used in the West Indies, the United States and the Phillipine Islands and ascertaining whether any modifications of these can be used under Indian conditions.
- (iv) Use of Suction gas for boiling purposes.
- (v) Use of vacuum pans in conjunction with direct fired bels.
- (vi) Improving the design of bel furnace for burning partially moist bagasse.

D.—CLARIFICATION :

- (i) Testing present indigenous clarifying agents,
- (ii) Trying new indigenous clarifying agents,
- (iii) Devising a simplified form of liming and sulphitation process suitable for the Khandsari industry.

E.—CRYSTALLIZATION :

- (i) Use of a modified form of oscillator,
- (ii) Use of metal and wooden vessels of different types for cooling and crystallization of rab.

F.—PUGMILLS AND CENTRIFUGAL MACHINES :

- (i) Designing a simple type of wooden pugmill to prevent breaking of crystals,
- (ii) Devising a special type of electrically driven centrifugal machine with the motor forming an integral part of the machine,
- (iii) Testing different types of screens in centrifugals, with rabs of varying textures,
- (iv) Determining optimum speeds of centrifugal basket for rabs of different consistencies,
- (v) Application of a simplified form of double curing process to rab.

G.—SUGAR DRYING :

Designing a simple type of wooden sugar dryer to take the place of the present system of drying in the sun. Air to be heated by chimney gases and a hand blower to be used.

H.—GUR MANUFACTURE :

- (i) Designing a pan for the continuous boiling of gur,
- (ii) Improving the keeping quality of gur by eliminating the entrained molasses and reducing the final acidity.

15. *Estimate of Cost.*—Two schedules showing details of cost are given in Statements I and II attached. A summary of these is given below :—

Year.	Capital	Recurring	Total.
	expenditure.	expenditure.	
	Rs.	Rs.	Rs.
First year	52,000	17,796	69,796
Second „	6,000	18,396	24,396
Third „	6,000	18,996	24,996
Fourth „	6,000	19,596	25,596
Fifth „	6,000	20,196	26,196
Total	76,000	91,380	1,67,380

Explanatory notes on the various items of expenditure are given in the following paragraphs.

16. *Capital Expenditure.* (a) *Land*: About four or five acres of land will be required for the buildings and also to provide space for drying bagasse and sugar and keeping supplies of cane and fuel. As the work is of a temporary nature, an attempt will be made to take the land on rent, in which case this item of expenditure will be substantially reduced.

(b) *Buildings*: One shed will be required for housing the machinery (consisting of cane mills, engine, pugmills and centrifugal machines), and another shed for bails of different types, for boiling juice and molasses. A godown, suitably partitioned will be required for storing rab, gur, sugar, molasses and sundry stores. For housing the laboratory and office a block consisting of two rooms, and a verandah will be provided. A small shed for accommodating the fitters' repair-shop completes the list of buildings. Wire fencing will be used in place of a boundary wall round the buildings.

As the experiment station will be on a temporary basis, all buildings will be of cheap design. Complete plans and estimates will be submitted for approval before construction work is taken in hand.

(c) *Laboratory equipment*: A good laboratory is an absolute necessity for proper scientific control of manufacturing and experimental work. Such a laboratory will however cost a great deal of money. The provision made in the budget will cover the cost of the essential apparatus and material and will permit of such additions each year as may be found to be necessary for the research work in hand at the time. It is likely that for some researches costly instruments may be required. Instead of purchasing these attempt will be made to obtain them on loan from other laboratories.

(d) *Repair Shop equipment*: A small fitters' workshop and Smithy will be required for the maintenance of the plant and for making alterations necessary for experimental purposes. It will be cheaper and more convenient to have this work done at site than to send it out to engineering firms.

(e) *Machinery*.—In order that the Research Station may be in a position to compare the different types of machines in use and to make improvements in them, it is necessary that it should be equipped with as wide and representative a set of these machines as possible, such a set will however involve considerable expenditure. The list of machinery given in the budget is the minimum that will be required for this purpose. It is hoped that most manufacturers of machinery will send machines free of charge for testing and demonstration purposes and hence much of the expense that would have been incurred in purchasing a complete set of machines, will be saved.

The annual lump sum provisions made in the budget for machinery in the four years after the first year are to cover the cost of new types of machines which may be purchased and of making machines according to designs evolved at the Research Station.

(f) *Furniture and fittings*.—The provision under this head is to cover the cost of the minimum quantity of furniture and fittings for the office, laboratory and factory.

(g) *Water Supply*.—The provision made for water supply is only tentative and approximate: the exact requirements cannot be ascertained till the site has been selected and the source from which water is to be obtained (e.g., from tube well, from ordinary type of well with pump or from public water supply) is known.

(h) *Lighting arrangement*.—For working at night electric light (if available) or kerosene lights and hand lanterns will be necessary.

(i) *Contingencies and miscellaneous expenses*.—These are to cover sundry unforeseen expenses.

17. *Recurring Expenditure*:—(a) *Establishment*.—Particulars of the qualifications and duties of the permanent staff are given below:—

(i) *Chemist*.—The chemist should have received training in Sugar Technology in a recognized institution in India or abroad and should possess at least five years' experience in a sugar factory as manufacturer and chemist. Knowledge of the plant and process employed in the indigenous sugar and gur industry should be treated as useful additional qualification.

During the off-season the Chemist will continue his work in the experimental factory and chemical laboratories of the Technological Institute, Cawnpore, under the direction of the Sugar Technologist.

(ii) *Engineer*.—An engineering graduate or diploma holder, with some works experience should be employed for this post. He should be capable of making simple engineering tests,—*e.g.*, power consumption, evaporation, heat balance, etc.,—and should be able to erect, adjust and maintain the various machines, and to look after the workshop.

After the sugar making season, he will be employed in overhauling the machinery, making alterations to plant, assisting in the preparation of designs of new plant, supervising their manufacture and erecting them.

(iii) *Mistry*.—A mechanic with experience of oil engines, electric motors, cane mills and centrifugal machines will be required for attending to these machines. During the off-season he will work under the Engineer in overhauling the plant and erecting new machines.

(iv) *Clerk-Accountant*.—The office establishment will consist of one clerk who will attend to accounts work also. The clerk should have knowledge of accounts and typing.

(v) *Inferior Servants*.—Provision has been made for one chaprasi and one chowkidar.

(b) *Seasonal Establishment*.—(i) *Assistant Chemists*.—Two junior chemists, with experience of sugar factory, laboratories will be required during the manufacturing seasons for doing routine analyses, maintaining technical records and supervising experiments.

(ii) *Mistries*.—During the working season, when all the machines are in use, two mistries (in addition to the one permanent mistri) will be required to keep them in proper order and to carry out urgent repairs when necessary.

(iii) *Clerk*.—One extra clerk will be required during the working season to attend to the additional work in connection with purchase of raw material, stores, etc., and sale of finished products, maintaining attendance registers, records of consumable stores and other miscellaneous work.

(iv) *Weightment Clerks*.—For all experimental work it is essential that raw material and finished products as well as the more intermediate products and fuel should be regularly weighed. Three weightment clerks will be required for this purpose.

(v) *Supervisors*.—To ensure that work is carried out in strict accord with the prescribed experimental conditions, the services of educated supervisors will be required. Three such supervisors have been provided.

(vi) *Bel Karigars*.—Four bel karigars (sugar boilers) will be required for working the juice and molasses boiling pans.

(vii) *Centrifugal men*.—Two men will be required for operating the centrifugal machines,—one for First Sugar and another for Second Sugar.

(viii) *Workmen*.—The number of workmen required will vary according to the amount and nature of work in hand at the time. Moreover, it will be necessary and economical in some cases, to engage certain types of operatives for the entire season on a monthly basis, whilst the ordinary unskilled labour can be employed on daily wages. It is estimated that on an average 30 workmen will be required.

(c) *Allowances and Honoraria*.—The provision under this head is to meet the travelling expenses of the staff for journeys to and from Cawnpore in connection with work during the off-season, and for visits of demonstration parties to different centres.

(d) *Supplies and Services*.—This sub-head covers a gross provision of Rs. 20,000 for commercial operations, and allows for recoveries each year of Rs. 18,000 the net expenditure therefore being Rs. 2,000. The object of providing funds in this manner is twofold—firstly it permits of an arrangement similar to a revolving bank credit, under which money

is drawn according to requirements and sale proceeds are credited into the treasury so that no large amounts are outstanding at any time, and secondly by limiting the net annual expenditure to Rs. 2,000 it is made obligatory to sell the finished products and realise other assets promptly.

(e) *Contingencies*.—The items under this sub-head are self-explanatory. It may be pointed out however that the provision of Rs. 2,000 for "repairs and modification of plant" is distinct from the provision of Rs. 5,000 annually under "Machinery" in the budget estimate of capital expenditure. The former item covers expenses in connection with repairs and alterations to existing machinery, which do not increase the value of the assets and cannot therefore be charged to capital account. The latter item, on the other hand, covers additions to plant which are chargeable to capital account.

18. *Necessity for flexibility*.—As pointed out in connection with the programme of experimental work, it is not possible in a research station of this kind, to lay down an exact programme of work, because new problems arise as work progresses. It is evident therefore that, under such conditions, the expenditure cannot be expected to be strictly in accordance with a rigid budget. In sanctioning the budget a certain measure of flexibility may therefore be permitted, provided the total expenditure does not exceed the budgeted amount.

19. *Recoveries on completion of work*.—The present proposal is for a research Station for five years. On completion of this period, unless it is decided to continue the work further, all the machinery, buildings and other material will be disposed of resulting in the realization of a substantial amount. This should materially reduce the total cost of the scheme. No exact estimate of this can however be given at this stage.

CAWNPORN :

The 31st July 1931.

R. C. SRIVASTAVA,

Sugar Technologist.

STATEMENT I.—Capital Expenditure for the proposed Research and Testing Station for the indigenous gur and sugar industry.

Serial No.	Heads and items.	I Year.	II Year.	III Year.	IV Year.	V Year.	Remarks.
		Rs.	Rs.	Rs.	Rs.	Rs.	
1	Land—4 to 5 acres ..	1,000					
2	Buildings :—						
	(a) One shed for cane mills, engine, pug-mills and centrifugal machines, 30' x 50'.	3,750					
	(b) One shed for boiling bels, 30' x 50'.	3,750					
	(c) One godown (suitably partitioned for rab, gur, sugar, molasses and stores, 30' x 50'.	4,500					
	(d) Laboratory (20' x 15') and office (15' x 15') with verandah 8' wide.	2,700					
	(e) Shed for repair shp, 15' x 35'.	1,300					
	(f) Wire fencing and gates.	1,000					
3	Laboratory equipment	4,000	1,000	1,000	1,000	1,000	
4	Repair shop equipment ,	3,000					
5	Machinery—						
	(a) Bullock cane mills	200					
	(b) Power driven cane mills.	5,000					
	(c) Oil engines ..	5,000					
	(d) Juice pumps ..	1,000					
	(e) Juice boiling bels ..	1,000					
	(f) Molasses boiling bels	200					
	(g) Pugmills ..	700					

STATEMENT I.—Capital Expenditure for the proposed Research and Testing Station for the indigenous gur and sugar industry—contd.

Serial No.	Heads and items.	I Year.	II Year.	III Year.	IV Year.	V Year.	Remarks.
		Rs.	Rs.	Rs.	Rs.	Rs.	
5	Machinery—contd.						
	(h) Centrifugal machines	1,000	5,000	5,000	5,000	5,000	
	(i) One 3-ton weigh-bridge.	1,500					
	(j) One 1-ton weigh-bridge.	1,000					
	(k) One 5-cwt. weigh-bridge.	600					
	(l) One bean scale with weights.	100					
	(m) Kerosene tins ..	350					
	(n) Tanks for juice, rab molasses, etc.	500					
	(o) Crystallizers of metal and wood.	500					
	(p) Ladles, Sieves, Strainers, etc.	250					
	(q) Piping, shafting, pulleys, belting, etc.	1,500					
	(r) Foundation and erection of plant.	1,000					
6	Furniture and Fittings	500					
7	Water Supply ..	1,500					
8	Lighting arrangements	200					
9	Contingencies and Miscellaneous expenses.	2,400					
	Total ..	52,000	6,000	6,000	6,000	6,000	
	GRAND TOTAL FOR FIVE YEARS.	76,000					

STATEMENT II.—Recurring Expenditure for the proposed Research and Testing Station for the indigenous gur and sugar industry.

Serial No.	Heads and items.	I Year.	II Year.	III Year.	IV Year.	V Year.	Remarks.
		Rs.	Rs.	Rs.	Rs.	Rs.	
1	Pay of Establishment—						
	(a) Chemist (250—25—500).	3,000	3,300	3,600	3,900	4,200	
	(b) Engineer (125—15—275).	1,500	1,680	1,860	2,040	2,220	
	(c) Mistri (50—5—100)	600	660	720	780	840	
	(d) Clerk-Accountant (50—5—100).	600	660	720	780	840	
	(e) Chaprasi, Rs. 12 ..	144	144	114	144	144	
	(f) Chowkidar, Rs. 11	132	132	132	132	132	
	Total ..	5,976	6,576	7,176	7,776	8,376	
2	Pay of Seasonal Establishment (6 months per year)—						
	(a) Two Assistant Chemists at Rs. 50.	600	600	600	600	600	
	(b) Two Mistris at Rs. 30.	360	360	360	360	360	
	(c) One Clerk at Rs. 30.	180	180	180	180	180	
	(d) 3 Weighment Munshi at Rs. 15.	270	270	270	270	270	
	(e) 3 Supervisors at Rs. 15.	270	270	270	270	270	
	(f) 4 Bel Karigars at Rs. 30.	720	720	720	720	720	
	(g) 2 Centrifugal men at Rs. 20.	240	240	240	240	240	
	(h) 30 Workmen at Rs. (12) (or 6 annas per day).	2,160	2,160	2,160	2,160	2,160	
	Total ..	4,770	4,770	4,770	4,770	4,770	

STATEMENT II.—Recurring Expenditure for the proposed Research and Testing Station for the indigenous gur and sugar industry—contd.

Serial No.	Heads and items.	I Year.	II Year.	III Year.	IV Year.	V Year.	Remarks.
		Rs.	Rs.	Rs.	Rs.	Rs.	
3	Allowances and Honoraria—						
	Travelling Allowance of Establishment.	250	250	250	250	250	
4	Supplies and Services—						
	Commercial Operations.*	2,000	2,000	2,000	2,000	2,000	
8	Contingencies—						
	(a) Stores and lubricants	500	500	500	500	500	
	(b) Fuel	500	500	500	500	500	
	(c) Chemical Clarifying agents and manufacturing materials.	500	500	500	500	500	
	(d) Consumable stores for laboratory.	500	500	500	500	500	
	(e) Repairs and modifications of plant.	2,000	2,000	2,000	2,000	2,000	
	(f) Tools and tackle ..	100	100	100	100	100	
	(g) Maintenance of buildings.	250	250	250	250	250	
	(h) Stationery ..	250	250	250	250	250	
	(i) Postage and telegrams.	100	100	100	100	100	
	(j) Miscellaneous contingencies.	100	100	100	100	100	
	Total ..	4,800	4,800	4,800	4,800	4,800	
	GRAND TOTAL ..	17,796	18,396	18,996	19,596	20,196	
	GRAND TOTAL FOR FIVE YEARS ..					91,380	

* NOTE.—This comprises —

	Rs.
Gross Expenditure	20,000
Recoveries	18,000
Net expenditure ..	2,000

ENCLOSURE IV.

REPORT.

Report of the Sub-Committee on Item Nos. 8, 9 and 10 (a) of the agenda of the 4th meeting of the Sugar Committee held at New Delhi on 7th December 1931.

The United Provinces scheme part I. Agricultural. (Enclosure II).

Subject to the following modifications, the Sub-Committee recommend for sanction parts (a) and (b) of this scheme. The Director of Agriculture explained that the Shah-jahanpur sugarcane research farm has been placed under the control of Mr. Sethi, Economic Botanist, United Provinces, who will be in charge of both rice and sugarcane research. Statistical assistance will be available from the Bureau of Economics in connection with the planning and interpretation of field experiments. The following reductions are recommended :—

- (1) Omission of the storekeeper's post.
- (2) Substitution of a clerk on Rs. 50—5—75 for a stenographer clerk.
- (3) Reduction of travelling allowances to Rs. 5,000 for the whole period of 5 years.
- (4) Reduction of provision of manures from Rs. 10,000 to Rs. 5,000. This involves the reduction of the total grant for sections A and B to approximately Rs. 75,000 spread over 5 years.

As regards Agricultural C, physiological and chemical, the Director of Agriculture would like to re-consider the proposal for physiological work. The Sub-Committee emphasised that sub-section (c) (2) was the more important. The question of a further grant for chemical physiological work may be examined a year later.

The Sub-Committee recommend the addition to the United Provinces scheme (Enclosure II), as now revised, of provision for an Assistant Entomologist (or a Plant Pathologist) on a scale of Rs. 200—20—300 per mensem for investigation of sugarcane pests under the direction of the Government Entomologist.

Punjab Agricultural scheme (Item 8). (Enclosure I).

The Sub-Committee are not satisfied that Lyallpur is the best centre for a sugarcane research station in the Punjab. At previous meetings of the Sugarcane Committee the importance of the central tract has been emphasised and they would like the question of establishing the sugarcane research station on the departmental farm at Jullundur to be re-examined.

Subject to the re-examination of the site, the scheme (Enclosure I) is recommended for sanction with the following modifications :—

- (1) Pay of Sugarcane Specialist :—

It is considered that the scale of Rs. 250—25—500 with liberty to pay an initial salary up to Rs. 400 per mensem is adequate.

- (2) The post of Technical Chemist is unnecessary for the programme put forward and should be omitted: also one post of Chemical Assistant.

This will reduce the expenditure on staff to about Rs. 83,220 spread over five years.

As regards the expenditure shown in statement No. 2 (Enclosure I) no special grounds have yet been shown for a departure from the Council's principle that buildings should be provided by the local Government. Provision for machinery and implements is excessive; a sum of Rs. 6,000 would be adequate if the Station is established at Jullundur where water-lifting machinery would be needed: otherwise about Rs. 2,000. The recurring grant for machinery and equipment on the manufacturing portion of the scheme should be reduced to Rs. 2,000 per annum for reasons subsequently stated. This reduces the total cost of the scheme to approximately Rs. 1,73,170 or Rs. 1,33,170 net after deducting the 40,000 offered by the Punjab Government.

* * * * *

II. Technological—

(1) United Provinces :—(Enclosure II).

Mr. Srivastava explained that this was an experiment in the use of hydro-electric power for sugarcane crushing and sugar manufacture and not an experiment with sugarcane crushers or in sugar-boiling. The Sub-Committee enquired why the whole cost should not be met by the Hydro-electric circle of the Irrigation Department ; it was explained that this would lead to indefinite delay and that the main object of the present scheme was the utilisation of electric current for agricultural purposes. The Sub-Committee recommend that the grant be sanctioned on the condition that the United Provinces Government will undertake to purchase the machinery at 75 per cent. of its cost at the end of the first year. The Sub-Committee desire to emphasise that as the object of the experiment is to ascertain the relative cost of electric motors and oil-engines for this class of agricultural operation, full electrical records should be maintained and a report made to the Council on this point at the conclusion of the experiment.

Punjab.

It is recommended that sections 6 and 7 of the proposed programme of work (Enclosure I) be omitted pending further experience, by the Sugar Technologist of the problems now under examination has been gained. It is recommended that a grant of Rs. 10,000 spread over the 5 years be provided for the purchase and testing of equipment to enable the Punjab Agricultural Department, to co-operate with the Sugar Technologist and to take advantage of his results and test their applicability to local conditions in the Punjab.

In connection with this report Chowdhry Mukhtar Singh enquired if there was any co-ordination between the research schemes of the various provinces to which Mr. Burt replied that all these schemes were the result of our previous decision to have a chain of research stations in the main sugarcane belt. Rao Bahadur Venkataraman, referred particularly to the United Provinces scheme (Enclosure II) and the reference therein about Mr. Howard's book and the Indian Sugar Committee's report. He said that in the light of world experience it was not essential that the breeding and the crossing work should be done in the area for which the sugarcane variety was needed, and in support of this he quoted the instance of canes bred in Demerara which were being used in Louisiana and also of cane bred in Java (P. O. J. 213) which was grown in Louisiana and Argentina. Similarly, the canes grown in Japan had been obtained from Java. There was no ground for the view that the actual production of crosses should be effected in the areas where they were to be grown. He added that Coimbatore crossed seeds were being sent to Hawaii and Australia and the United Provinces in India were nearer to Coimbatore than either Hawaii or Australia. Mr. Noel Deerr endorsed this and said that he agreed with R. B. Venkataraman in every particular. R. B. Venkataraman also mentioned for the information of the Committee that he had been successful at Karnal in getting sugarcane seeds to germinate in sub-tropical India and added that, with proper technique, proper supervision and sowing at the proper time, it was quite possible to get sugarcane seed to germinate in Upper India. This made practically redundant the scheme which had already been sanctioned for Shahjahanpur to transport seedlings at a cost of Rs. 6,000. The 3rd point he mentioned was that he was now investigating the different times of sowings for sorghum hybrids and the Shahjahanpur scheme will be very useful to him.

In connection with the Punjab scheme (Enclosure I), Mr. Burt explained that the question of site was very important. The Sugar Committee had all along been of opinion that the sugarcane research station should be located in the central Punjab. R. B. Venkataraman said in this connection that in Lyallpur cotton was a competitive crop with sugarcane and the area under sugarcane fluctuated very considerably from year to year in that tract depending upon the price of cotton. It was important therefore that our research station should be established in a tract where the area under cane was steady.

* * * * *

In connection with the technical side of the Punjab scheme (Enclosure I) Mr. Burt explained and the Committee agreed that they should wait till Mr. Srivastava's work progressed a little further, it was on this account that the Sub-Committee had reduced the proposed annual grant of Rs. 10,000 for sugar machinery a year to Rs. 2,000 per annum.

Mr. Burt referred to page 4 of the printed papers (Enclosure II) in connection with item 10 (a) and said that in view of the discussion on subject 4 it would seem sufficient to place on record that the agency for carrying out the investigation in connection with the cost of sugarcane cultivation should be the Board of Economic Enquiry in the United Provinces and its attached Bureau. This was approved.

ENCLOSURE V.

Revised Statement No. 1, showing detail of staff required for the Sugarcane Research Station at Risalewala.

Post.	Monthly rates of pay.				
	1st year.	2nd year.	3rd year.	4th year.	5th year.
	Rs.	Rs.	Rs.	Rs.	Rs.
1. Sugarcane Specialist with special knowledge of Botany, Rs. 250—25—500. (Starting Rs. 400)	400	425	450	475	500
2. Farm Manager, Rs. 130—10—170	130	140	150	160	170
3. 1 Agricultural Assistant, Rs. 100—10—140	100	110	120	130	140
4. 4 Mukaddams, Rs. 20—1—29	100	104	108	112	116
5. 1 Storekeeper on Rs. 50 ..	50	50	50	50	50
6. 1 Chankidar on Rs. 14 ..	14	14	14	14	14
7. 2 Sweepers on Rs. 13 each ..	26	26	26	26	26
8. 1 Chemical Assistant, Rs. 120—10—160.. ..	120	130	140	150	160
9. 1 Entomological Assistant, Rs. 120—10—160	120	130	140	150	160
0. 1 Mycological Assistant, Rs. 120—10—160	120	130	140	150	160
1. 2 Laboratory Attendants, Rs. 20—1—24 each ..	40	42	44	46	48
Total Monthly expenditure ..	1,220	1,301	1,382	1,463	1,544
Total Yearly expenditure --	14,640	15,612	16,584	17,556	18,528
1dd pay of one Engine driver for three months	180	180	180	180	180
Total ..	14,820	15,792	16,764	17,736	18,708
GRAND TOTAL ..	83,820				

Revised Statement No. 2, showing details of miscellaneous expenditure required for the Sugarcane Research Station at Risalewala.

	Non-recurring.	Recurring.
	Rs.	Rs.
BUILDINGS.		
Labour—		
16 Beldars at Rs. 18 .. .. .	..	3,500 (round).
Variable labour .. .. .	..	2,000
Purchase and maintenance of bullocks—		
16 Bullocks at Rs. 200	3,200	..
Maintenance at Rs. 20 per pair per month plus Rs. 280 for replacements .. .. .	..	2,200
Machinery and Implements (Agricultural) .. .. .	..	1,200
Machinery and equipment to be developed or purchased (manufacturing)	6,000	2,000
Manure .. .. .	..	1,000
Travelling Allowance .. .. .	..	2,000
Water Rates .. .. .	..	1,000
Apparatus and Chemicals	200	500
Contingencies and other charges	250	500
Total	9,650	15,900
For five years	9,650	79,500
Staff for 5 years .. .. .	..	83,820
	9,650	1,63,320
GRAND TOTAL	1,72,970	

ENCLOSURE VI.

Agricultural A and B (Non-recurring).

Apparatus for recording discharge of water	Rs.	6,000
Total Agricultural A and B (Non-recurring)		6,000

Agricultural A and B (Recurring).

Staff and Establishment.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One Assistant Sugarcane Expert (Rs. 250—25—750), Member of Provincial Service	3,000	3,300	3,600	3,900	4,200	18,000
One Assistant Entomologist (or a Plant Pathologist) (Rs. 200—20—300)	2,400	2,640	2,880	3,120	3,360	14,400
Two Research Assistants (Rs. 110—10—150)—one in Botany and other in Agriculture	2,640	2,880	3,120	3,360	3,600	15,600
One Assistant (Rs. 80—5—105) (will be in charge of drawings required to be made of plant material)	960	1,020	1,080	1,140	1,200	5,400
Two Laboratory Assistants (Rs. 30—3—42).	360	396	432	468	504	2,160
Two Fieldmen (Rs. 30—3—42)	360	396	432	468	504	2,160
One Clerk (Rs. 50—5—75)	600	660	720	780	840	3,600
Two Attendants (Rs. 12—1—16)	288	312	336	360	384	1,680
ALLOWANCES.						
Travelling Allowance for officers and subordinates (during the first year more travelling will have to be done for collecting varieties) .. ..	..	..	..	..	..	5,000
CONTINGENCIES.						
Research Farm Contingencies	3,000	3,000	3,000	3,000	3,000	15,000
Manures—Chemical and organic .. ..	..	..	..	..	..	5,000
Scientific Literature	500	500	500	500	500	2,500
Total Agricultural A and B (Recurring) .. ..	..	..	..	..	..	94,820

II.—TECHNICAL.

Estimated cost	Rs.	17,000
Total—Technical		17,000

				Non- Recur- ring. Rs.	Recur- ring. Rs.	
Agricultural	..	..	..	6,000	94,820	} Or Rs. 1,17,820 in all over 5 years.
Technical	..	..	..	17,000	..	
Total			..	23,000	94,820	

ENCLOSURE VII

8. Scheme for a Research and Testing Station for the Indigenous System of Gur and Sugar Manufacture, drawn up by the Sugar Technologist, Imperial Council of Agricultural Research (Enclosure III).

The Chairman pointed out that these proposals (Enclosure III) arose out of the report on the Bilari experiments. Mr. Mehta suggested that a short pamphlet based on the Bilari report should be printed in Urdu and Hindi. This was agreed to and Mr. Srivastava was asked to prepare this pamphlet.

Mr. Mehta proposed, and Khan Bahadur Fateh-ud-Din seconded, that the scheme (Enclosure III) as put forward by Mr. Srivastava be adopted. They said that this scheme was the logical result of the appointment of the Sugar Technologist. The scheme as presented to this Committee had been worked out fully in all details and needed no further comments.

Mr. Burt said that information was needed on several points; he asked if the United Provinces Government's attitude had been ascertained on the proposal to establish a research station in the United Provinces under the direct control of the Research Council. Mr. Mehta, replying in the negative, said that he felt sure that the United Provinces Government would welcome it. It was agreed that the Committee's support to the scheme was conditional on the United Provinces Government's cordial approval. The Chairman asked Messrs. Noel Deerr and Millar as to their opinion on the scheme. Mr. Noel Deerr said that in the present Indian Sugar Industry there was the large industrialist or the factory owner and the small grower and he said that the *khandsari* was an intermediate stage and as an intermediate step in progress it was important to develop the *khandsari* industry. He said that although the *khandsari* was inimical to the interests of the large proprietor still he was of opinion that steps should be taken to protect the small grower and he agreed with the general principles of the scheme. Mr. Millar, agreeing with Mr. Noel Deerr, added that the gur industry was a separate problem and it needed the support of this Committee. Mr. Burt next enquired if it was not possible to work the scheme (Enclosure III) in conjunction with the Harcourt Butler Technological Institute at Cawnpore to which the Imperial Council of Agricultural Research had made a substantial grant for Sugar technology. There was something to be said for the view that such an industrial research experiment should be carried out where chemical and engineering assistance was readily available. Mr. Srivastava did not see much benefit in locating this research station at Cawnpore. He said that there would be practically no saving in building or in machinery. Moreover, his idea was to train men and carry on demonstrations in the improved methods of the *khandsari* industry and from that point of view it was necessary to have this work carried out somewhere in the centre of the *khandsari* industry, especially as no special engineering help was needed, for the plant which he proposed to put up could either be repaired and altered in the villages or could not be repaired and altered even in Cawnpore. In answer to Mr. Burt he said that the Portable Sugarcane Mill referred to in the Harcourt Butler Technological Institute scheme had been designed and ordered and he expected the Mill at Cawnpore in a month's time. Mr. Burt enquired if it would be feasible to put this research station at Shahjahanpur adjoining the Sugarcane research station. Mr. Srivastava was of opinion that Shahjahanpur was not such an important centre for the *khandsari* industry as Bareilly or Moradabad. Mr. Burt asked

if the supply of cane to the experimental plant could be guaranteed. The old experiment, at Nawabganj in the United Provinces had failed largely because of inadequate cane supply. Chowdhry Mukhtar Singh offered to supply 20,000 maunds of cane per annum in connection with this research scheme, provided the plant was located at Meerut. He said that he would supply the cane and take back the finished product so that the expense of purchasing cane and also the difficulty of selling the produce would be eliminated. It was agreed that before the location of the research station was decided the cane supply will have to be guaranteed and this question also was left to the Vice-Chairman for final decision. Mr. Burt then read a note (not printed) on this research scheme by Mr. Milne in which it was suggested that this scheme may be amalgamated with the Punjab research scheme; at Lyallpur, there was a well-equipped Engineering Section and College Laboratory to co-operate. Mr. Srivastava however was against amalgamating the scheme. Moreover, he said that Lyallpur would be inconvenient from his point of view. It was decided to record Mr. Milne's note. Subject to the budget details being scrutinized by the Vice-Chairman, the scheme was approved.

ENCLOSURE VIII.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH HELD IN JANUARY 1932.

Professor Gangulee enquired as to the nature of work the Sugarcane Specialist would have to do and also why the proposed salary of Rs. 250—25—500 for him was fixed on a higher scale than in the Mysore scheme. Mr. Milne explained that the Specialist would be in charge of the scheme. His salary had been fixed after taking into consideration the amount necessary for attracting a suitable man. Dr. Coleman explained that in Mysore the general scale of salaries was lower than in British India. The Sugarcane Specialist in Mysore would be placed under some superior officer, so that a man with less experience would be sufficient. Professor Gangulee was however not satisfied and expressed the opinion that both the men in Mysore as well as in the Punjab should be paid the same salary by the Imperial Council of Agricultural Research; if the Punjab Government were unable to secure the services of a suitable man at this salary they were at liberty to pay more from their own budget.

Mr. Main pointed out the necessity for co-ordination between the four schemes and stated that the reply given by Mr. Burt to the Sugar Committee "that these schemes were the result of our previous decision to have a chain of Research Station in the main sugarcane belt" did not satisfy him. He considered that there should be co-ordination in selecting the type of work which each province should undertake so that there may be no duplication. Mr. Milne considered that it was not possible to co-ordinate work in this manner, although the pooling of results obtained was not only feasible but desirable.

Mr. Plymen said that on the small salaries proposed it would be difficult to get suitably qualified staff and that the Punjab Government should arrange for suitable technical staff from Lyallpur or elsewhere. He also considered that the problem on the technological side was an all-India one and there was necessity for co-ordination in respect of this. Mr. Mehta pointed out that the Sugar Technologist would function as the co-ordinating agent on the technological side and on the Agricultural side the Coimbatore station would perform the same function, as the testing work at the proposed Research Stations would be confined to the Coimbatore varieties. Professor Gangulee said that if the work of the Research Stations was to be confined to testing only and there was to be no breeding work, there was no necessity for the technical and chemical staff provided for in the schemes and that all the schemes should therefore be referred back to the Sugar Committee for reconsideration. Mr. Sethi pointed out that the North Bihar scheme which had already been sanctioned was also for providing a purely testing station and the salary of the Specialist for that station was also Rs. 350. In Northern India it was difficult to get a suitable man on a lower salary. Dr. Subramanyam considered that unless there was co-ordination there was bound to be duplication of work and it would also be difficult to compare the work done at the different stations. He suggested that there should be some provision for collecting all the information at one place as was being done in foreign countries. Mr. Milne agreed that collaboration was necessary in so far as the collection of data in one

place was concerned. Mr. Mehta pointed out that Dr. Subramanyam's point did not arise as the schemes provided for testing the Coimbatore seedling canes under local conditions obtaining in different parts of the country. As regards the standardisation of pay he considered that this might be left to the Vice Chairman. The agricultural aspect of the work would be definitely under Mr. Venkataraman, who would be sending out the seedlings. Mr. Plymen said that if these were to be only testing stations the work should properly be done by the provincial departments of agriculture. Dr. McRae considered that the problems were of local importance and should be dealt with by local scientists. Mr. Milne supported this view but added that the provincial departments had no spare staff which they could put on this work.

Professor Gangulee at this stage formally moved the following amendment which was seconded by Mr. Main:

"Recommended that the three sugarcane schemes for the North of India be referred back to the Sugarcane Committee for consideration with special reference to the definition of problems and allotment of work."

Mr. Mehta opposed the amendment saying that Bombay and Bihar had already received grants for exactly similar work and it would be unfair to the other provinces to refuse the grant to them. Mr. Srivastava pointed out that co-ordination, on which so much stress had been laid, could be of two kinds—firstly—one central authority prescribing and controlling the work of the stations in all the technical details, e.g., the selection of problems and the manner of conducting the researches. He considered that co-ordination of this kind was not provided for and was in fact not required. Secondly co-ordination might be in the sense of pooling the information available at the different stations. Such co-ordination was desirable and was provided for by the Imperial Council of Agricultural Research which acted as clearing house in such matters. Mr. Finlow emphasised the importance of separating the technological work from the Punjab scheme. Mr. Sethi supported this view. Rao Bahadur Anand Rao considered that what was required was to define the kind of collaboration that was needed. Dr. Agharkar said that testing seedling canes was an all-India matter but manufacturing of Gur was of local importance and therefore the two should be separated. Mr. McRae however differed from this view and considered that seed testing was a strictly local problem. Mr. Srivastava pointed out that the provision made in the schemes for Gur and Sugar making was on a very limited scale and it was not so much for carrying on research in the Gur making industry as to utilise the facilities available for converting the sugarcane which was cultivated for experimental purposes into a saleable product. Mr. Milne supported this.

As Prof. Gangulee's amendment referred to item Nos. 14, 15 and 17, the Chairman ruled that it should be taken up after the remaining two items, Nos 15 and 17, had been discussed.

Application from the United Provinces Government for a grant of Rs. 1,76,810 for investigation into various problems of sugar industry in the United Provinces.

Mr. Mehta in introducing the scheme explained that it consisted of three parts, namely, the Agricultural, Technological and Economic. The Economic part had now been absorbed in item No. 11 relating to the scheme for economic enquiry into the cost of sugarcane production. The Technological part, according to Mr. Mehta, was on a very modest scale, as the net expenditure involved amounted to only Rs. 4,250. As regards the Agricultural side it was explained that this was on lines similar to those of the Punjab Scheme, but was on a more modest scale. Mr. Srivastava referred to the Technological side of the scheme and explained that if the work was done by the Sugar Technologist under his scheme for a Research and Testing Station, the Research Council would have to bear the full cost of Rs. 17,000, whereas if the scheme of the United Provinces Government was sanctioned only a quarter of this amount would have to be paid by the Research Council. Professor Gangulee considered that this scheme was subject to the same objections as the Punjab scheme. The scope of work was not confined to the testing of seedlings only, but extended to manurial experiments and to the whole gamut of the questions of sugarcane agriculture. He emphasized that the problems to be studied were not sufficiently well-defined. On the Technological side the scheme appeared to aim at demonstration

work in connection with the use of Hydro-electric power instead of carrying on any fundamental research. Dr. Agharkar referred to agricultural work described under sub-heading (c) namely Physiological and Chemical investigations and considered that the work was of too wide a nature. Mr. Mehta explained that the Sub-Committee had not sanctioned this part of the programme and that the Physiological and Chemical work had therefore been omitted. Mr. Sethi referring to the salaries of staff considered the scale of pay to be high. On the Technological side he recommended that the work should be transferred to the Sugar Technologist. Mr. Mehta explained that the Technological work would be under the Sugar Technologist. The Irrigation Department, United Provinces, would bear the expenses of making electric connections and fitting up the machinery. As regards the staff he stated that the Economic Botanist to the United Provinces Government who was now stationed at Shahjahanpur has also to look after the work of the Rice Scheme which was located at a distance of over 100 miles from Shahjahanpur and it would be difficult for him to give sufficient attention to the Sugarcane scheme also.

In reply to Mr. Main's enquiry if the United Provinces Government had agreed to take back the plant and pay 75% of the cost, Mr. Mehta stated that this had been agreed to. Dr. Coleman considered that the scheme was top heavy and suffered from the same defects as the Punjab Scheme and should therefore be reconsidered. In reply to Mr. Finlow Mr. Srivastava explained that the Technological work was not pure demonstration, but consisted of experiments in the adaptation of Hydro-electric power for sugar making and later on the demonstration of the plant so perfected. In the end Professor Gangulee moved his amendment, which was seconded by Mr. Main, that "The three sugarcane schemes for the north of India be referred back to the Sugar Committee for consideration with special reference to the definition of problems and allotment of work".

The Chairman ruled that the amendment should be taken up after item No. 17 had been discussed.

Scheme for a Research and Testing station for the indigenous system of Gur and Sugar Manufacture.

The scheme was introduced by Mr. Srivastava, who after explaining its main features emphasized that it was of an all-India importance as there was great demand all over the country for small scale plants for Sugar and Gur making and that if these were not provided, sugarcane cultivation would receive a severe set back. He also added that the actual nett cost of the scheme was likely to be appreciably smaller than that stated, as on completion of the work the machinery, buildings and other material would be disposed off which should result in substantial recoveries. He finally added that the present scheme was intended to take a comprehensive view of the entire problem of the indigenous industry and as such deserved the support of the Board.

Mr. Finlow supporting the scheme considered it to be of great importance as without suitable means for dealing with the Sugarcane crop the cultivation of cane would be seriously affected. Mr. Main agreed in regard to the importance of work covered by the scheme, but enquired as to why it could not be amalgamated with work at Cawnpore for which the Council had already given a grant. He also stated that as the Sugar Technologist will not remain at the proposed Research Station all the time, the Chemist and Engineer provided in the scheme should be of a better type. Dr. Coleman stated that the work would be of importance to Southern India also. He enquired, however, if the work was likely to be completed in five years, as otherwise the expected recoveries from the disposal of plant and building would not materialize. Professor Agharkar referred to the small amounts provided in the scheme for the equipment and building for the laboratory. He considered that with a laboratory on such a small scale, research of a fundamental nature would not be possible. He also pointed out that instead of the proposed arrangement whereby cane was to be provided by some farm owner and the produce was to be taken back by him, it would be more economical if the Shahjahanpur farm (which would now be financed by the Council) should supply cane free to the proposed Research Station, in which case the station may be located at Shahjahanpur. Rao Bahadur Anand Rao enquired as to the nature of work to be done during the off-season when cane crushing is stopped. Mr. Plymen was of the opinion that it would be more logical to locate in one place and

co-ordinate the four schemes for the United Provinces, e.g., The Testing Station at Shahjahanpur, the grant given to the Harcourt Butler Technological Institute and the two schemes covered by items 15 and 17.

Mr. Srivastava replying to the debate stated that it was not proposed to locate the Research Station at Cawnpore, because it was not a centre for sugarcane cultivation. For the small experimental sugar factory, special arrangements had been made for cultivating a small quantity of cane in the local Government farm, but the cost of this would be very high. As regards the objection that the Sugar Technologist would not remain at the Research Station, he explained that his presence there all the time was not essential. It would be sufficient if he visited the station, say, once a month during the cane season and the necessary reports were regularly sent to him by the staff there. As regards the likelihood of completion of the work in five years it was explained that scheme for grant from the Council were under the rules restricted to a period of not more than five years, and the present scheme had been framed accordingly. On the expiry of this period the question of continuance of the work will again be brought before the Council. With regard to Professor Agharkar's enquiry as to the equipment and buildings for the laboratory, it was stated by Mr. Srivastava that elaborate laboratory equipment was not required, as the laboratory was intended primarily for carrying on "Chemical Control Work" of the manufacturing operations and would therefore be equipped on lines similar to those of the commercial sugar factory laboratories which did not cost very much more. Where any expensive instruments were required, these could be always borrowed from the Technological Institute and the Department of Agriculture, both of which were closely co-operating with the Sugar Technologist. With regard to Rao Bahadur Anand Rao's enquiry as to the nature of work to be done during the off-season, Mr. Srivastava explained that this would consist essentially of work supplementary to that in the cane crushing season, e.g., Tabulation of results, Preparation of Reports, etc.

Mr. Mehta, further replying to the debate, stated that the Shahjahanpur farm could not supply cane free of cost as suggested by Professor Agharkar as the Research Council would be contributing only part of the expenses of running the farm, and that the grant would be utilized entirely for the experiments coming under the scope of the scheme. Replying to Mr. Plymen's criticism of duplication amongst the four United Provinces schemes he stated that the experimental factory at the Technological Institute was meant entirely for work in connection with the modern sugar factory industry, whereas the present scheme was for small scale indigenous sugar and gur making industry. He referred to the useful work which was being done by the Sugar Technologist, who had been able to give help to a large number of persons in connection with schemes for modern type of factories as well as for the small indigenous units. He considered that the offer of the Sugar Technologist to undertake fresh work as contemplated in the scheme under consideration should be accepted and the scheme passed.

Professor Gangulee finally moved his amendment which was seconded by Mr. Main that "The three sugarcane schemes, items 14, 15 and 17 for the north of India be referred back to the Sugar Committee for consideration with special reference to the definition of problems and allotment of work". The amendment was carried.

ENCLOSURE IX.

COPY OF LETTER FROM THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, TO THE SECRETARY TO THE GOVERNMENT OF THE UNITED PROVINCES, AGRICULTURE DEPARTMENT, LUCKNOW, No. 565/AGRI., DATED THE 1ST MARCH 1932.

SUBJECT :—*Application from the United Provinces Government for a grant of Rs. 1,76,810 for investigation into the problem of Sugar Industry in the United Provinces.*

I am directed to refer to the correspondence resting with Dr. Nehru's letter No 614-A/XII-A-138, dated the 22nd December 1931 on the subject mentioned above and to

forward herewith for your information a copy each of the marginally noted papers. It will

*1. Proceedings (Proof copy) of the Fourth Meeting of the Sugar Committee appointed by the Imperial Council of Agricultural Research held at New Delhi on the 7th and 8th December 1931.

*2. Papers circulated to the Advisory Board in connection with Item Nos. 14, 15 and 17 of the Agenda for the January 1932 Meeting.

*3. Extracts from the minutes of the meetings of the Advisory Board held in January 1932 (Enclosure VIII).

be seen therefrom that the scheme for investigation into the problem of sugar industry in the United Provinces has been referred back to the Sugar Committee for consideration with special reference to the definition of problems and allotment of work between the three sugar schemes for the north of

India.

2. In this connection I am to draw the attention of the Local Government to the note on the position of Sugarcane Research in the United Provinces which was forwarded with your letter No. 571-A., dated the 10th July 1929 addressed to the Department of Education, Health and Lands. In that note, the recommendations contained in which were specifically endorsed by the United Provinces Government, Mr. Clarke proposed *inter alia* :—

- (a) Continuation of the research work on sugarcane selection and cultivation at Shahjahanpur,
- (b) Establishment of sugarcane research stations at Meerut and Gorakhpur equipped and staffed for work on all problems connected with sugarcane production (at Meerut the physiological aspect was to be taken up by Dr. Singh), and
- (c) The appointment of a Mycologist for work on Mosaic. The other items are either provincial or have been the subject of separate schemes.

3. At the first meeting of the Sugar Committee, Mr. Clarke said that the United Provinces would press for three schemes, namely, (i) a fully equipped sugarcane research station at Meerut, at a cost of some Rs. 45,000 to Rs. 50,000 non-recurring and Rs. 30,000 per annum recurring, (ii) a similar research station at Gorakhpur and (iii) a grant-in-aid to the Harcourt Butler Technological Institute, which has since been made.

The Shahjahanpur Research Station, under these proposals, was to be maintained by the Local Government.

4. The proposals in the United Provinces scheme submitted to the 4th meeting of the Sugar Committee included :—

- (i) extensive trials of Coimbatore seedlings (a) at Shahjahanpur and (b) at Circle farms, namely, Partabgarh, Cawnpore, Benares, Gorakhpur and Aligarh ; this refers specially to new seedlings ;
- (ii) comparative trials of various canes, their manurial and water requirements and a study of growing times (presumably at Shahjahanpur and Circle farms); and
- (iii) Physiological Research including (a) Growth studies and (b) a study of the composition of sugarcane juice and the effect of manures and soil constituents on ripening.

Mr. Mehta, officiating Director of Agriculture, United Provinces, explained how conditions had altered since Mr. Clarke put forward his scheme, viz., that :—

- (i) Mr. Clarke, who personally directed the work at Shahjahanpur has retired ;
- (ii) The Assistant Chemist who worked with him has retired ;
- (iii) Khan Bahadur Naib Hussain, Deputy Director of Agriculture, Rohilkhand, who had worked with Mr. Clarke on the field aspect for many years, has died.

He stated that the Shahjahanpur sugarcane research farm was being continued ; but he had placed it under the general control of the Economic Botanist who would be responsible for sugarcane and rice and that a new Deputy Director has been appointed to the Rohilkhand Circle but he is not a Sugarcane Specialist.

5. It will be observed that the present scheme differs from the original scheme outlined by Mr. Clarke, and approved by the United Provinces Government, in the following respects :—

- (a) No reference is made to the establishment of a Research Station at Gorakhpur.
- (b) No definite reference is made to the establishment of a Research Station at Meerut. Nor is Meerut even mentioned as one of the farms at which experimental work on varieties, cultivation, manuring and irrigation will be carried out.
- (c) It is apparently proposed to carry out the Physiological work at Shahjahanpur instead of at Meerut though this point is still open to discussion as the Director of Agriculture, United Provinces, withdrew this portion of the scheme for re-consideration.
- (d) The expenditure now proposed will be mainly on staff for the Shahjahanpur Research Station, which, under the original proposal, was to be maintained by the Local Government.

6. The criticisms made by the Advisory Board of the Council, though expressed in more general terms, were partly due to the lack of apparent connection between the earlier and present schemes. It would therefore seem desirable that before the scheme is again discussed by the Sugar Committee and Advisory Board a more definite statement should be given of (i) how the special problems of the important tracts in the east and west of the province will be dealt with ; (ii) what work will be carried out in Gorakhpur and Meerut and by what staff, and (iii) what staff at the Shahjahanpur Research Station was paid for by the United Provinces Government in 1929 and what staff the United Provinces Government now propose to maintain there in addition to that provided in the scheme.

7. The opinion of the United Provinces Government is also requested on a scheme put forward by the Sugar Technologist to the Imperial Council of Agricultural Research which is of special interest to the United Provinces which formed item 17 of the Agenda of the Advisory Board. Criticism of this scheme for a Research and Testing Station for the indigenous system of Gur and Sugar manufacture, in the Advisory Board turned entirely on the question of site and working details and the main proposal was generally supported. The two suggestions made were :—

- (a) that the proposed experiment station should be located at Cawnpore in order to secure laboratory facilities and the whole-time presence of the Sugar Technologist, and
- (b) that it should be located at Shahjahanpur adjoining the Sugarcane Research Station thus linking up the two sides of the work. These points were raised in the Sugar Committee and the Sugar Technologist satisfied the Committee that it would be better to select an independent site. The same explanations were offered to the Advisory Board but the Board was not satisfied that the question had been fully examined.

It is recognised that proximity to an agricultural experimental farm will neither ensure to the technological experimental station an adequate cane supply or a cheap cane supply since the bulk of the area under suitable varieties at an agricultural farm is reserved, for seed supply and is not available for sale. The technological experimental station cannot experiment with rejected or unproved varieties of cane. It is also realised that Cawnpore is not a real sugarcane district, and that most of the cane grown there is thick cane for chewing. A supply of standard varieties of cane for *gur* and *rab* making could only be assured by making contracts ahead and there would always be the risk of an inadequate supply in unfavourable seasons. It is doubtful if a supply of cane for both the experimental factory at the Harcourt Butler Technological Institute and the ' indigenous methods ' station could be guaranteed at a reasonable cost. Further Cawnpore does not seem to be a good centre for demonstrating improved village methods of cane crushing and boiling.

Nevertheless, it is considered that the possibility of placing the Research and Testing Station for indigenous methods at Shahjahanpur or Cawnpore should be further examined.

and I am to request that this Department may kindly be favoured with the observations of the United Provinces Government in this connection.

8. Apart from the question of the location of the proposed Testing and Research Station mentioned in paragraph 7 above, I am also to ask for the opinion of the Local Government on the scheme of the Sugar Technologist as a whole, and (ii) on the general question whether they approve of an Institute under the direct control of the Imperial Council for the purpose and whether they can assist in obtaining land.

9. As it is necessary that the schemes should be placed before the Sugar Committee at an early date, I am to request that the United Provinces Government reply may be communicated to this Department as soon as possible.

ENCLOSURE X.

COPY OF A LETTER FROM THE SECRETARY TO THE GOVERNMENT OF UNITED PROVINCES, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 180-A., DATED MAY 23, 1932.

Application from the United Provinces Government for a grant of Rs. 1,76,810 for investigation into the Problem of Sugar Industry in the United Provinces.

I am directed to acknowledge with thanks the receipt of your letter No. 565/Agri., dated March 1, 1932 (Enclosure IX), together with its enclosures and to say that the delay in replying to it is much regretted.

2. It is necessary to explain at the outset that the apparent lack of connection between the schemes of 1929 and 1931, is more apparent than real. The idea underlying both is the same and it was intended to carry on exactly the same research under both schemes. The only point of difference is that whereas the earlier scheme proposed to take up different kinds of research at different places, the later scheme provided for concentrating all this research at one centre for, viz., at Shahjahanpur. There are obvious advantages in such concentration; but as the Advisory Board have pointed out it will be difficult to deal with the special problems of the different tracts if all the research is concentrated at one place. The scheme has now accordingly been revised, providing for research at different centres.

3. It is now proposed to carry on research simultaneously at Meerut, Gorakhpur and Shahjahanpur.—

- (a) The research at Meerut would be in connection with insect pests of sugarcane. This would include a study of the life histories of insects inimical to the cane, the control of insects mainly by the introduction of their parasites and the quarantine and examination of imported plants.
- (b) At Gorakhpur it is intended to examine the question of mosaic. This will include a study of the various fungoid diseases attacking cane and their means of control, soil studies connected with such diseases, the quarantining of areas known to be infected with disease and the distribution of immune varieties. It will be necessary to appoint a mycologist for this purpose and it is proposed to do so by cutting out the provision for drawing assistant, two laboratory assistants and a clerk.
- (c) In addition agricultural research would be carried on at both places including comparative trials of various canes and their manurial and water requirements; while their growing times would also be studied.
- (d) Further, the physiological aspect of the work will be taken up at Shahjahanpur in addition to the research that is already being carried on there at present. This will include growth studies and a study of the composition of the sugarcane juice and the effect of manures and soil constituents on ripening.

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4. The staff at Meerut which will deal primarily with insect pests, is (1) an Assistant entomologist on a pay of Rs. 200—10—300, cost Rs. 13,200, (2) an Agricultural Research Assistant, pay Rs. 110—10—150, cost Rs. 7,800, (3) one Fieldman, pay Rs. 30—3—42, cost Rs. 2,160, and (4) one Attendant, pay Rs. 12—1—16, cost Rs. 840. The travelling allowance would be Rs. 2,500 and contingencies, Rs. 11,250. The total cost at Meerut thus works out at Rs. 37,750.

5. The staff at Gorakhpur where work would be carried on in connection with mosaic would be: (1) The Assistant Sugar Expert, pay Rs. 250—25—750, cost Rs. 18,000, (2) a Mycologist, pay Rs. 200—10—300, cost Rs. 13,200, (3) a Botany Research Assistant pay Rs. 110—10—150, cost Rs. 7,800, (4) one Fieldman, pay Rs. 30—3—42, cost Rs. 2,160, and (5) one Attendant, pay Rs. 12—1—16, cost Rs. 840. Travelling allowance and contingencies would be Rs. 2,500 and Rs. 11,250 respectively, as at Meerut. The total cost at Gorakhpur is thus Rs. 55,750.

6. The staff at the Sugarcane Research Station at Shahjahanpur in 1929 and at the present time are as follows:—

Staff in 1929 at Sugarcane Research Station, Shahjahanpur.

Mr. G. Clarke, C.I.E. (Part time)	..	Director of Agriculture, United Provinces.
Khan Sahib M. Naib Husain	..	Deputy Director of Agriculture, Rohilkhand Circle.
Mr. S. C. Banerji	..	Assistant Agricultural Chemist.
Mr. R. B. Roy	..	Member, Subordinate Agricultural Service, Chemical Assistant.
Th. Bijaipal Singh	..	Member, S. A. S., Superintendent, Sugarcane Research Station.
Ch. Kedar Singh	..	Member, S. A. S., Assistant Superintendent.
M. Ghore Khan	..	Fieldman.
Two Laboratory Attendants	..	(Menial Staff).

Present Staff.

Mr. R. L. Sethi, M. A., B. Sc., I. A. S.	..	Economic Botanist to Government, United Provinces (in complete charge of the Sugarcane Research Station).
Mr. S. D. Joshi, B. Sc., B. S. (Agri., London).	..	Deputy Director of Agriculture, Rohilkhand and Kumaon Circle (in charge of the circle and not in charge of the farm).
Mr. Ram Brikah Roy, L. Ag.	..	Member, S. A. S., Chemical Assistant.
Mr. Jai Vishnu Lal, L. Ag.	..	Member, S. A. S., Chemical Assistant.
Th. Vishwaram Singh, L. Ag.	..	Member, S. A. S., Assistant in Botany.
M. Aziz Dulah Khan, L. Ag. (Pusa Trained).	..	Member, S. A. S., Field Assistant.
Th. Bijaipal Singh	..	Member, S. A. S., Superintendent, Sugarcane Research Station.
M. Ghore Khan	..	Fieldman.
Th. Chatardhari Singh	..	Laboratory Assistant.
Two Laboratory Attendants	..	(Menial Staff).

It will be seen that there has been no reduction and there never was any intention of reducing the staff at Shahjahanpur. In the proposals of 1931 the idea was to have the staff referred to therein at Shahjahanpur in addition to the staff maintained there by the Local Government for purposes of research and not to substitute any member of the

existing staff by the new staff which would be entertained from the grant received from the Imperial Council of Agricultural Research.

7. The Physiological aspect of the work which is entirely separate from the rest of the scheme had been temporarily withdrawn but is not resubmitted. The details are mentioned in the enclosure (Annexure A). On account of other facilities at Shahjahanpur it is proposed to undertake this work there, in addition to the work that is going on there in other directions.

8. It is hoped that with the modifications made in the scheme along the lines suggested by the Advisory Board and the definition of the problems and the allotment of work that have now been made clearer, the scheme will be accepted by the Council and the grant asked for will be sanctioned. Printed copies of the scheme as further revised now will be sent as soon as practicable. The technical and economical portions of the scheme will remain unaltered.

9. This Government also strongly support the scheme of the Sugar Technologist for a research and testing station for the indigenous system of gur and sugar manufacture as it is in the best interests of the cultivators. Though large scale factory production is bound to increase, the indigenous system must continue to exist side by side with it as a cottage industry for a long time to come. In order to enable the cultivator to get a fair price for his cane, it is essential to get a higher percentage of extraction of sugar and the possibility of doing so deserves to be carefully and systematically investigated. Improvements are required in the furnace, in the shape and size of the pans used, in the method of boiling and also in power crushers. Without experiments and research to bring about such improvements sugarcane cultivation is likely to receive a severe set back.

10. The research station to be of real use must be in close and intimate touch with the small cultivators in the rural areas: it is their problems which have to be studied and solved. Further it is better for the station to be in Rohilkhand as that is the heart of the indigenous sugar industry. Moreover, as it is advisable to develop the use of power crushers worked if possible by electric power to the site selected should be in the Hydro-electric grid area. Cawnpore and Shahjahanpur are therefore both unsuitable. It is recommended that the research station should be located at some convenient place in the rural areas near a railway station in the district of Moradabad or Bijnor: both these districts are in Rohilkhand and Hydro-electric power is available in both. This Government would give all help in acquiring or leasing land for this research station if necessary and have no objection to the station being under the direct control of the Sugar Technologist.

ANNEXURE A.

REVISED ESTIMATE OF EXPENDITURE.

Agricultural I (c) (Non-recurring).

	Rs.
Fittings to an existing room for converting it into a Physiological laboratory	2,000
Two microscopes	1,800
One microtome	800
Two incubators and thormostats	750
Two thermographs	280
Two hygrographs	320
Blackman's transpirometer	700
Corks, rubber tubes, etc.	400
Analytical balance	800
Glass thermo regulators	100
Miscellaneous	3,000
Total	10,930

Agricultural I (c) (Recurring).

Particulars.	1st year.	2nd year.	3rd year.	4th year.	5th year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<i>Staff and Establishment.</i>						
One Research Assistant with special knowledge of plant physiology (Rs. 150—25—250)	1,800	2,100	2,400	2,700	3,000	12,000
One Assistant (Rs. 110—10—150) ..	1,320	1,440	1,560	1,680	1,800	7,800
One trained fieldman (Rs. 65 per mensem)	780	780	780	780	780	3,900
One clerk (Rs. 50—3—65) ..	600	636	672	708	744	3,360
One laboratory assistant (Rs. 30—3—42)	360	396	432	468	504	2,160
One attendant (Rs. 12—1—16)	144	156	168	180	192	840
<i>Allowances.</i>						
T. A. for visits to sugarcane growing and other research centres	1,000	1,000	1,000	1,000	1,000	5,000
<i>Contingencies.</i>						
Miscellaneous expenditure on chemical and glass ware	1,500	1,500	1,500	1,500	1,500	7,500
Field work (2 acres) near physiological laboratory	600	600	600	600	600	3,000
	8,104	8,608	9,112	9,616	10,120	45,580
Total recurring and non-recurring .. ..	..	..	..	..	..	56,490

APPLICATION FROM THE UNITED PROVINCES GOVERNMENT FOR A GRANT OF RS. 1,83,590 (RS. 1,49,660 RECURRING AND RS. 33,930 NON-RECURRING) FOR INVESTIGATION INTO THE PROBLEM OF IMPROVEMENT OF SUGAR INDUSTRY IN HE UNITED PROVINCES.

(The scheme has been prepared with the approval of the Provincial Agricultural Research Committee).

India occupies one of the foremost positions in the cane-growing countries of the world and over 50 per cent. of the Indian crop is found in the United Provinces. The general facts of distribution, and the present condition of the industry, all point to the United Provinces, as being the centre of the subject, as far as the improvement of sugar production in India is concerned. The area under cane is already considerable and sugar-cane is perhaps the most important money crop cultivated. The importance of the crop is on the increase since the opening of the Sarda Canal and introduction of the improved varieties from Coimbatore; more so, when in these days of slump in prices, sugar-cane is one of the very few crops which is paying to the cultivator. A most striking fact brought out by studying the statistics of the sugar industry is the extraordinary low production of sugar in India per acre compared with that of the other main cane-growing countries. The world's cane sugar output is about 14 million tons. India's production in proportion to

its area should have been 7 million tons, but it is only 3.5 million tons, inclusive of this province 1.75 million tons or an eighth of the total cane sugar production of the world. The general line of advance, from an agricultural point of view, appears to lie in increasing the production of cane and of juice per unit area, at the same time reducing the cost of each ton of cane grown. This can be achieved by substituting more rapidly growing and early maturing varieties for those now grown and by introducing more intensive methods of cultivation. Such varieties are being evolved at Coimbatore, which is the chief centre of sugar-cane breeding, but it is necessary that the first generation trials and subsequent acclimatization and propagation for distribution must be done in the United Provinces itself. According to Howard (Crop Production, page 129) "No effective preliminary selection of the seedlings for Northern India is however possible in South India, so that a mass of material of necessity, mainly unsuited, has to be sent to the plains for trial." The Sugar Committee of 1920 in its report, page 301, also says "the opportunities of deciding at Coimbatore what seedlings are and what seedlings are not likely to prove successful in Northern India are strictly limited, and any attempt to exceed those limits may involve the rejection of seedlings, which would on local trial have proved suitable for introduction. The behaviour of cane on the soil of the cane breeding station is not an index of its behaviour elsewhere, nor is it always possible, even granted the most intimate and scientific knowledge of the local conditions of another tract, to infer from the results at Coimbatore the prospect of a particular cane proving successful in that tract."

Some acclimatization and distribution work of Coimbatore varieties has already been done at the existing Sugarcane Research station at Shahjahanpur, but it is intended now to develop it into a first generation sub-station, where extensive trials will be carried out, and to carry out the seedlings trial at other circle farms under Deputy Directors. Besides there are many important problems—agricultural, technical and economic—the solution of which would be of considerable benefit to the field and factory, which still remain to be tackled, will also be investigated in these provinces. A few of the important problems are as follows.

I.—AGRICULTURAL.

The work which it is proposed should be covered in this scheme is the same as that which was outlined when this application was presented by the United Provinces Government at the last meeting of the Advisory Board. At that time it was suggested that all the work should be concentrated at Shahjahanpur. The present proposal conforms more closely to one originally suggested by Mr. Clarke. It practically amounts to the use of the staff asked for at Meerut and at Gorakhpur and the establishment of two stations at these centres, which will work in association with the staff at Shahjahanpur, in dealing with the research classified as A and B. The proposals, however, now include (1) the addition of a mycologist at the Gorakhpur centre in view of the importance and the possibility of study of Mosaic in that tract. This will include a study of the various fungoid diseases attacking cane and their means of control, soil studies connected with such diseases, the quarantine of areas known to be infected and the distribution of immune varieties. It will be necessary to appoint a Mycologist for this purpose and it is proposed to do so by cutting out the provision for a drawing assistant, two laboratory assistants and a clerk, as shown in the original scheme, (2) an Entomologist at Meerut for the study of insect pests of cane, in particular Pyrilla. This would include a study of the life history of insects inimical to cane, the control insects mainly by the introduction of parasites and the quarantine and examination of imported plants. The former officer Mr. Clarke considered essential for complete research in the cane crop and the latter was considered as desirable by the Sugarcane Committee of the Advisory Board.

Section C has been re-introduced. The work associated with this has been extended and more detail has been given. This is attached as an Annexure A. Re-introduction has been done, in view of Mr. Clarke's insistence on the necessity of research in this direction. Mr. Clarke had suggested that this might be done at Meerut; but in view of the fact that special location appears immaterial and of the difficulty of accommodation at Meerut and its existence at Shahjahanpur, it has been proposed, if the need for such work is accepted, to locate this at Shahjahanpur. Such chemical work as may be needed at Meerut and Gorakhpur will be done at or from Shahjahanpur. The staff at this centre, if need be, being strengthened for this purpose.

A and B will be undertaken at Shahjahanpur by the staff supplied by the U. P., and Meerut and Gorakhpur by the staff as herein proposed.

- (a) The establishment of 1st generation sub-stations. For extensive trials of Coimbatore seedlings at Shahjahanpur, Meerut and Gorakhpur.
- (b) The comparative trials of Coimbatore and local canes and their manurial, water and tillage requirements :—

A well-thought out plan of experiments will be laid out on the lines of field experimental technique recently elaborated at Rothemstead, with a view to obtain results capable of correct statistical interpretation, and to find out the best and cheapest combination of organic and artificial manures, and the least quantity of water required by the crop. A thorough study of different times of sowing of various varieties which seems to vary in different parts of the United Provinces will also be made.

- (c) *Physiological and chemical*.—Experimental investigation of some of the external and internal factors controlling the growth and final yield of sugarcane. The work under this head will be altogether different from that of a purely academic nature for physiological study of the sugarcane, and will not conflict with any of the scheme, which the Imperial Council might have already sanctioned. It may conveniently be divided into two sections. The detail of this work is given in appendix A.

The present method of carrying on tests of juice in cane has not been standardized owing to which the results are not even comparative. According to Java standard the cane is to be crushed to such an extent as to give at least 72 per cent. juice on its weight either by single or repeated crushings, when the juice is to be polarized, under this condition the juices can be considered as comparative. Inside the cane there are bundles containing sugar free water. These are harder than the sugar-bearing tubes. Therefore as the pressure is exerted the juice comes out first and water afterwards. Therefore when the canes are crushed not so much the juices are rich in sugar, but when crushed more this juice becomes diluted. Therefore it is essential to fix the conditions of extrating the juice on the weight of the cane before it is analysed for its juice contents. The work has never been attempted in a scientific way nor systematized properly.

NOTE.—Before sending this part of the scheme to the Imperial Council of Agricultural Research for sanction, it was thought fit to get the opinion of sugar experts. A meeting was consequently convened at the Upper India Chamber of Commerce, Cawnpore, on Thursday, October 29, at 10 A. M., and the following gentlemen were present :—

- (1) Mr. N. C. Mehta, I.C.S., Director of Agriculture, United Provinces, Chairman.
- (2) Mr. J. G. Ryan, Secretary, Upper India Chamber of Commerce.
- (3) Mr. Noel Deerr, Sugar Expert to Messrs. Begg, Sutherland and Company, Cawnpore.
- (4) Mr. B. I. Gray, Director, Messrs. Begg, Sutherland and Company, Cawnpore.
- (5) Mr. R. C. Srivasvata, Sugar Technologist, Imperial Council of Agricultural Research, Cawnpore.
- (6) Mr. R. L. Sethi, Economic Botanist to Government, United Provinces, Cawnpore.
- (7) Mr. A. R. Khan, Head of the Sugar-Section of the Harcourt Butler Technological Institute, Cawnpore.

The following resolutions were passed :—

- (1) In the opinion of the Committee, it is desirable that a research sub-station should be opened in these provinces preferably at the headquarters at Shahjahanpur, in charge of an expert officer where experimental work should be concentrated chiefly on the cane seedlings got from Coimbatore and on the local canes of the United Provinces. The Committee, however, do not desire to exclude any experiments on plant-breeding, if the officer in charge is suitably equipped for the purpose.

(a) The Committee further recommend that the scheme should be taken up as soon as possible by the local Government, and in case there is any difficulty for financing it, the matter may be referred for help to the Imperial Council of Agricultural Research that it is necessary for the success of the scheme that an expert officer should be posted in charge of the sugar-cane farm and the laboratories at Shahjahanpur.

The Government of the United Provinces is already spending a considerable sum annually over the Shahjahanpur Research Station, capital about two lakhs and annual revenue expenditure, Rs. 17,000. This further work, for which a scheme is now forwarded, is the natural outgrowth of the work already in progress. The local Government, being unable to spare money under the present conditions of acute financial stringency, is applying for the help of the Imperial Council of Agricultural Research in this important matter.

II.—Technical.

Introductory.—This is re-introduced. After very careful thought it is felt that it must be placed in an area where cane is plentiful and the country methods in full operation and for that neither Cawnpore or Shahjahanpur will be satisfactory.

The manufacture of sugar by the indigenous methods in the United Provinces is in the hands of *Khandsalis* who are generally not wealthy enough to instal oil engines or electric motors and most of the crushing is done in bullock-driven mills which never give a yield of juice from the cane of over 60 per cent. and which employ all the available labour and oxen to the detriment of the preparation of fields for the ensuing sugar-cane crop. Co-operative societies are developing in various villages and now that hydro-electric power is available, it would be possible to enable these societies to use electrically driven machinery for the manufacture of sugar. *Khandsalis* would also profit by the use of such machinery. The margin of profit on sugar manufacture is so small that any more efficient methods would result in a large total return owing to the enormous tonnage of cane produced in the grid area.

Object of the grant.—The purpose for which the present grant is required is to instal a suitable plant in the grid area for demonstrating the advantages of the use of hydro-electric energy and for helping in the introduction of similar plants run either by business firms or by Government.

Details of the scheme.—Mr. Srivastava, the Sugar Technologist, has prepared a specification (Annexure I) for a plant for making Sugar or Gur by the open pan process and having a capacity of 700 maunds of cane per day of ten hours. This quantity of sugar-cane of the improved varieties represents the produce of one acre. The plant which will be driven by a 50 horse power motor, will therefore deal with about 50,000 maunds of cane per season and will be of the correct size for working by co-operative societies. The complete plant is estimated to cost about Rs. 17,000. The freight, erection and electric connection on charges and buildings will cost approximately another Rs. 5,000. The present application is for a non-recurring grant from the Imperial Council of Agricultural Research of Rs. 17,000 to cover the cost of the plant. The Irrigation Branch will arrange for the trial to be carried on through the agency of a co-operative society in the grid area in the Bijnor district in collaboration with the Registrar of Co-operative Societies. All cost of erection and running of the plant will be borne by the Irrigation Branch of the United Provinces Government who would recover it from the co-operative society by making a small charge on the electrical units used. At the end of the first season the society will have the option of taking over the plant at a price to be settled with the Imperial Council of Agricultural Research, not exceeding 75 per cent. of the original cost. If the society does not chose to take the plant the Imperial Council of Agricultural Research will dispose it off as it considers best.

Conclusion.—The Irrigation Branch are installing near Moradabad a 15 horse power Massey plant lent by the firm and it will be possible, during the current season, to obtain some data regarding the possibilities of this method of sugar manufacture. A plant of this size is, however, much too small even for one village, and a larger plant, of at least 50 B. H. P. size, is necessary for economical working.

If the experiment is successful, the main items of future plant could be obtained on the hire-purchase system from the manufacturers and the cost recovered from the charge

made for units used. It is very difficult to predict whether such a scheme introduced with the closely organized sugar manufacturing industry will be a success or not, but its ultimate success by giving larger yields of sugar per acre of cane is of such importance for the economics of this province that a trial, on the modest lines indicated in the memorandum, appears to be definitely worthwhile.

III. ECONOMICAL.

There is but little on record to show whether this section of the application, as submitted last December received the approval of the Sugar cane Sub-Committee or not. As it is felt that this economical study of the position of sugarcane is a most important part of the whole scheme it is resubmitted.

The Board of Economic Inquiry considered the scheme of Dr. Radha Kamal Mukerji for the investigation of agricultural marketing methods and practices in the United Provinces at its first meeting on November 20, 1931, and approved the scheme. The Board is prepared to undertake a detailed inquiry on the subject with the help of the Bureau of Statistics and Economic Research.

It is proposed to make local investigations in representative districts of the province regarding the cost of production, transit charges, markets, marketing practices, finance, etc., of sugarcane in particular and other agricultural commodities in general. The information thus obtained will be collated and sifted in the office and also thoroughly discussed by a sub-committee of the Board before formulating definite proposals for submission to the Imperial Council of Agricultural Research and the public.

The United Provinces Government have already established a Bureau of economic research since April 1931, and allotted a sum of Rs. 15,570 per annum. The Bureau is at present in the charge of the Director of Land Records who is also the Director of Statistics. A trained Economist is in charge of this Bureau with a staff of investigators. The Economic Bureau has already conducted an inquiry into the visible stocks of wheat and barley in the province and is well adapted by its experience and technical knowledge to undertake an inquiry into the cost of production of sugarcane. The Economic Bureau of the United Provinces Government is in a position to undertake the inquiry immediately which is the subject matter of item No. 4 of the agenda of the Sugar Committee of the Imperial Council of Agricultural Research. The inquiry will be conducted under the supervision of the Director of Statistics.

EXPENSES.

I.—AGRICULTURAL.

The scheme on the agricultural part of the work is expected to be finished within a period of five years, but if however at the end of that period any work remains incomplete, an application for further extension of the period will be submitted.

The details of expenses are as under :—

Agricultural A and B (non-recurring).		Rs.
Apparatus for recording water discharge .. .. .	.. .. .	6,000
(One of these has been installed at Shahjahanpur and another in possession of the department will be erected at Gorakhpur. One is required for Meerut).		
Total Agricultural A and B (non-recurring) .. .. .	.. .. .	<u>6,000</u>

Agricultural A and B (Recurring).
Gorakhpur (in charge of the Deputy Director).

Particulars.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<i>Staff and Establishment.</i>						
One Assistant Sugarcane Expert (250—25—750) Member of Provincial Service.	3,000	3,300	3,800	3,900	4,200	18,000
One Research Assistant (100—10—150).	1,320	1,440	1,560	1,680	1,800	7,800
One Fieldman (30—3—42) ..	360	396	432	468	504	2,160
One Attendant (12—1—16) ..	144	156	168	180	198	840
One Mycologist (200—10—300) ..	2,400	2,520	2,640	2,760	2,880	13,200
<i>Allowances.</i>						
Travelling allowances for Officers and Subordinates.	500	500	500	500	500	2,500
<i>Contingencies.</i>						
Research farm contingencies ..	1,500	1,500	1,500	1,500	1,500	7,500
Manures—Chemical and organic ..	500	500	500	500	500	2,500
Scientific literature	250	250	250	250	250	1,250
Total ..	9,974	10,562	11,150	11,738	12,326	55,750

Meerut (in charge of the Deputy Director).

<i>Staff and Establishment.</i>						
One Research Assistant (110—10—150).	1,320	1,440	1,560	1,680	1,800	7,800
One Fieldman (30—3—42) ..	360	396	432	468	504	2,160
One Attendant (12—1—16) ..	144	156	168	180	192	840
One Entomologist (200—10—300) ..	2,400	2,520	2,640	2,760	2,880	13,200
<i>Allowances.</i>						
Travelling allowance for Officers and Subordinates.	500	500	500	500	500	2,500
<i>Contingencies.</i>						
Research farm contingencies ..	1,500	1,500	1,500	1,500	1,500	7,500
Manures—Chemical and organic ..	500	500	500	500	500	2,500
Scientific literature	250	250	250	250	250	1,250
Total ..	6,974	7,262	7,550	7,838	8,126	37,750
Total Agricultural A and B (recurring).	..	..	..	..	..	93,500

Agricultural C (non-recurring).

	Rs.
Two microscopes	1,800
One Microtome	800
Two incubators and thermostats	750
Two thermographs	260
Two hygrographs	320
Blackman's transpirometer	700
Corks, rubber, tubes, etc.	400
Analytical balance	800
Glass thermoregulators]	100
Miscellaneous	3,000
<hr/>	
Fitting to an existing room for converting it into a Physiological laboratory	2,000
<hr/>	
Total Agricultural C (non-recurring)	10,930

Agricultural C (recurring) (in charge Dr. S. B. Singh) Shahjahanpur.

Particulars.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<i>Staff and Establishment.</i>						
One Research Assistant with special knowledge of plant physiology (150—25—250).	1,800	2,100	2,400	2,700	3,000	12,000
One Chemical Assistant (110—10—150).	1,320	1,440	1,560	1,680	1,800	7,800
One trained fieldman Rs. 65 ..	780	780	780	780	780	3,900
One laboratory assistant (32—3—42)	360	396	432	468	504	2,160
One attendant (12—1—16) ..	144	156	168	189	192	840
<i>Allowances.</i>						
Travelling allowance for visits to sugar-cane growing and other research centres.	1,000	1,000	1,000	1,000	1,000	5,000
<i>Contingencies.</i>						
Miscellaneous expenditure on chemicals and glassware and field requirements.	1,500	1,500	1,500	1,500	1,500	7,500
<hr/>						
Total Agricultural C (recurring) ..	6,904	7,372	7,840	8,308	8,776	39,200

NOTE.—The staff demanded above for the agricultural part (A, B and C) of the scheme, is required in addition to those already employed on the farm in charge of general supervision work. No money has been demanded for capital expenditure, as buildings, laboratories, gas plant and other necessary requirements already exist at Shahjahanpur.

II.—TECHNICAL.

Details of expenditure (Annexure I).

1. One cane crushing plant consisting of two three-roller mill arranged in tandem. Size of rollers—12" dia. × 18" long, complete with double reduction compound gearing. Arranged for belt drive.
2. One oil engine 50 B. H. P. (50 H. P. electric motor).
3. Two *rab* juice receiving tanks size 3' × 3' × 3' complete with strainers.
4. One belt driven centrifugal pump for mill juice, capacity 150 gallons per minute, complete with piping.
5. Three juice collecting and measuring tanks size 3' × 3' × 3' each in one set.
6. Four sets of juice-boiling batteries, each capable of dealing with 125 maunds of juice per day, complete with fire grate, furnace doors, dampers and two chimneys, 20 feet high.
7. Two batteries of two pans each for re-boiling molasses, complete with fire grate.
8. Set of ladles and hand strainers.
9. Eight brass wiremesh strainers, two for each battery of juice-boiling pans.
10. Guttering for juice from measuring tanks to boiling pans.
11. Two centrifugal machines, size of basket 18" diameter, belt-driven, having a maximum working speed of 2,100 B. H. P. each machine to have a separate oil engine, 2½ H. P.
12. 2,000 empty kerosine oil tins for *rab*.
13. Line shafting plumber blocks, pulleys and belting.

	Rs.
Estimated cost	17,000
Total Technical ..	17,000

III.—ECONOMICAL (RECURRING).

Details.—In addition to the present staff of the Bureau, the following additional hands will be required for the investigation of agricultural marketing methods and practices in the United Provinces for a period of two years :—

	First year.	Second year.	Total.
	Rs.	Rs.	Rs.
One research assistant at Rs. 200 p. m. ..	2,400	2,400	4,800
To investigators on Rs. 150 each ..	3,600	3,600	7,200
One clerk on Rs. 40	480	480	960
Total ..	6,480	6,480	12,960

Besides additional staff the following items will also be required in connection with the above investigation :—

				Brought forward ..		Rs.
<i>Allowances.</i>				Rs.	Rs.	Rs.
Travelling allowances for staff ..	..	..	..	1,500	1,500	3,000
Contingencies ..	..	..	..	500	500	1,000
				2,000	2,000	4,000
Total Economical ..				..	..	16,960

An abstract of the cost of the complete scheme.

Name of section.	Non-recurring.	Recurring.	Total.	Remarks.
	Rs.	Rs.	Rs.	
I. Agricultural A & B—				
Meerut	} 6,000	37,750	} ..	Recurring in five years.
Gorakhpur		55,750		
	6,000	93,500	99,500	
C.	10,930	39,200	50,130	Do.
II. Technical	17,000	..	17,000	
III. Economical .. .. .	..	16,960	16,960	Recurring in two years.
Total	33,930	1,49,860	1,83,590	

ANNEXURE 'A'.

Part (I) C of the scheme.

Physiological and Chemical.—Experimental investigation of some of the external and internal factors controlling the growth and final yield of sugarcane. The work under this head will be altogether different from that of a purely academic nature or physiological study of the sugarcane, and will not conflict with any of the scheme, which the Imperial Council might have already sanctioned. It may conveniently be divided into two sections :—

- 1 (a) A detailed study of the growth rate of sugarcane plant and its parts will be made throughout the life cycle. Fortnightly determinations of increase in fresh and dry weights of leaves, stem and root will be made. The term growth is often used to imply an increase in the length of a plant or its organs : but increase in area or length is no sure indication of the increase in the mass of the plant material. Thus an etiolated plant will be longer, though its

dry weight will not compare favourably with that of a normal plant. Growth is to use Dr. F. F. Blackman's phrase, "The finished product of the metabolic loom". The sure index of growth is increase in dry weight and it is only this method that would be adopted to study the growth rate during the progress of this work.

- 1 (b) The increase in dry weight of the plant will be compared with fresh and dry weights of leaves and its area throughout the life cycle to see whether there is any close physiological relation between the relative growth rate and the carbon assimilating area. The observations of Briggs, Kidd and West show a close relation between the growth rate and the area exposed by leaves. Results of similar nature have been obtained by the author of this scheme on cotton plant.
- 1 (c) It is a well known fact that sugarcane plant does not grow so rapidly in the dry months of April, May and June, as during the rainy season even when there is ample moisture in the soil. There is no experimental data to throw any light on the real cause of this retardation in relative growth rate and also whether this retardation is real or apparent. With a view to solve the above problem the following records will be maintained :—
 - (1) Weekly determination of the moisture content in the sugar field upto a depth of 2 ft.
 - (2) A continuous record of temperature, humidity and wind velocity of air and rainfall will also be maintained. Two hourly determinations of transpirations and stomatal opening of a sugarcane plant will be made at weekly intervals.

In certain plants it has been observed that under very dry conditions the stomata close to stop excessive transpiration, but the closure of stomata effectively stops carbon assimilation, resulting in retardation of growth.

- 1 (d) There are marked differences in the behaviour of different varieties of cane under different climatic conditions. It will be very interesting to study the morphological characters of different varieties with a view to correlate these with the marked physiological differences. For instance it was noticed in 1930-31, sugarcane crop in the Meerut Division, that all the varieties were badly damaged by an insect pest *Pyrilla*; except Co. 244 which was damaged only slightly. This comparative immunity to this attack is probably due to some marked difference in the morphology of the leaf of this variety and other varieties which were attacked.

Differences in the size and shape of stomatal opening and intercellular spaces inside the leaf may be responsible for differences of growth rate to some extent. The difference in the character of the epidermal tissue and cuticle of leaves and root system may explain the differences in the behaviour of different varieties under varying climatic and soil conditions. Ecological study therefore may reveal the marked differences in physiological behaviour much before the differences are noticed on the field by varietal trials. This sort of study can prove very helpful to the plant breeder.

II. A detailed study of the variations in the composition of sugar-cane juice from July to March under different manurial conditions will throw light on the effect of different chemicals on the ripening processes of sugarcane. Effect of different elements in the soil like Potassium, Magnesium and Calcium on the ripening of sugarcane will also be studied. These experiments will be carried out mostly in pot cultures.

ENCLOSURE XI.

COPY OF A LETTER FROM THE DIRECTOR OF AGRICULTURE, BIHAR AND ORISSA, AND MEMBER OF SUGAR COMMITTEE, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, No. 5656, DATED THE 28TH JUNE 1932.

With reference to your Memo. No. 1551-A., dated the 23rd June 1932, asking my views on the three schemes of research work on sugarcane of the Punjab, the United

Provinces and the Sugarcane Technologist's scheme, I have the honour to state that I support the Punjab scheme and the Sugar Technologist's research scheme subject to the condition that the Vice-Chairman will please scrutinise the financial details before sanction is accorded.

2. As regards the revised scheme now submitted by the United Provinces, I beg to state that I support the agricultural part (a, b and c) of this scheme but I am not prepared to support Part II—Technical and Part III—Economic—of the scheme for the following reasons :—

- (a) *Part II—Technical.*—This refers to a demonstration to be conducted by the United Provinces Government. As it is not a research scheme it should not be financed from the funds of the Imperial Council.
- (b) *Part III—Economic.*—This part should be merged in the Council's general scheme for the investigation into the costs of production of crops in the principal cotton and sugarcane tracts in India and no separate provision should be made for it under the sugarcane research scheme.

COPY OF A LETTER FROM M. R. RY, RAO BAHADUR T. S. VENKATRAMAN, AVL., B.A., I.A.S., GOVERNMENT SUGARCANE EXPERT, IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 1228 OF 1932, DATED THE 4TH JULY 1932.

With reference to your circular No. 1551-A., dated 23rd June 1932, I have the honour to urge that all the three schemes—the latest scheme in the case of the United Provinces—be again recommended for sanction, subject to the usual scrutiny of budget details by the Vice-Chairman. In doing so, I have the following remarks to offer, certain of them bearing on the discussions at the meeting of the Advisory Board.

2. Sugarcane research needs special treatment at the hands of our Council. The development of the sugarcane industry in India is urgent—as admitted on the floor of the Legislative Assembly, and its best chance is during the period of protection which is by no means too long. To place the Indian industry on a footing of something like equality with that in other countries, a great deal of ground has to be covered during this short period. The fact, that many new factories are definitely known to take shape during the 1932-33 season, it is a happy augury of the future of the industry. To borrow a simile, this infant industry—till very recently in its quiescent stage is just beginning to kick itself back to life and needs almost at once all the best nourishment in the shape of research on all the aspects of the industry.

3. The thorough and proper testing of the new canes in the Provinces is as important as the production of the canes themselves. This necessitates a full equipment at the testing stations for agricultural, chemical and technological work. Out of about hundred seedlings distributed from Coimbatore so far, only about half a dozen have proved their utility after the testing in the Provinces.

4. The agricultural and manurial investigations are inseparably associated with the testing of the canes under the conditions of each locality. From the large number of new canes now available, each tract has now to select, after local experimentation, the ones most economical to grow under its conditions. A particular cane may not necessarily be the highest in sugar value, but if it needs less water, manure or attention in the growing it, it might prove more economical than other canes with greater sugar values. There are many such instances in India today. One of the latest is the growth of Co. 213 at the Sugarcane Research Station, Anakapalle, in the north of the Madras Presidency. This Coimbatore cane, though inferior in sugar contents to the canes under cultivation in the locality, is being taken up on account of the lesser cost in growing this cane and its ability to stand the prevalent cyclones without lodging.

5. The cost of the raw product (cost of cane in the field) is notoriously high in India; and the future development of the industry depends directly upon our ability to bring it down. This, obviously, is a complicated piece of agricultural work involving the testing

of the new canes under different treatments. A full equipment at such stations is therefore a necessity.

6. In the nature of things, it is impossible for a central authority to decide or define the problems for each province, as conditions vary so much. In one case, the paramount problem might be one of water-logging while in another the problem might be the utilization of every drop of water available. In a third place, soil salinity might be the chief trouble. The kind of soil in which the crop is raised differs from place to place and necessitates difference in the kind of investigations to be undertaken. Thirdly, the kind of *gur* liked in each locality differs sometimes very widely including such factors as colour, grain, texture and flavour. This wide difference in the conditions of each province is seen reflected in the kind of cane that has proved useful in the different tracts.*

7. Before concluding, it might perhaps be mentioned that before recommending these three schemes, the Sugar Committee itself constituted a special sub-committee from amongst its Members with the object of scrutinizing, altering and trimming the various items of expenditure.

NOTE FROM SYED MOHAMMAD HADI KHAN BAHADUR ON MEMORANDUM No. 1551-A. OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, DATED THE 23RD JUNE 1932.

Sugarcane is generally recognised in these days of agricultural and economic depression to be the only remunerative crop from the cultivators point of view but with rapidly increasing cultivation of Coimbatore seedlings to the exclusion of the indigenous varieties and with continuous extension, at an astonishing speed, of the cane area, the position of the indigenous sugar industry, especially in the United Provinces, has lately become very precarious. The manufacture of *gur* into which about 72% of the cane crop grown in India is converted, is no longer a profitable concern, because not only has the *gur* of average quality been selling lately at the low rate of about Rs. 2-8-0 per maund, but the commodity does not command a ready sale in the market and large stocks are consequently held up in *gur* producing villages. Although there has been a corresponding fall in the prices of the indigenous forms of white sugar, it is generally recognised that there is still a fair margin of profit in making white sugar by the open-pan system. Under the *Bel-Khanchi* and the *Bel-Centrifugal* Systems, however, the yield of sugar varies only from 4 to just over 5 per cent. and the manufacturers' profits are consequently small. Much more attention is being paid therefore in the Panjab, United Provinces, and Behar than was ever done before towards adoption, in the cottage industry scale, of a profitable but simple and cheap system which would ensure a higher recovery of total sugar from the cane, because the obvious danger is that with the prevailing low prices of *gur*, sugar and molasses and a possible further drop in them, the prices of cane and of juice in tracts where indigenous sugar is manufactured will before long go down to such a low level as to make the cultivation of sugar cane entirely unremunerative for the cultivator, who has no other equally paying crop to fall back upon. The sugar producing industry as a whole is thus threatened with a very severe set back. Unless it is helped within a reasonable time with an improved process of sugar making which would secure a recovery of at least 7 per cent. of total sugar on cane, there is no possibility of averting the evils pointed out above. No branch of sugar research is therefore more important than one which would lead to the development of such a process, and none deserves such earnest attention as this problem demands immediately. No amount of physiological, chemical or agricultural research, however desirable it may be, will help the grower or the manufacturer out of the serious difficulty and danger with which he is confronted at present.

2. In this note I, therefore, emphasise this particular point which forms the subject of Enclosure III attached to the Imperial Council's memorandum, to which reference is invited. The Sugar Technologist's Scheme requires an initial outlay which is by no means inconsiderable, Rs. 52,000 in the first year and Rs. 24,000 during the four years to follow, total Rs. 76,000, besides recurring expenses, amounting to Rs. 91,380 total Rs. 1,57,380. Such a large amount of public money should be sanctioned only after very

* The only co-ordination desirable is the pooling of information about results obtained and this is best arranged through the Council.

carefully considering what return is likely to be obtained by the investment. In the first place, Rs. 52,000 is undoubtedly less than would be actually wanted in the first year, because no less than six (if not seven) centrifugals will be wanted, instead of two provided in the scheme, necessitating an additional outlay of several thousand rupees. Similarly the cost of juice boiling *bele* has been considerably under-estimated. Application for a supplementary grant will have necessarily to follow the application now under consideration, otherwise the quantity of sugar which it is intended to make during the first season could not possibly be manufactured.

3. Reference to head II.—Technical, on page 3 of Enclosure II will show that the grant asked for is wanted mainly for installation of a plant, the specification of which has been prepared by the Sugar Technologist. This plant which is claimed to combine all the good features of the various systems of open-pan boiling, so far practised in India forms the backbone of the scheme now under consideration. Without waiting, however, for the sanction this very plant was actually erected and worked under the auspices of the co-operative department U. P. on various scales at *Newari* (Partabgarh) Mohanlalganj (Lucknow) Ghugli (Gorakhpore) and Gola Gokaran Nath (Kheri). I visited the first two factories during the past season (accompanying the Registrar, Co-operative Societies at Newari) and saw most carefully the work going on at both places. At Newari the plant was working at a calculated loss of about Rs. 25 per diem, the main drawbacks being the heavy cost of extra fire-wood consumed by the furnace and a low out-put. At Mohanlalganj the boiling plant having proved unsuccessful had to be substituted, as the last resort, by the ordinary Rohelkhand *Bel* which produced *rab* yielding unsightly first sugar to the extent only of about 4½ per cent. on the cane, while the molasses did not yield to treatment for manufacture either of molassein gur or of 2nd sugar. At Gola it was the Rohelkhand *bel* that was used in preference to the new rival plant: what happened at Ghugli could no doubt be ascertained by the Council. Several enquirers from the Punjab, United Provinces, and Behar visited the Mohanlalganj Factory and were greatly disappointed. Thus the "demonstrations" given at the co-operative department's above named factories during the past season did more harm than good to the cause of the indigenous industry, by impeding its progress, as within my knowledge several capitalists keen on investing money on a small sugar business were deterred from doing so after visiting Mohanlalganj. In the Hydro-electric area of the Moradabad district, a power crusher was worked by electricity during the past season and the juice was boiled in the Rohelkhand *bel*, with results which I am informed on good authority were "very uneconomical". The Irrigation department is now trying, independently of the Sugar Technologist to find suitable boiling plants to ensure higher recovery of sugar.

4. Such have been the results of the practical demonstrations of a plant which no Co-operative Society in Oudh is willing now to use or to buy in its entirety, at any cost, but for the installation of which at an enormous public expense and at a prominent centre in the heart of Rohelkhand (where experts of the *Bel* Khanchi and the *Bel* Centrifugal systems are to be found in very large numbers), this scheme has been placed before the Council.

5. Reference to page 2 of Enclosure VII will show that the Sugar Technologist's idea was "to train men and to carry on demonstrations in the improved methods of the *Khandeari* industry". It is essentially necessary therefore that in the first instance a process yielding from 7 to 8% of sugar on cane should be perfected and exhaustively tested, so as to justify (a) its demonstrations being given fearlessly in presence of the experts of Rohelkhand, or (b) people being invited to come for "training" in "improved Methods". An abundant supply of cane throughout a season or a multiplicity of crushers or boiling sets or of centrifugals and other accessories will not be wanted for evolving such a process. It would be quite enough if a boiling plant with a suitable furnace is evolved which would work off about 125 maunds of juice in the ordinary working day and produce *rab* of a quality which would yield 7 to 8 per cent. or more of sugar on the cane. Such a plant need not be worked for test purposes throughout a season. One or two tests every week commencing from the beginning of January and going upto the end of the season should furnish enough data for striking a fairly reliable average of sugar recovery for a whole working season. About 200 maunds of cane required for each of such tests can be easily secured once or twice a week either at Cawnpore or at Shahjahanpur. A really good hand or power centrifugal and a pug mill are not difficult to get nor are they expensive. Even a power crusher is not

essentially wanted for such a research as 10 or 12 efficient bullock mills which generally extract a little more juice than three roller power mills can be easily hired and employed with advantage. The cost of a research of this character should be insignificant compared with the large amount demanded, and may conveniently be met perhaps from the special grant already given to the Sugar Technologist by the Government or from the grant for the Shahjahanpur Farm or the general budget of the Agricultural Department or partly from the latter and partly from the budget of the Technological Institute. If not, a reasonable special grant may be sanctioned for this particular purpose by the Imperial Council. The research can even be commenced with a plant designed to deal with smaller quantities than 200 Maunds of cane per day, and when found satisfactory, it can be enlarged.

6. Speaking on the basis of a life-time's experience of research in the open-pan system, I may be permitted to point out that the first essential for improvement of the open-pan industry is the evolution of a system of boiling which would ensure uniformity in the colour of the rab and its richness in sucrose throughout the working day; inversion and caramelisation being minimised and use of fuel other than the bagasse and trash being entirely avoided. It should be the main business of the official entrusted with the research to devise such a system, which it is no easy matter to do, considering that it would be equally necessary that the rab produced should be capable of yielding uniformly a total recovery of 7 to 8 per cent. of sugar on cane in the first half of the season and over 8 per cent. in the latter half. Once this has been done, the rest of the sugar problem is not difficult to solve. Laboratories fully equipped for analytical work on sugar already exist both at Shahjahanpore and Cawnpore, and the necessary chemical assistance is thus available at both centres. All that is wanted, therefore, for research towards development of the desired system of boiling, is a set of bullock mills (or a power crusher) a pug mill and a centrifugal. These appliances are available either at the Shahjahanpur Farm or at the H. B. Technological Institute at Cawnpore; presumably at both places. There is thus quite enough scope already available to the investigator for evolving an improved process of manufacture at either of the above mentioned centres.

7. When such a plant has been evolved, tested, criticised and demonstrated with complete success, then and not till then, should a number of such plants be erected for demonstrative and educative or experimental purposes instead of the unsuccessful sets of pans and inefficient centrifugals such as those included in the scheme under consideration.

My humble opinion therefore is that either the Technologist at Cawnpore or some other officer sufficiently interested in sugar research at Shahjahanpore, should be requested first to bring into existence not more than one set of boiling pans and a furnace which would adequately satisfy the special requirements of the industry just pointed out, and which after public demonstrations and examination by the experts of Rohelkhand is adjudged to be superior in merits to other open-pan systems at present in use. The Sugar Technologists' boiling plant specified in enclosure III and mentioned on page 3 of enclosure II having proved a pronounced failure at no less than four places, where it was elaborately tested during the past season, there will be no object in sanctioning at this stage a huge grant for installing the same plant as ground work for further investigation, at a prominent centre in Rohelkhand, where the time-honoured *bel* system is already working. It would however be only reasonable to ask the Technologist to specify some other plant which he believes would give results markedly superior to those obtained from the Rohelkhand *bel* and give details of the minimum expenses required for working the plant specified. Till the new specification is received by the Council, the scheme embodied in enclosure III should be held in abeyance. It is needless to emphasise the importance in these hard times of avoiding investment of large sums of public money on schemes of doubtful utility.

8. With regard to the scheme for the establishment of a sugarcane research station in the Punjab, I agree with the opinion expressed by the Chairman of the Committee on page 4 of the memorandum.

COPY OF A DEMI-OFFICIAL LETTER FROM L. HAN SAHAI GUPTA, MEMBER, SUGAR COMMITTEE, BILARI (MORADABAD), TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, DATED THE 10TH JULY 1932.

With reference to your No. 1551-A. of the 23rd June 1932, I have to say that I have thoroughly gone through the various points raised therein regarding the three schemes—namely:—

- (i) Scheme for the establishment of a Sugarcane Research Station in the Punjab ;
- (ii) Application from the U. P. Government for a grant for investigation into the problem of Sugar Industry in the U. P. ; and
- (iii) Scheme for a Research and Testing station for the indigenous system of gur and sugar manufacture.

As regards No. (i), I would like to say that this scheme very well seems to fit in with the Sugar Committee's general scheme for a chain of Research Stations. There was some difficulty with regard to selection of suitable site and it was decided that it should be established in a tract where area under cane was steady and Jullundur was recommended for that. Under the circumstances, I am for recommending the grant.

As regards No. (ii), I have seen the papers and read the letter of the U. P. Government and I am for supporting the revised scheme merging the 'Economic' portion in the Council's general scheme for an investigation into the cost of production of crops in the principal cotton and sugar tracts of India.

As regards the Sugar Technologist's scheme for Research and Testing station for the indigenous system of Gur and sugar manufacture, I give my general support to it. I would like to add a word as regards suitability of location since the U. P. Government has mainly recommended Bijnore and Moradabad districts in their letter. As most of the problems dealt with will be of the following nature:—

- (a) Training of artisans ;
- (b) Testing of plants ;
- (c) Devising of plants ;
- (d) Utilisation of power from hydro-electric scheme ;
- (e) Demonstration, etc.,

it is hoped that site selected will be one which has advantages bearing on the points dotted above and besides ensure a regular supply of sufficient cane both thin and thick, soft and hard. It is further expected that in selection of locality due regard will be paid to the fact of the possibility of utilisation of the recommended machinery in the near future by neighbouring manufacturers.

APPENDIX XXXIII.

SUBJECT No. 35.

APPLICATION FROM LIEUTENANT-COLONEL R. N. CHOPRA OF THE SCHOOL OF TROPICAL MEDICINE, CALCUTTA, FOR A GRANT FOR RESEARCH IN SYSTEMATIC CULTIVATION OF MEDICINAL PLANTS AND STUDY OF FOOD POISONS IN INDIA.

Attention is invited to the attached letter (and enclosures) from the Government of Bengal, No. 108, dated the 4th January 1932 (Enclosure I) forwarding the scheme mentioned above. The recommendation of the Provincial Agricultural Research Committee will be found in Enclosure II. The scheme involves an expenditure of Rs. 12,572 per annum or a total expenditure of Rs. 62,860 spread over a period of five years.

2. It is understood that the Indian Research Fund Association gives the school of Tropical Medicine a grant of Rs. 25,000 a year for research in Indian indigenous drugs. This amount is spent on research in connection with the medical aspects of the problem.

3. The scheme was considered (Enclosure III) by the Advisory Board at its meeting held in January 1932. As Colonel Chopra was not present at the meeting to answer the points raised in the course of discussion it was decided to defer consideration of the scheme till Colonel Chopra could attend and reply to the points raised.

4. Lieutenant-Colonel Chopra has accordingly been invited to attend the meeting of the Advisory Board as a visitor. The criticisms made at the Board and the answers to some of them furnished either by Lieutenant-Colonel Chopra or by the Director of the School of Tropical Medicine and Hygiene are summarised in the form of a statement in Enclosure IV.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 26th May 1932.

ENCLOSURE I.

LETTER FROM THE SECRETARY TO THE GOVERNMENT OF BENGAL, AGRICULTURE AND INDUSTRIES DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 108, DATED CALCUTTA, THE 4TH JANUARY 1932.

In continuation of this Department letter No. 7441, dated the 28th December 1931 (Not printed), I am directed to forward herewith another scheme (Annexure I) for research in systematic cultivation of medicinal plants and study of food poisons in India, submitted by Lieutenant-Colonel R. N. Chopra of the School of Tropical Medicine, Calcutta, which has been approved by the Provincial Agricultural Research Committee, Bengal, for inclusion in the agenda of the meeting of the Advisory Board to be held in the current month, together with relevant extracts from the minutes of the committee meeting on the subject.

2. The scheme has been approved by the Government of Bengal (Ministry of Agriculture) on condition that no financial liability devolves on them. One hundred spare copies of the scheme will follow.

* * * * *

Annexure I to Enclosure I.

Papers relating to Colonel Chopra's Scheme for Research in Systematic Cultivation of Medicinal Plants and Study of Food Poisons in India.

LETTER FROM LIEUTENANT-COLONEL R. N. CHOPRA, I.M.S., PROFESSOR OF PHARMACOLOGY, SCHOOL OF TROPICAL MEDICINE, CALCUTTA, TO THE VICE-CHAIRMAN, IMPERIAL COUNCIL IN AGRICULTURE, SIMLA, DATED CALCUTTA, THE 3RD JULY 1930. (THROUGH THE DIRECTOR, SCHOOL OF TROPICAL MEDICINE, CALCUTTA.)

I have the honour to put before the Imperial Council of Agriculture a scheme for research in systematic cultivation of medicinal plants and study of food poisons in India.

2. The subject of cultivation of medicinal plants is important both from medical and economic points of view. India is a veritable emporium of medicinal plants, nearly three-fourths of the drugs mentioned in the British and other Pharmacopoeias grow here in a state of nature. The country possesses climatic conditions varying from the coldest to the hottest, so that the drugs which do not naturally grow within her bounds can be easily made to do so. Acclimatisation is possible in India to a large extent with almost any plant, in fact it has been amply proved in the case of digitalis, ipecacuanha, cinchona, jalap, etc., and there is no reason why the country should not grow every drug to supply her own needs if not for export. As matters stand at present, India imports not only large quantities of drug preparations but also crude drugs to the extent of many millions of rupees annually. Vast tracts of land are lying waste at present in India which if utilised for the cultivation of drugs will not only enrich those concerned in the enterprise but will give the people drugs at a reasonable price. A study of the statistics shows that very little is being done at present in this connection. This fact is indeed deplorable. In countries like Germany and Belgium medicinal plants and essential oil gardens have proved a great success. The State in France is taking a great deal of interest in growing drugs on a large scale and in the United States medicinal herbs are being cultivated on an industrial scale and the cultivators are reaping a rich harvest and making large profits. More interest created in this direction in India will greatly be to the advantage of all concerned. In the United States of America there is a bureau of plant industry attached to the Botanical Survey Department of the Department of Agriculture. This bureau sends its agricultural experts to various parts of the world to investigate into the climate, soil and environments suitable for the growth of a particular plant with a view to its introduction in their own country. Even the Commonwealth of Soviet Russia have a bureau for carrying on drug trade. All these departments are carrying on splendid work for the respective countries. Research in this important branch of agriculture will greatly benefit the country.

3. *Food poisons.*—There are a number of food poisons, both of man and animals, about which very little is known. Examples of these are:—

Beri-beri and epidemic dropsy due to diseased rice ;

Lathyrism due to *Lathyrus sativus* ;

Lolismus due to *Lolium temulentum* ; and

Paspalismus (kodo poisoning) due to *Paspalum scrobiculatum* (kodo), a millet, are known to occur in India. Besides, there are forage poisons communicated to animals. An investigation into these is very important from an agricultural point of view.

If funds are placed at my disposal I propose to work on the following lines:—

(1) To make a general survey of the medicinal plants which are natives of India and of those which have been naturalised. Most of the surveys done are very old and during the last ten years of my association with research in indigenous drugs I have strongly felt that a fresh survey is absolutely necessary.

(2) To get in touch with the Agricultural Departments and Institutions in different provinces and encourage them to grow suitable medicinal plants.

(3) To analyse the medicinal plants so produced in order to see if their active principle come up to the standard required by the pharmacopoeias. In this way it will be possible to determine in what part of the country particular drugs do best.

- (4) To test pharmacologically and therapeutically the action of these drugs.
 (5) To carry out a systematic investigation of different food and forage poisons occurring in the country.

The following staff in addition to what I have will be required to take up this work :—

	Per mensem.	Rs.
One Botanist at Rs. 250 to Rs. 350		3,600
One Chemist at Rs. 250 to Rs. 350		3,600
Two Laboratory Assistants at Rs. 50 each		1,200
Two Lab-boys at Rs. 20 each		480
One Sweeper at Rs. 16		192
Travelling allowance		2,500
Contingencies, etc.		1,000
		12,572
	Total ..	12,572

All the pharmacological and therapeutic testing of drugs and the investigation of food poisons will be done by myself for which the Council will not have to pay anything. The unit will be housed in the Calcutta School of Tropical Medicine and Hygiene. Not only will it have the direction, advice and resources of the Department of Pharmacology at its disposal, but the collaboration of various experts in other departments of the School as well. I am willing to start this work as soon as funds are placed at my disposal.

Annexure II.

DEMI-OFFICIAL LETTER FROM LIEUTENANT-COLONEL R. N. CHOPRA, I.M.S., PROFESSOR OF PHARMACOLOGY, SCHOOL OF TROPICAL MEDICINES, CALCUTTA, TO R. S. FINLOW, Esq., C.I.E., DIRECTOR OF AGRICULTURE, BENGAL, NO. 186, DATED CALCUTTA, THE 2ND OCTOBER 1931.

When I was in Kashmir, you were good enough to write to me about the scheme for research which I put up to the Imperial Council of Agricultural Research. You sympathised with the scheme and said that you would be very glad to collaborate in this investigation. You also suggested that the amount asked for may be cut down. On return from leave I have gone into the matter and I find that the only reduction which I can make is to cut down one laboratory assistant, which will reduce the amount by Rs. 600.

The Imperial Council of Agricultural Research wrote (Annexure III) to me a letter (copy of which I am attaching) asking for some further information. I am also sending you copy of the reply I have given to this communication. I understand that the meeting of the Provincial Council is going to be held shortly. I shall be grateful if you will be so good as to put this matter through.

Annexure III.

DEMI-OFFICIAL LETTER FROM THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, TO LIEUTENANT-COLONEL R. N. CHOPRA, I.M.S., PROFESSOR OF PHARMACOLOGY SCHOOL OF TROPICAL MEDICINES, CALCUTTA, NO. 1244/AGRI, DATED SIMLA, THE 6TH JUNE 1931.

Scheme for research in Systematic Cultivation of Medicinal Plants and Study of Food Poisons in India.

Please refer to your letter, dated the 3rd July 1930 (Annexure I) on the subject mentioned above.

2. I am to enclose an extract from notes prepared in this office for favour of your remarks.

3. We should also like to have any information on the following :—

- (i) The drugs which are at present being imported into India and their marketing.
- (ii) The plants regarding which you propose to make a general survey.

4. If you can arrange to get the scheme through the Provincial Research Committee, and the Local Government, by, say, November next, we shall place it before the Advisory Board in January 1932.

EXTRACT FROM THE FILE REGARDING LIEUTENANT-COLONEL R. N. CHOPRA'S SCHEME FOR RESEARCH IN SYSTEMATIC CULTIVATION OF MEDICINAL PLANTS AND STUDY OF FOOD POISONS IN INDIA.

* * * * *

2. The reference to food poisons seem to me to be a little inaccurate, unless there is newer work of which I am not aware. I was under the impression that beri-beri was definitely proved to be a deficiency disease, due to the consumption of polished rice without the necessary accessory foods, and not due to any disease, or fundamental fault, in the rice itself. Secondly, lathyrism has been shown, by work carried out by the Howards and the Indian Research Fund Association jointly, to be due mainly to weed seeds which are commonly mixed with khesari (*Lathyrus sativus*) and not to the khesari itself. I do not know what the position is as regards kodo-poisoning. We should like to have the latest facts on these points before putting the matter up to the Advisory Board.

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Annexure IV.

LETTER FROM LIEUTENANT-COLONEL R. N. CHOPRA, I.M.S., PROFESSOR OF PHARMACOLOGY, SCHOOL OF TROPICAL MEDICINES, CALCUTTA, TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, DATED CALCUTTA, THE 1ST OCTOBER 1931.

I regret your letter No. 1244/Agri., dated the 6th June 1931 (Annexure III) was not replied earlier as I was away on leave.

2. With reference to the remarks made in the extract from notes prepared by your office, I have to make the following observations :—

(i) *Beri-beri (epidemic dropsy)*.—It is true that between 1925 and 1928 beri-beri was considered to be a deficiency disease, due to consumption of polished rice without the necessary accessory foods. Since then, however, there has been almost a universal change of opinion and the toxic theory has gained ground. Even Colonel McCarrison, whose work on nutritional diseases is well known, appears to think that there is probably a toxic factor present. There are three main schools of thought regarding the causation of beri-beri—(I) Bernard of Saigon who thinks that beri-beri is produced by a bacteria which may infect rice or which may infect the patient; (II) In the Calcutta School of Tropical Medicine we have done a large amount of research work in support of the theory that beri-beri is produced by eating diseased rice. The disease of the rice is produced by its becoming infected with a bacillus very similar to that described by Bernard; and (III) Japanese workers, who think that toxins are present normally in polished rice and these cause the disease; Vitamin B has the power of neutralising these toxins.

(ii) *Lathyrism*.—Here also the position is not clear. There are three theories about the causation of this condition—(I) Stockman's theory of the poison being contained in the seeds is believed by us in the Calcutta School of Tropical Medicine. We, however, consider that this poison is only present in the grains which are cut ripe, and, therefore, germinate; (II) Howard, Anderson and Simenson, who consider that the poison was due to an adulterant called "Akti" or "Akta" (*Vicia sativa*) from which an alkaloid called *vicine* could be obtained; and (III) McCombie Young working with McCarrison thought that the

disease was due to avitaminosis caused by one-sided diet when the people live on *lathyrus sativus*.

A perusal of the above remarks will show that the causation of these two conditions is by no means a settled fact as your office note appears to imply. It is for this reason that research on these conditions is very strongly urged. We in this country are in a most advantageous position to work out the problem and the Calcutta School of Tropical Medicine is particularly fortunate in being situated in the middle of the endemic area of one and near the endemic area of the other.

As regards paragraph 3 of your letter—(1) The majority of the drugs used in the British Pharmacopoeia are being imported into India either in crude form or in the form of finished products. The Custom reports do not give details of quantities of each drug imported but a perusal of the table I am attaching will show you that the total value of these amounts to an average of over Rs. 70,00,000 annually, exclusive of such preparations as proprietary and patent medicines, cod liver oil, etc.

I am of opinion that a good deal of this drain could be saved by increasing the production and improving the quality of these drugs, most of which either grow in India in a state of nature or can be made to grow under suitable conditions. This is only possible if an inquiry such as I have suggested is instituted.

(2) As regards the plants about which I propose to make a general survey, I would say that practically all the important plants, whether those used in the western system or in the indigenous systems, will be involved. I shall begin with the important plants used in the British Pharmacopoeia first and will then go on to the important drugs of the indigenous systems which are largely used by the people of India, and also those which researches in the Calcutta School have shown to be of proved utility.

I am writing to the Provincial Research Committee to put the scheme through the Local Government as soon as possible.

List of crude drugs imported into India.

1. *Aconitum napellus*.
2. *Aloe chinensis* (aloes).
3. *Anacyclus pyrethrum* (pyrethri).
4. *Anthemis nobilis* (anthemidis or chamomila).
5. *Aretostaphylos uva-ursi* (uva-ursi).
6. *Aristolochia serpentaria* (serpentarii).
7. *Arnica montana* (arnica).
8. *Artemisia maritima* (santonin).
9. *Atropa belladonna* (belladonna and atropine).
10. *Berosma betulina* (buohu).
11. *Carum carui* (carui).
12. *Caryophyllum aromaticum* (cloves).
13. *Cinchona succirubra* (cinchona).
14. *Cinnamomum camphora* (camphor).
15. *Citrullus colocynthis* (colocynth).
16. *Claviceps purpurea* (ergot).
17. *Coccus caoti*.
18. *Convallaria majalis*.
19. *Colchicum autumnale* (colohicum).

20. *Croton eluteria* (cascarilla).
21. *Digitalis purpurea* (digitalis).
22. *Erythroxyton coca* (cocaine).
23. *Euonymus atropurpureus* (euonymus).
24. *Ferula foetida* (asfetida).
25. *Gelisemium mitidum* (gelsimium).
26. *Gentiana lutea* (gentian).
27. *Grindelia camphorum* (grindelia).
28. *Guaiacum officinale* (guaiacum).
29. *Haematoxylon campecluanum* (haematoxyli).
30. *Hamamelis virginiana*.
31. *Hemidesmus sarsaparilla* (sarsaparilla).
32. *Hydrastis canadensis* (hydrastis).
33. *Hyoscyamus niger* (hyoscyamus).
34. *Ipomoea purga* (jalap).
35. *Juniper communis* (juniper).
36. *Krameria argentea* (krameria).
37. *Lobelia inflata*.
38. *Papaver rhoeas*.
39. *Picrosma quassioides* (quassia).
40. *Pilocarpus microphyllus* (jaborandi).
41. *Pimpinella anisum* (anisi).
42. *Podophyllum emodi* (podophyllum).
43. *Polygala senega* (senega).
44. *Prunus serolina* (pruni virg).
45. *Quillaja saponaria* (quilliae).
46. *Rhammus purshianus* (caecara sagrada).
47. *Rheum officinale* (rhubarb).
48. *Strophanthus kombe* (strophanthus).
49. *Taraxacum officinale* (taraxaci).
50. *Urginea scilla*.
51. *Valerian officinale* (valerian).
52. *Viburnum prunifolium* (viburnum).
53. *Psychotria ipecacuanha*.

Table showing the quantity and value of drugs and medicines (excluding chemicals and narcotics) imported into India from 1925-26 to 1929-30.

	1925-26.	1926-27.	1927-28.	1928-29.	1929-30.
QUANTITY.					
Camphor (lbs.)	2,945	266	320	776	11,869
Cocaine (oz.)	762	205	398	508	488
Cod Liver Oil (lbs.)	70,787	49,788	65,670	59,754	58,462
Morphia (oz.)	529	854	797	1,355	834
Preparation of opium and morphia	..	..	..	..	..
Proprietary and patent medicines	..	..	..	..	..
Quinine salts (sulphate or bisulphate)	57,999	56,167	44,455	49,297	47,592
Quinine hydrochloride or dihydrochloride.	9,224	8,886	9,164	9,682	9,821
Other salts (lbs.)	4,704	6,323	5,080	5,313	6,593
Saccharin (lbs.)	137	124	1,037	890	3,188
Sarsaparilla and preparation thereof.	..	..	..	..	..
Storax including liquid storax (rose mellas) (lbs.).	43,362	4,200	89	4,200	6,592
Other sorts of drugs and medicines	..	..	..	..	..
Total drugs medicines .. ..	..	..	..	..	..
VALUE.					
	Rs.	Rs.	Rs.	Rs.	Rs.
Camphor (lbs.)	5,405	610	869	1,797	17,381
Cocaine (oz.)	13,088	6,388	8,649	10,385	7,289
Cod Liver Oil (lbs.)	1,16,632	79,111	81,411	81,249	70,148
Morphia (oz.)	13,102	13,307	19,448	22,830	21,343
Preparation of opium and morphia	42,690	78,837	88,746	85,801	75,441
Proprietary and Patent medicines	12,44,325	14,92,904	13,57,526	23,12,712	24,28,660
Quinine salts (sulphate or bisulphate).	15,43,562	12,16,924	9,46,084	10,49,403	10,19,748
Quinine hydrochloride or dihydrochloride.	3,50,959	2,95,518	2,97,306	3,05,975	3,25,424
Other salts (lbs.)	1,36,586	1,35,898	1,40,520	1,39,454	1,68,342
Saccharin (lbs.)	10,274	9,447	17,325	16,510	30,417
Sarsaparilla and preparation thereof.	16,896	10,277	15,985	15,877	20,681
Storax including liquid storax (rose mellas) (lbs.).	12,049	962	100	1,200	2,500
Other sorts of drugs and medicines	49,64,598	52,94,956	54,48,953	48,54,790	53,41,840
Total drugs and medicines	84,70,166	86,35,139	84,22,922	88,97,983	95,29,214

Note on Professor Chopra's scheme, by Dr. G. P. Hector, Economic Botanist to the Government of Bengal.

Colonel Chopra proposes—

- (1) To make a survey of medicinal plants, both native and introduced.
- (2) To get the help of the Agricultural Department in growing suitable medicinal plants.
- (3) To analyse the plants so produced.
- (4) To test the pharmacological and therapeutical action of drugs obtained from these.
- (5) To carry out investigations of food and forage poisons, e.g., beri-beri, lathyrism, lolismus, paspalismus.

The items of work in which the Agricultural Department could assist are (2) and (5).

It might be quite possible for the Agricultural Department to arrange to grow on its various farms medicinal plants required by Professor Chopra, provided he supplied the seeds. Such as do not grow in the plains could be grown at Kalimpong. As regards (5), the Agricultural Department is already in a position to supply almost any information required regarding varieties of rice grown in Bengal, and could easily supply samples of rice required by Professor Chopra for his studies of beri-beri.

The same applies to lathyrism, lolismus and paspalismus.

The Agricultural Department could very easily grow the plants responsible for these and supply samples as required. Items (3) and (4) do not concern the Agricultural Department, nor item (1).

Item (1), survey of medicinal plants, could best be carried out in collaboration with the Botanical Survey at Sibpur, and for this the services of a systematic Botanical Assistant would probably be required for a few years.

The scheme seems to me a very practical one, and one in which this department could easily assist, as explained above.

Annexure V.

LETTER FROM THE SURGEON-GENERAL WITH THE GOVERNMENT OF BENGAL, TO THE SECRETARY TO THE GOVERNMENT OF BENGAL, LOCAL SELF-GOVERNMENT (MEDICAL) DEPARTMENT, NO. 3060, DATED CALCUTTA, THE 28TH FEBRUARY 1931.

I have the honour to submit, for favour of disposal, the accompanying copy of a letter No. 608, dated the 11th February 1931 (Annexure VI) and of its enclosure from the Director, School of Tropical Medicine and Hygiene, Calcutta, in which he puts forward a scheme from Lieutenant-Colonel R. N. Chopra, I.M.S., for a grant of Rs. 12,572 for research in systematic cultivation of medicinal plants and study of food poison in India. I recommend the scheme and accordingly request that it may be transmitted to the Director, Imperial Council of Agricultural Research, New Delhi, as requested therein.

Annexure VI.

LETTER FROM THE DIRECTOR, CALCUTTA SCHOOL OF TROPICAL MEDICINE AND HYGIENE TO THE SURGEON-GENERAL WITH THE GOVERNMENT OF BENGAL, NO. 608, DATED CALCUTTA, THE 11TH FEBRUARY 1931.

In forwarding herewith a scheme from Lieutenant-Colonel R. N. Chopra, I.M.S., for a grant of Rs. 12,572 for research in Systematic Cultivation of Medicinal Plants and Study of Food Poisons in India, I have the honour to state that the need is an urgent one for a closer co-operation between a botanist and a school such as ours, which is devoted to research on tropical diseases. There are many questions regarding food supplies where it is necessary to have such a department attached to the school. At present I am working on beri-beri and epidemic dropsy and have to undertake the study of the classification of the rices, their digestibility, structure and certain diseases that affect the grain. An expert on this subject would be of invaluable help in this investigation. There are, moreover, several diseases that are caused by eating certain grains and pulses. Another very important department is the Pharmacological Department where my colleague, Colonel Chopra, is studying indigenous drugs. Such a department would be invaluable to him in identifying the different samples of drugs. The result of these investigations of Colonel Chopra's are leading to three very important issues—

(1) That of the indigenous drugs which are known to Western medicine there are Indian species often more powerful, and can easily be grown in India. This would lead to the encouragement of the cultivation of these drugs, so that in time India may be self-supporting in this respect.

(2) There are many substitutes such as bitters, etc., that grow in India, and could be utilized more economically than the more expensive Western drugs.

Finally, there are drugs that are used in Ayurvedic, Unani and Tibi medicine, not known to Western medicine, but are extremely useful in the treatment of diseases.

A botanical section would be a very great help to important researches which are being carried on at the school, and in time will ultimately lead to a good deal of benefit to the country. Such a department will bring together those who are working on medicine with the Agricultural Department and the Botanical Survey of India.

I would, therefore, request you to kindly arrange to have the scheme sent to the Director, Imperial Council of Agricultural Research, New Delhi, through the usual channel, as laid down by that Council, namely, through the Provincial Agricultural Research Committee at an early date.

This may kindly be treated as very urgent.

Generally, I support the underlying idea in the proposal which is, in its botanical side, to get together a Liaison Department joining medicine with all departments of Government capable of giving help in the cultivation or exploitation of medicinal plants. The idea is good and deserves support. In the circumstances of a Drug Manufacturing Committee no longer functioning, such a strengthening of the Calcutta School of Tropical Medicine may allow this institution to tackle the work it was once hoped the Drugs Manufacturing Committee could do. Some good may come of it. But I none the less think that the proposal and the methods need to be clarified. On its botanical side a botanist is proposed—

- (1) To make a general survey of the medicinal plants which are natives of India and of those which have been naturalised.
- (2) To get in touch with the Agricultural Departments and institutions in different provinces and encourage them to grow suitable medicinal plants.

I agree whole-heartedly with (2), for it is not improbable that all the departments interested in plants—Forests, Agriculture, Horticulture and Botanical Survey—could help if the Pharmacological Department could specifically indicate the directions in which help is needed. But I am dubious of the immediate practical value of (1), the so-called medicinal plant survey. We have had this before. We have it in academic lists of plants that vary in their importance to medicine. We could extract it easily enough from half-a-dozen standard works that give us some general information on multitude of plants without giving us much help regarding the development of any one in India's conditions. I doubt not for a moment that a dozen or twenty or more plants could be grown profitably to medicine and to India, if the Pharmacological Department could let us have a list of those which its present or to be acquired knowledge of the drug market indicates as likely to repay growing, and can at the same time give us some hope or guarantee of trade sale of our grown stocks, the Departments of Forests, Agriculture, Gardens and Botanical Survey might between them take charge of the twenty or thirty crops or whatever number may be.

I am in complete agreement with Colonel Chopra's method when he argues the economic and makes his proposal stand on its own legs. "It will enrich those concerned and give the people drugs at a reasonable price." My experience here, however, tells me to be wary and that it is easier to be carried away by a sweeping optimism than to get the hard economic facts to justify such optimism. I, therefore, agree at once that what we are asked to grow, or exploit somehow, should offer some chance of paying for itself, which is, I think, the best reason why the list should be restricted.

I should advise letting the survey of Indian medicinal plants be a practical one, finding its impetus in the development of the first twenty selections and the proof that these do pay in India's conditions. But, besides in the Pharmacological Department, a botanist is also wanted at the school to co-operate with workers in other departments and this strengthens Colonel Chopra's proposal.

I have already indicated to Government (in my No. 263, dated the 12th September 1929, to the Director-General, Indian Medical Service) (Annexure VII) how I thought the Botanical Survey could best co-operate in such work, and we have since then had our

offer of help accepted. (A Botanical Survey officer has been deputed to the north-west for the Santonin Enquiry.)

If we can help by putting literature and collections at the disposal of officers of the new Drugs Development Department—so to call it—at the School of Tropical Medicine, or can otherwise co-operate with them in their work, such co-operation may be taken for granted. From the new department I should hope to get advice as to the directions our medicinal plant-growing efforts should take.

In the past I have felt handicapped for lack of such advice, and even when we had produced well and cheaply we have not always been able to dispose of our product.

Colonel Chopra speaks of the import to India of drugs valued at millions of rupees. Some indication of what these are and of their marketing might constitute just the help we require in proving that import is unnecessary and that they can be grown well and profitably in India. For the help that a co-ordinating department, one linking the Medical with producing Departments, is likely to give the Botanical Survey, I support Colonel Chopra's proposal. But I would seek to emphasise the importance of the economic and would let a medicinal plant survey grow out of the economic (*cf.* letter No. 263 above referred to). I am aware that this proposal is heterodox, that it can be criticised as putting the cart before the horse, but I take the view that a survey is not the less pure and scientific because it is economic, and our experience proves conclusively that if any results are to be had they will come through specialisation in drug plants.

C. C. CALDER.

The 12th September 1930.

Annexure VII.

LETTER FROM C. C. CALDER, ESQ., DIRECTOR, BOTANICAL SURVEY OF INDIA, TO THE DIRECTOR-GENERAL, INDIAN MEDICAL SERVICE, No. 263, DATED SIBPUR, THE 12TH SEPTEMBER 1929.

I have the honour to acknowledge receipt of your letter No. 380/6458, dated the 28th June 1929, and to enclose herewith a list of plants of medicinal value that have had their literature indexed here. This work was undertaken at the instance of the Officiating Director, Botanical Survey of India, while I was on leave, and was at once restricted when I returned and suspended as soon as I could suspend it. I did this because I found myself completely out of sympathy with the method of tackling work of this description, and because I saw an increasing expenditure with no commensurate results in the real development of the medicinal resources of India.

2. The aims of developing such resources in this country can, in my opinion, best be attained by good team work involving the co-operation of officers with pharmacological, chemical, botanical and horticultural qualifications, and I was so conscious of the ease with which the real problems could be side tracked that I had to take the responsibility of at once stopping the library ledgering work begun. In my opinion this was no substitute for the combined pharmacological, botanical and chemical work that had to be done, and in it lay the danger of delaying the real effort that had to be made if these resources were to gain the attention they deserved.

3. Moreover, if the work was to be undertaken in the manner in which I had confidence, the ledgering of knowledge already acquired would only give the minimum of help in the practical development of the drug resources. No scientific officer in real earnest in tackling the economic development of a single drug plant would have to spend much time reading up the literature of a scientific, quasi-scientific or popular nature in leading English or American journals that ledgering clerks ignorant of other languages, can deal with. He would go straight to work already quite well indexed (or ledgered) in some of the leading German botanical works and would quickly be on the track of the originals of all the published works of real value to his purpose. Having done this, he would not necessarily be much further ahead as regards Indian products, and the further he went the more would become apparent the little use diffuse ledgering work was. At the same time, the truth that practical results are the outcome of specialisation on particular products would force itself home.

4. This is the truth of all the drug development work accomplished by the various departments in India that have engaged in it and, in my opinion, is the index to organisation for further development. I would seek to revise the term "Field Survey" in connection with medicinal plant work,—not that a proper survey of all the medicinal plant resources of India is not overdue,—but because I would seek from the beginning to emphasize the economic side of the work and look for future support in the fact that the part had directly paid for itself.

5. Further, I feel the term "Field Survey" somewhat loose or diffuse and, unless Field Officers of rare capacity are obtained, likely to be confined in meaning to the compilation and publication of lists of plants of various degrees of importance as drug sources with their geographical distribution and prevalence. This would be very useful work, and I should welcome it, but between the fact of geographical distribution and prevalence of a drug plant and the possibility of its economic development or exploitation by collection or cultivation lies the danger of a large unbridgeable gap, and this danger concentration on pure field survey work would hold. This danger can best be avoided by appointing the officer or officers to develop specific medicinal plants and by leaving their initiative and interest to expand their scope of usefulness by undertaking medicinal plant surveys. This wise one can hope to see the more important drug plants tackled first and the bringing of them to market. In short, I would link the purely scientific with the economic by the creation of a self-supporting economic.

6. That there is the possibility of self-supporting industries in drug plants I have evidence enough from the work we are at present doing with them in the Cinchona Department (apart from the production of quinine).

7. But the problem is first of all a medical one or one in which the Medical Store Department or Pharmacological Departments under the Medical Department can combine to give advice on. We want to have the Medical Department's advice from some of its numerous sections as to what medicinal plants we ought to start with and specialize on. The list should be limited in recognition of the fact that a Drugs Department if so called and formed, separate from present departments, will have to be small to start with and the list should comprise only those drugs for which a constant demand can be guaranteed by Government and in which a constant well established trade goes on. I mention this, because, in the past some of us engaged in drug growing and collection have not been well advised as to the direction our efforts should take, and because loss on this account has occurred. There has been a failure in marketing facilities that, possibly, Medical Stores Department could help us out of. Thus, excess quantities of *Digitalis folia*, *Lycopodium* spores and *Felix mas*, all more or less perishable products, have been left on our hands through absence of official knowledge or demand or absence of marketing knowledge or facilities. Good production work has gone lost. We should therefore stick at first to what is generally and largely needed and what medical stores can take or put us on to the market for.

8. The compiler of the list to be drawn up for our guidance might see this to keep our difficulties in mind by a judicious selection of standard drug necessities. He should also know what is at present being done in the way of medicinal plant cultivation or collection and where it is.

9. I am aware of only a limited number of drug plants at present being exploited.

10. There are at the Cinchona Departments of the Government of Bengal and India (besides the Cinchonas)—

A. (1) *Digitalis*, (2) *Lycopodium* and (3) *Ipecacuanha*.

B. In the Nilgiris—*Digitalis*.

C. In the North-West, (1) *Digitalis*, (2) *Artemisia* (*Santonin*), (3) Possibly *Datura*, (4) *Scilla* and (5) *Atropa*.

11. But this is a very limited list, and there may well be others receiving attention at some of the provincial gardens or by the Forest or Agricultural Departments and regarding which enquiries would have to be made of these departments and gardens before the list, on which further work should be attempted is drawn up. There are also, of course, large

numbers of plant products used in Indian medicine that are getting the necessary attention from traders and Indian practitioners.

12. If the appointment of ledgering clerks or botanical officers engaged in pure medicinal plant survey work is not recommended as the proper way to the development of these resources, it remains to discuss what would be a good organization and how it should be cared for administratively. My view here is that results can only come from team work by medical, chemical, botanical and horticultural officers and that the administrative organization to be successful must recognize the necessity for and take steps to ensure the union of the work. That this is so is, I think, borne out by the history of the organizations already attempted to look after Drugs work.

13. Although work on Indian medicinal resources predates by a long period Sir George Watt's work for his Dictionary of Economic Products, and much knowledge of these plants and their value to medicine had been gained and recognized by the systems of medicine indigenous to India, it is yet true that Sir George Watt's Dictionary work focussed medicinal, chemical and botanical opinion on the immense medicinal resources latent in India and gave a directional impetus to their study.

14. The first conscious organization was largely Sir George Watt's and when the Dictionary came to an end an attempt was made to continue Drugs work by the services of the "Indigenous Drugs Committee." The formation of this committee was an attempt at finding an organisation that could co-ordinate the chemical, botanical and pharmacological work necessary. The Committee had some meaning so long as a Chemist, Dr. Hooper, remained attached to the Economic Section of the Indian Museum, but it never had any power and never functioned satisfactorily, and the subsequent formation of a "Drugs Manufacture Committee" was a tacit admission of the previous failure and recognition of the need for team work.

15. But here again, if one may speak out, the Committee system failed. What was everybody's responsibility was nobody's, and it seems to have been with a feeling of relief that the meetings were postponed *sine die* and that the responsibility was shuffled back to the Botanical Survey Department unequipped as this was for it. It is wrong perhaps to say that it was shuffled back, for the Officer-in-charge then showed a zeal to harbour it that certainly outran discretion, if one judges by the attempt to attain results in the appointment of ledgering clerks, but in any case back it came through the decay of its proper home—the "Drugs Manufacture Committee."

16. I cannot help regretting the abolition of the "Drugs Manufacture Committee", for I should have thought that it was just to such a body properly constituted and given the necessary power that workers in all lines pharmacological, chemical, botanical and horticultural on the medicinal resources of this country would have looked for that co-ordination and co-operation, for that management of team work that is necessary to their effort and that I feel is the key to any advance.

17. The problems are not purely botanical. In my opinion they are not even principally botanical. They are first medical and chemical and these decided, they become combined botanical and horticultural.

18. But if the work is to become the preserve of the Botanical Survey alone, I am quite clear as to the nature of the strengthening required. The aim, I think, should be to make the work pay for itself as quickly as possible, and to this end we need recognition of the fact that we have to import trained horticulturists, there being no horticultural training centre in India.

19. Amongst the limited number of medicinal plants we are at present in practice with I have plenty of problems waiting the trained horticulturists now, and as regards financial results, with one of the drug crops other than Cinchona, we are entering a stage where everything points to operations paying for themselves handsomely, provided always they have the undivided attention of the trained nursery man. This is one of the important drug plants for which a standing demand is assured, and it is such specialization and such work I would seek to extend as the next botanical survey contribution to any scheme for the development of the medicinal resources of this country. In this direction I see results. In the diffuse survey of medicinal plants I see results much less certain. But the problem as a

whole has medical and chemical aspects just as important as the botanical and essential to the success of the botanical, and I think it is necessary before we go any further to recognise the whole problem and the interdependence of its parts in any organization for its solution.

20. Perhaps these suggestions may influence further discussion you may initiate. I regret this late reply to your letter. I was unfortunate in missing Colonel Lapsley at Simla last month. I called on him to discuss these questions with him, but found he had gone on tour.

ANNEXURE II.

EXTRACT FROM THE MINUTES OF THE FOURTH MEETING OF THE BENGAL PROVINCIAL AGRICULTURAL RESEARCH COMMITTEE HELD AT CALCUTTA ON SATURDAY THE 7TH NOVEMBER 1931.

* * * * *

(3) Colonel Chopra's scheme (Annexure I to Enclosure I) for an investigation into :—

- (a) Indian indigenous drugs and the possibility of increasing the supply, not only for home use, but also for export; and
- (b) food poisons :

In regard to (a) it was pointed out that a somewhat similar scheme from Madras had been accepted by the Advisory Board in June 1931, but it was agreed that Bengal has numerous facilities for such an investigation, not only in its wide range of climate and altitude, but in the Royal Botanic Gardens at Sibpur; also especially in the School of Tropical Medicine, and in the large hospitals, where ample facilities for pharmacological and therapeutic testing of drugs are always available.

With reference to (b), a large amount of work has already been done at the Calcutta School of Tropical Medicine on *beri beri* in which the conclusion has been reached that classical *beri beri* as a purely deficiency disease does not account for all the symptoms met with, and that there is evidence that certain types of rice develop a definite poison which produces a disease distinct from classical *beri beri*. There is necessity for further investigation in this direction, also in the investigation of the other food poisons mentioned in the scheme, *viz.*, Lathyrism, Lolismus and Paspalismus.

The Committee adopted the following resolution drafted by Dr. Ghosh :—

“ That Calcutta is a very suitable centre for carrying out the type of work outlined in Colonel Chopra's scheme, and in view of the facilities available in Bengal for this research the Advisory Board of the Imperial Council of Agricultural Research should favourably consider this scheme and, if necessary, decide on the nature of collaboration which is possible between this scheme and the Madras scheme which has already been approved. The Department of Agriculture is prepared to afford all necessary help in any such work done in the province ”.

* * * * *

ENCLOSURE III.

EXTRACT FROM THE PROCEEDINGS OF THE ADVISORY BOARD HELD IN JANUARY 1932.

* * * * *

3. Application from Lt.-Col. R. N. Chopra of the School of Tropical Medicine, Calcutta, for a grant for research in systematic collection of medicinal plants and study of food poisons in India.—The Chairman announced that Col. Chopra was unavoidably prevented from attending the meeting of the Board to explain the scheme, but invited members all the same to comment upon it on the information contained in the papers circulated already. Mr. Mehta said that the problems of the systematic cultivation of medicinal plants was taken up in the United Provinces several years ago and during the War years cultivators made considerable profit by the cultivation of such plants. With the return of normal peace conditions the problem which was chiefly an economic one was—how to get cultivators to grow the right varieties of medicinal plants; and it was to the economic side of the question which he would like Col. Chopra, whose scheme he supported, to pay paramount

importance. Mr. Milne suggested that Col. Chopra should get into touch with the Forest as well as with the Agricultural Departments. Mr. Ware pointed to the need for collaboration of the Veterinary Departments also in so far as the study of food poisons was concerned. Mr. Blascheck while supporting the scheme was of the opinion that the staff proposed was not sufficient to undertake work on such a broad front as indicated by Col. Chopra. Speaking from his experience in the utilisation of minor forest produce, he suggested that work should be concentrated on a few plants. Dr. Agharkar doubted the suitability of Calcutta for this research as most of the medicinal plants were Alpine plants and required a temperature or a cold climate for proper cultivation. In his opinion the question of working up the cultivation of medicinal plants in India was largely a question of organisation. Gen. McGaw who was invited by the Chairman to give his views said that the scheme was very desirable in itself especially as giving an opportunity of linking up medical with agricultural and veterinary research. Nor had he any doubts as to Col. Chopra's competence to undertake the enquiry. In view, however, of his already heavy duties as Professor and as Director of other research enquiries, he doubted whether Col. Chopra would be able to devote adequate attention to this new line of enquiry. While he had no desire whatever to dissuade the Board from recommending the present scheme for sanction, he would prefer a more comprehensive scheme being worked out in collaboration with the various interests concerned, such as the Forest, Agricultural, Botanical and Veterinary Departments. Dr. Coleman informed the Board that in Mysore the Medical and the Forest Departments were co-operating in this work. He was afraid that the one botanist provided for the Scheme would not be able to do much of value as felt that this survey work would have to be carried out by officers of Local Departments, Forest or otherwise. In Dr. Forster's opinion the chemical part of the scheme was defective. One chemist getting as low a pay as Rs. 250 to Rs. 350 per month with two untrained laboratory assistants would not turn out satisfactory work. Whatever chemical work Dr. Chopra required to be done would be better done if he referred it to an Institute where proper facilities for the conduct of such work were available, such as the Dehra Dun Forest Research Institute, the Indian Institute of Science or any University where there was a good chemical side. General Graham while paying a tribute to Col. Chopra's eminence as a research worker referred to the criticisms he had made to Mr. Burt on the original scheme as far back as the middle of 1930. For example, no proposals for plant growing were included in this piece of research, nor at that time had there been any immediate co-ordination of the proposed work with that of the Botanical Survey. He had then suggested that, if the proposals were better defined and perhaps narrowed down somewhat, the scheme could be supported *prima facie*. Mr. Devadhar supported on the grounds of promotion of indigenous industries and swadeshi enterprise and economy. It would create great activity in the forest departments of various provinces thus checking considerably the present 'drain' in this direction, as stated by Col. Chopra in his note on the subject. At this stage the Chairman suggested that as several members had raised points of enquiry which Col. Chopra alone could satisfactorily deal with, the Board might defer consideration of this scheme till Col. Chopra could attend and reply to the points raised. The Board agreed.

M. S. A. HYDARI,

The 25th January 1932.

Secretary.

ENCLOSURE V.

Criticism of the Advisory Board.

REPLY.

(By Col. Chopra.)

1. The staff proposed was not sufficient to undertake work on such a broad front as indicated by Col. Chopra; work should be concentrated on a few plants.

It is only because I shall have the advantage of collaboration with the indigenous drugs inquiry financed by the Indian Research Fund Association that it will be possible for me to work the new inquiry with the small staff I have asked for in my scheme. Most of the chemical, pharmacological and clinical work will be done in collaboration with the staff of the other inquiry. This inquiry will really be

supplementary to the Indigenous drugs inquiry. It was never my intention to carry out this survey on any large scale. On the other hand the difficulty of the identification of medicinal plant is very great. At present there is nobody who has devoted much time to the study of medicinal plants and even the Botanical Survey of India often cannot give us much help. I hope with the help of the Botanist of this inquiry we will be able gradually to collect materials and gain information from the Forest and Agriculture Departments of various provinces so that a rough survey can be made of the distribution of medicinal plants. This would form the basis for a more detailed survey which will be taken up later when funds permit.

With respect to the suggestion that the Department of Agriculture in the different provinces may take up cultivation of 20-30 important drugs, without preliminary investigation such as this inquiry will carry out, I wish to point out that there are a number of instances in this country of failure of such haphazard schemes of cultivating medicinal plants and the waste and disappointment that has resulted. On the other hand, the success and advantages of a thorough investigation before starting plantations are before the world in case of cinchona and ipecacuanha plantations by the Dutch in Java. In suggesting this scheme my idea is to set up the nucleus of an advisory organisation for cultivation of medicinal plants.

(By Director of the School of Tropical Medicine.)

2. In view of his already heavy duties as Professor and as Director of other research enquiries, whether Col. Chopra would be able to devote adequate attention to this new line of enquiry.
3. A more comprehensive scheme should be worked out in collaboration with the various interests concerned, such as Forest, Agricultural, Botanical and Veterinary Departments.
4. One botanist provided for the scheme would not be able to do much of value.

The present application is to enable Colonel Chopra to extend his research work on indigenous drugs from the botanical side. At present the whole of the botanical aspect of the question has to be done in his laboratory or by asking other people to give him help in the matter. The services of a botanist would be of the greatest assistance to Lt.-Colonel Chopra, relieving him of a good deal of this work and forming a link with the botanical side. We would have asked for a much bigger scheme but this would not have been feasible at the present time. Later on if the Board should consider the work to be of the same importance as we attach to it, they will no doubt extend the sphere of the activity of this research by appointing a more highly qualified research worker or workers as they considered to be necessary.

Criticism of the A. B.

(By Director.)

5. One chemist getting as low as Rs. 250 to Rs. 350 per month with two untrained laboratory assistants would not turn out satisfactory work.
6. No attempt at plant growing was included nor was there any immediate co-ordination of the work with that of the Botanical Survey.
- About the Chemical side, Colonel Chopra has the help of Dr. S. Ghosh, Professor of Chemistry at the school and no less than four chemists at his disposal. The Chemist asked for was merely to extend the work already being done on the subject.

APPENDIX XXXIV.

SUBJECT No. 27.

APPLICATION FROM THE GOVERNMENT OF ASSAM FOR A GRANT OF Rs. 48,000 SPREAD OVER FIVE YEARS FOR THE PROPOSED EXTENSION OF SUGARCANE WORK AT THE JORHAT EXPERIMENT STATION, ASSAM.

Attention is invited to this Department Memorandum (and enclosure) addressed to all members of the Sugar Committee, No. 860-Agri., dated the 26th March 1932 (Enclosure I) on the subject of proposed extension of sugarcane work at the Jorhat Experiment Station, Assam.

The Committee, by a majority of 7 against 2 votes, has supported the revised scheme for the consideration of the Advisory Board. Certain members have, however, made suggestions to reduce the cost of the scheme still further. Extracts from their letters and also copies of replies from the two dissenting members will be found in Enclosure II.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 26th May 1932.

ENCLOSURE I.

MEMORANDUM TO ALL MEMBERS OF THE SUGAR COMMITTEE, No. 860-AGRI., DATED THE 26TH MARCH 1932.

Proposed extension of sugarcane work at the Jorhat Experiment Station, Assam.

At its meeting held in August 1930 the Sugar Committee considered an application from the Government of Assam for a grant of Rs. 60,000 non-recurring and Rs. 40,000 recurring per annum for the extension of sugarcane work at the Jorhat Experimental Station. At that time the Local Government stated that they would be prepared to consider an annual grant, so long as the Jorhat Station remained under the control of the Council, of an amount equal to the expenditure they were then incurring upon it, about Rs. 16,000 per annum. The Committee however, did not recommend the scheme and the Local Government were informed accordingly.

2. The Government of Assam have since submitted a revised scheme (Annexure I) which was received too late for consideration at the meeting of the Sugar Committee held in December 1931. This involves a net expenditure from the funds of the Council of Rs. 18,000 non-recurring and Rs. 9,000 recurring. The Government of Assam have however, since reported that there would be an estimated receipt of Rs. 3,000 per annum from the proposed additional area under sugarcane at the Jorhat farm and that this would correspondingly reduce the annual grant to be paid by the Council from Rs. 9,000 to Rs. 6,000 per annum recurring or a total of Rs. 48,000 (Rs. 30,000 recurring and Rs. 18,000 non-recurring) spread over a period of 5 years.

3. The Agricultural Expert to the Council considers the present scheme to be reasonable and supports it. The principal objections to the original scheme have been removed and the scheme is now more in keeping with the area under sugarcane in Assam. It would obviously be an advantage to have a sub-station for the proper testing of Coimbatore seedlings near the Eastern limit of the Northern India sugarcane belt. Moreover though the area under sugarcane in Assam is small the prospects of development have increased on account of the fall in jute prices which has led to increased interest in sugarcane growing in North East India.

4. As it is considered desirable that this scheme should be placed before the Advisory Board of the Council at its next meeting to be held sometime in June or July 1932, and as the scheme itself has now been revised considerably and is much less expensive

than the original one, the views of the members of the Sugar Committee are now sought by circulation.

It is requested that a reply may kindly be sent so as to reach the undersigned not later than 17th April 1932.

ANNEXURE I.

COPY OF A LETTER FROM THE SECRETARY TO THE GOVERNMENT OF ASSAM, TRANSFERRED DEPARTMENTS, SHILLONG, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, NO. 2438-E., DATED THE 5TH DECEMBER 1931.

I am directed to refer to your letter No. 2689/Agri., of 12th November 1931, and to enclose a copy (with fifty spare copies) of a revised sugarcane research scheme (Annexure II) which the Government of Assam have decided to put forward in view of the fact that the scheme outlined in this Department letter No. 1205-E., of 13th May 1930, has not been accepted. I am to explain that the present expenditure and the contribution of the Local Government would be reduced by the economies at present under consideration, when these are known, should the present scheme be accepted by the Council.

ANNEXURE II.

NOTES ON THE PROPOSED EXTENSION OF SUGARCANE WORK AT THE JORHAT EXPERIMENT STATION.

A proposal that Jorhat Experiment Station should be constituted as one of the proposed sub-stations for sugarcane research in Upper India, together with details of the proposed scheme, was submitted to the Imperial Council of Agricultural Research with Mr. Dennehy's letter No. 1205-E., dated the 13th May 1930.

Briefly, the scheme proposed was to extend the area of the Jorhat Farm by about 40 acres and to test under chemical control promising seedling canes which fail to pass the final test at Coimbatore but which might be successful under local conditions in Assam.

The cost of the scheme was estimated at about Rs. 60,000 non-recurring and Rs. 40,000 recurring, and it was suggested that the Local Government would be prepared to consider an annual grant, so long as the Jorhat Station were under the control of the Council, of the expenditure now incurred on it, which is given as approximately Rs. 16,000.

This scheme was not accepted by the Council on the grounds that "the small area of sugarcane in Assam coupled with the poor prospects of extension of sugarcane growing in the province do not justify the establishment of a sugarcane research station there".

In submitting the following revised scheme it may be pointed out that, although the area under sugarcane in Assam is comparatively small, the crop is of considerable importance to the Assamese cultivator especially in the upper districts of the Assam Valley where little else but rice is cultivated. Sugarcane is a "money crop", and the proceeds of the sale of *gur* provide the cultivators with cash for the payment of land revenue, etc.

In the revised scheme now submitted it is proposed to extend the Farm by about 40 acres as in the previous scheme, which would give us about double the present area under sugarcane annually, i.e., about 16 acres instead of 8 in rotation with other crops. This should enable us to test about 50 of the Coimbatore seedlings every year under chemical control in addition to recommended varieties. Other work will include the study of improved methods of *gur* manufacture, preservation and packing, and also manurial and cultivation experiments on sugarcane.

The annual expenditure of the station at present is approximately Rs. 17,000 as against about Rs. 26,000 plus Rs. 18,000 non-recurring under the revised scheme now

submitted. It is proposed that the Experiment Station should continue under the control of the provincial Agricultural Department, the Local Government financing it up to Rs. 17,000 annually, and the balance of Rs. 9,000 recurring being provided by an annual grant for 5 years and a non-recurring grant of Rs. 18,000 from the Research Council.

The additional expenditure involved in the proposed scheme is estimated approximately as follows :—

<i>Non-recurring.</i>				Ra.
(1) Acquisition of land				500
(2) Fencing				5,500
(3) Reclamation				1,500
				1st year Rs. 1,000. 2nd year Rs. 500.
(4) Buildings—				
Cattle shed				3,000
Godown				2,500
Fieldman's quarters				1,000
Cooly quarters				1,500
5. Implements				500
6. Appliances for <i>gur</i> making				2,000
				<hr/>
Total ..				18,000
				<hr/>
<i>Recurring.</i>				
(1) Establishment—				
1 Assistant Farm Manager				864 (average for 5 years.)
1 Chemical Assistant				864 (average for 5 years.)
1 Fieldman				408 (average for 5 years.)
(2) Wages of labourers				2,500
(3) Purchase and feed of cattle				1,000
(4) Seeds, plants, manure, etc.				1,000
(5) Miscellaneous				1,000
(6) Contract contingencies				1,500
				<hr/>
Total ..				9,136 (say Rs. 9,000).
				<hr/>

A. G. BIRT,

Director of Agricultural, Assam.

The 27th November 1931.

ENCLOSURE II.

I

EXTRACT FROM A LETTER FROM MR. R. G. ALLAN, DIRECTOR OF AGRICULTURE, UNITED PROVINCES, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 17212/I.-373-A (20)/5, DATED THE 13TH APRIL 1932.

My only doubt lies in the construction of so many buildings of a permanent type from the Research Council funds. I feel that the Assam Government should express its intention of taking over buildings and fixing at their depreciated value at the end of five years. I think it would be most advisable if this was clear when the proposal is put up in June.

II

EXTRACT FROM A LETTER FROM CHOWDERY MUKHTAR SINGH, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, DATED THE 4TH MAY 1932.

As to the scheme proper I have no objection in its being sanctioned but what I feel objectionable is that the non-recurring amount locked up in buildings will be a dead loss to the Research Council and this should not be encouraged. The local Government should provide money for the buildings themselves. If the money cannot be found then temporary and very cheap arrangement should be made. We have already been given a lead in this connection by Rao Bahadur Venkataraman inasmuch as his expenditure for his sub-stations is very very low. If this can be done in the case of breeding new varieties, it can be more easily done in the case of an ordinary farm.

The amount provided for fencing and reclamation seems to be very high and should be considerably curtailed.

III

COPY OF A NOTE BY RAO BAHADUR T. S. VENKATARAMAN, B.A., I.A.S., IMPERIAL SUGAR-CANE EXPERT, COIMBATORE, No. 664 OF 1932, DATED THE 8TH APRIL 1932.

I am not in favour of the grant being made and for the following reasons :—

(1) The area under sugarcane in Assam is comparatively small, only about 35,000 acres, much less than in some of the Tahsils of the United Provinces. The province does not figure much in the recent Tariff Board Report.

(2) The prospects of improvement of the industry — at any rate through the small grower — is by no means great in the opinion of an expert committee like the Indian Sugar Committee of 1920.

(3) Assam is in the sub-tropics but without any of the natural advantages possessed by the great cane growing tracts of the United Provinces, the Punjab and Bihar.

(4) The possibilities of development, through the establishment of large estates to feed central sugar factories, are not bright either after the example within the last decade of Kamrup with its financial loss estimated at about 5½ lakhs of rupees. Low tonnage, unhealthy climate, difficulty of road communications and scarcity of labour (as a result of the scant population) appear to be certain of the handicaps.

(5) The Indian Sugar Committee have thrown serious doubts upon the suitability of Jorhat for sugarcane work (paragraph 142) and the present scheme is for an extension of this very Jorhat farm.

(6) The scheme includes expenditure for reclamation of land under 'Non-recurring' (item 3). Reclaimed land is not the best for the kind of work contemplated.

(7) Paragraph 2 of the Assam scheme gives undue importance to chemical control in the testing of Coimbatore seedlings. Gurdaspur and Jullundur in the Punjab, Nawabganj and Muzaffarnagar in the United Provinces did not only discover the right cane for the tract, but also spread it over considerable areas in the locality with little or no chemical facilities on the spot. Simple comparative tests on the quantity and quality of gur per acre and needing comparatively less staff are sufficient for discovering the right

type, at any rate during the early stages of the work. The fine chemical control is generally needed only when matters have progressed well beyond the stage of the Assam of to-day.

8. The eight acres, said to be now available at Jorhat for cane work, would appear to be enough for Assam's needs for the present. In more than one station in North India which had discovered and successfully spread improved canes, the annual area under cane has not been far beyond 8 acres.

9. To my mind it would appear desirable that, as far as possible, further monies should be spent on stations which have already shown good work on canes. We shall thus be surer of our monies being spent to the best advantage. Varietal tests have apparently been in progress at Jorhat for over a decade and a half; and one would like to know the tangible results on the cane cultivation in the vicinity.

10. There are quite a number of stations in North India already organized or being organized with the help of our Council funds to test Coimbatore productions; and it is desirable to have more experience before financing a scheme in such a far off and comparatively unimportant province like Assam. In the proposed chain of sugarcane research stations it would appear that the link in Assam could be added sometime later.

In conclusion I feel that the Assam scheme is not of such obvious importance or urgency as to justify the special circulation method now proposed before sending it up to the Advisory Board.

IV

COPY OF A NOTE BY KHAN BAHADUR FATEH-UD-DIN, B.A., M.R.A.S. (E.), A.R.H.S., I.A.S., DEPUTY DIRECTOR OF AGRICULTURE, JULLUNDUR CIRCLE, DATED THE 18TH APRIL 1932.

SUBJECT.—*Proposed extension of sugarcane work at the Jorhat Experiment Station, Assam.*

I am not in favour of this grant being made for:—

(1) Assam, though in the Sub-tropics does not possess the natural advantages possessed by the cane growing tracts of U. P., Punjab and Bihar.

(2) The area under sugarcane in Assam is only about 35,000 acres.

(3) The opinion of the Indian Sugar Committee of 1920, was that the prospects of the improvement of industry were by no means great in that Province.

(4) In paragraph 142, the Indian Sugar Committee has thrown serious doubts upon the suitability of Jorhat for sugarcane work and the present scheme is for the extension of this very farm.

(5) Paragraph 2 of the Assam scheme gives undue importance to chemical control in the testing of Coimbatore seedlings. The Punjab and the U. P. where Coimbatore canes have spread over considerable areas discovered the right cane for their tracts with little or no chemical facilities on the spot. Simple comparative tests on the quantity and quality of gur per acre are sufficient for discovering the right type of cane during the early stages of the work. The chemical control is generally needed only when canes have progressed well beyond the early stages.

(6) The 8 acres said to be available at Jorhat for cane work ought to be enough for Assam's needs at present. Varietal tests have apparently been in progress at Jorhat for over a decade and a half and it would be interesting to know the tangible results these have produced on the cane cultivation in the vicinity.

To me it appears desirable that as far as possible further monies should be spent on stations which have already shown good work on canes. In the proposed chain of sugarcane Research Stations the link in Assam could be added sometimes later.

I may add in conclusion that the Assam scheme does not appear to me so urgent as to be rushed through like that and I suggest that it should come before the Sugar Committee at its next meeting.

APPENDIX XXXV.

SUBJECT No. 28.

APPLICATION FROM MR. A. R. SRINIVASA RAO FOR A GRANT FOR CONDUCTING CERTAIN EXPERIMENTS IN SUGARCANE.

Attention is invited to the attached letters (and enclosures) Nos. 3589-III and 3583-III/30-4, dated the 5th November 1930, and 18th December 1930, respectively (Enclosures I and II) from the Government of Madras regarding an application for a grant for conducting certain experiments in sugarcane. The scheme which is explained in Mr. Srinivasa Rao's letters dated the 20th October 1930 (Annexure to Enclosure I) and the 13th December 1930 (Annexure III to Enclosure II) involves an expenditure of Rs. 5,000 per annum or a total expenditure of Rs. 25,000 spread over a period of five years. The Government of Madras recommend a grant but of a smaller sum—Rs. 1,500 per annum or Rs. 7,500 spread over five years.

2. The Advisory Board at its meeting held in June 1931 decided to refer this scheme to the Sugar Committee which dealt with all schemes of sugarcane research.

3. The Sugar Committee considered the scheme at its fourth meeting held in December 1931 but did not recommend it as the scheme was not considered to be either a research project or a scheme of experimental work. On this Mr. Srinivasa Rao forwarded a representation (Enclosure III) explaining his point of view. The subject was placed before the last meeting of the Advisory Board held in January 1932; but before it could be taken up a fresh representation (Enclosure IV) had been received requesting that the scheme may be postponed till the next meeting of the Board. The consideration of the subject was accordingly postponed.

The scheme is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 26th May 1932.

ENCLOSURE I.

LETTER FROM S. V. RAMAMURTY, Esq., I.C.S., SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, No. 3589-III, DATED THE 5TH NOVEMBER 1930.

I am to forward for favourable consideration the enclosed application, for a grant, of Mr. A. R. Srinivasa Rao for conducting certain experiments in sugarcane and to state that the views of the local Director of Agriculture in the matter, which have been called for, will be forwarded in due course. The applicant's work in the past has been appreciated by Government who have been helping him in the diverse ways detailed in the application.

ANNEXURE.

LETTER FROM A. R. SRINIVASA RAO, 14/2, SENGALANIE PILLAYAR KOVIL ST., MYLAPORE, MADRAS, TO THE SECRETARY, IMPERIAL AGRICULTURAL RESEARCH COUNCIL, NEW DELHI, THROUGH THE SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, FORT ST. GEORGE, No. 3583-IV-30, DATED THE 20TH OCTOBER 1930.

I beg to state that I am one of the promoters of the Pioneer Agricultural Syndicate, Valluvambakkam, an organization started by educated middle class men to carry on agriculture as a business on modern scientific lines. The Syndicate owns a farm of about 40 acres in the abovesaid village of the North Arcot District and the wells in the farm are the only source of irrigation. The farm was originally a plot of uncultivated waste and we reclaimed it at considerable cost.

2. Before we could carry on any cultivation on a commercial scale, we had first to carry on experiments to study the suitability of the locality for particular crops by actual experiments. The first crop that I tried was groundnut and I introduced the ridge system of growing groundnuts which gave me fourfold yield. I herewith enclose an article* by me on 'Groundnut Cultivation' published in the annual Supplement of the 'Hindu', wherein I have shown that the yield could ordinarily be doubled by the adoption of the ridge system of cultivation in the three million acres in this Presidency. I have further shown that by reducing the area to half, we can get the same yield as before and release the other half for growing food crops and thus cheapen food stuffs. My work received the kind attention of His Excellency Lord Goschen, at whose instance the departments of Government examined the question in its various aspects and finally the Government of Madras were pleased to issue G. O. No. Mis.-866,* dated 15th May 1929, a copy of which I herewith enclose. In appreciation of my work, the Government have also been pleased to issue G. O. Mis. No. 1018,* dated 17th June 1929, requesting the Director of Industries to give all the assistance and help in his power besides giving me certain concessions. A copy of this G. O. is also herewith enclosed. I may be permitted to state that the Government of Mysore and the Government of Western Australia are also interesting themselves in this question. The Agricultural Department have repeated this experiment in the Palakuppam Research Station and I understand that this was demonstrated to conference of demonstrators last year. The Agricultural Department have further thought it worth while to exhibit groundnut plants in the agricultural section of the Madras Exhibition last year to demonstrate the superiority of the plant grown under the ridge system in respect of the yield and the ability to withstand drought. In appreciation of my work in groundnut cultivation Mr. C. E. Wood, M.L.C., the Managing Director of Messrs. Parry & Co., has been good enough to direct the manure and machinery departments to give me credit facilities in the firm.

3. The Madras Agricultural Department have been good enough to ask me to take up the work of supplying seeds in respect of groundnut, paddy, fodder cholam, etc., to meet the requirements of the public as there was a long felt want in the country. They have also asked me to multiply sugarcane setts of special varieties for purposes of propagation. At their instance we have supplied specially selected groundnut seeds to His Exalted Highness the Nizam's Government, Zamindars, Co-operative Societies and landholders of this Presidency. For want of resources we have not yet been in a position to develop this side of our activities as yet and the condition of our provincial finance is not encouraging enough to permit us to approach Government for any financial aid.

4. In regard to paddy I conducted an experiment this year to determine the best form of green manure and tried margosa leaves, Pungam leaves, Avaram leaves, Tobacco leaves (refuse), Nona leaves and groundnut leaves each in a separate plot and had a plot manured solely with cattle manure as the check plot. Even before the formation of the earheads, from the growth of the crop in the several plots the District Agricultural Officer who visited our farm was able to fix that the plot with groundnut leaves would come up first and it proved true after harvest. I irrigated the plots once in four to ten days as opposed to the usual method of allowing not less than half a foot of water always to stagnate near the roots. I had the neighbouring ryot's land treated under the latter condition as a check plot and the result showed that I got better yield. If this is confirmed by further trials conducted by the department under more carefully controlled conditions I see the possibility of the present area of double crop lands doubled, the single crop lands converted into double crop lands and a general increase of the area under paddy without any large outlay on the part of the State and with the cost of cultivation reduced to the ryot.

5. I have shown that the Sivapuri chewing tobacco which is at present the sole monopoly of a single village in the whole of India could be grown successfully elsewhere with the cost of cultivation reduced.

6. I have been doing some work in regard to fruit culture for which I believe there is a great future in this Presidency. I see a wide scope for work in this direction and I hope to do some humble work in this and other directions with sufficient encouragement

* Not printed.

and help. I am now trying the Sathguri oranges, Khandabar and Krishnagri grapes, mangoes of a few varieties, Kow pines, Sapodillas, etc.

7. I respectfully beg to invite your attention to the work I am now doing in sugarcane. I am now carrying on for the third time in our farm an experiment on a field scale introducing the Java methods of cultivation. I utilised the material obtained in the first two experiments for purposes of rapid propagation. Even in that short period the introduction of the Java methods of cultivation showed a remarkable advantage in that I was able to grow the crop to a height in six months which was not attained in 12 months by the ryots who followed the indigenous method. I have showed this contrast by the photographic illustrations of the respective fields in my articles* on the Java methods of cultivation in the 'Hindu' to which attention is invited. I have explained the various details of the Java methods so far as they could be incorporated under our conditions in the course of the series of articles* by me published by the 'Hindu'. I enclose the reprints* of the articles on the Indian Sugar Problem and request that they may be treated as part of this application in so far as they detail the method of cultivation. I submit that the line of work I am pursuing is novel and unique. The work done in the Imperial Sugar Cane Station at Coimbatore is confined to the evolution of new varieties by the process of hybridization. The Agricultural Department is confining its attention to multiplication work and manurial trials. My work is restricted solely at present to effecting improvements in the cultural methods. It will thus be seen that my work is in no way duplicatory but entirely supplementary in a direction which deserves thorough research and which has not so far been attempted. It may be that within the limited compass of this application I may not be able in so many words to envisage before the mind's eye the unique nature of my experiments and the promises behind them. But I have no hesitation in saying that the standing crop in our farm just at present will bear testimony to the potentialities of my endeavours in the sugarcane line in regard to the improvement of cultural methods tending to an increase of yield not generally obtained in this country. I may state that I have been taking full advantage of the valuable work so far done by the department in respect of manurial trials and am also going a step further. By long years of patient work the Department has found out that 120 lbs. of nitrogen per acre is the maximum required for a sugarcane crop in this country and that two-thirds of it must be in the organic form. The ryot is at present puzzled at the various forms of chemical manures now being pushed forward in this country and is at a loss to know which to select and which to reject. In my experiments in regard to the introduction of the Java methods of cultivation I am incidentally carrying on a test to find out which chemical manure is most suitable to our conditions. The Imperial Chemical Industries (India), Limited, the Indo-Agriculture Limited, and the Chilean Nitrate Delegation have all been good enough to co-operate with me by supplying me their respective manures free of all cost including transport charges. By the courtesy of Mr. G. R. Hilson, the Director of Agriculture, I am also having the help of the Government Agricultural Chemist and the officers of the Agricultural Department in this behalf. Should it be so desired I shall be only too glad to include in the experiments any special tests that the Madras Department or the Research Council would like me to undertake or test any new canes or seedlings that the Imperial Sugarcane Station at Coimbatore might wish me to try out.

8. It will thus be seen that within a period of two and a half years I was able to do some work which has attracted the attention of various Governments, the public and the press. I beg to invite your attention to the following remarks of Mr. R. D. Anstead, C.I.E., the late Director of Agriculture in his letter No. D.-734/29, dated the 11th May 1929 addressed to the Director of Industries:—

"I have the honour to state that I believe this Syndicate are making an honest and whole-hearted attempt at agriculture on a practical scale. My department have given them every help in its power. . . . I should be very glad if you could see your way to grant them the small concession for which they ask. I am convinced that they are worthy of this help."

Mr. G. R. Hilson, the present Director of Agriculture, continues to take the same interest and has helped me by his advice and guidance. The following extract from the

* Not printed.

letter of the Government Agricultural Chemist would show that he has been taking the same interest :—

“ Your letter of the 21st May 1930 to the Director of Agriculture, Madras has been forwarded to me to render you all the assistance I can in the matter of the manurial experiments with sugarcane proposed by you.”

The officers of the Agricultural Department who have been periodically visiting our farm have been much impressed with our work and have reported favourably.

9. I further beg to submit that I have been receiving innumerable letters of appreciation and enquiry from different parts of the country and herewith submit copies* of a few typical instances to show how my work stimulates the interest of enlightened agriculturists all over the country.

10. It will also be observed that the press is also most sympathetic. I herewith submit a few extracts* from the editorial notes of the ‘ Hindu ’ and the ‘ Swadesamitran ’.

11. During the past two and a half years, we have spent over Rs. 15,000 in bringing the land to a workable condition and carrying out a few experiments. All this money is, in commercial parlance, a block expenditure which awaits replenishment when ultimate results bring profit in years to come. The amount spent so far should have been more, had it not been for the various forms of help that the Government had been good enough to give me such as :—

- (1) the lending of machinery to deepen the wells to enable them to give a continuous supply of water to the pumping engine ;
- (2) the placing at our disposal of boring sets free of rent, transportation charges, etc., with the aid of which we have been able to strike a sub-artesian spring yielding 65 gallons of water per minute in a dry district like ours ;
- (3) the exemption from the payment of compounding fees ;
- (4) the direction to the engineering section to send mechanics whenever required by us ;
- (5) the placing at our disposal of a test engine of the Industries Department for pumping out water to enable the enlargement of the well ;
- (6) the facility of utilising the water diviner to select sites ;
- (7) the facility of utilising improved and up to date agricultural machinery ;
- (8) the availability of technical officers like Agricultural Chemists, Industrial Engineers, Agricultural Officers, etc. ;
- (9) the assignment of land shortly to be made for the purpose of constructing homesteads to farm labourers ;
- (10) the grant of a revolver license to me for the purpose of protecting the lives and properties of the Syndicate ;
- (11) the issue of general instruction by the District Superintendent of Police to the Walaja Station Staff to render all assistance whenever the employees of the farm require such assistance ;
- (12) the prosecution and conviction of habitual cattle trespassers in the farm ;
- (13) the preparation of plans, etc., of the farm ;
- (14) the canvassing of orders for the disposal of our seed stocks, etc., etc.

As it always happens with Indian enterprises, just at a time when we have to do the actual practical work after being satisfied with the success of our experiments we are seriously handicapped for want of funds. I submit that it is not desirable that the work that I have undertaken and pushed through so far amidst great odds should come to a standstill for want of resources. I wish to carry on my experiments in sugarcane on a field scale of ten acres every year for a period of five years so that the results of my experiments

may be conclusive and beyond all doubt. At the rate of Rs. 500 per acre including cultivation costs and other overhead charges a sum of Rs. 5,000 will be required per annum. I therefore request the Research Council to be pleased to sanction a subsidy of Rs. 5,000 per annum for a period of five years. If I stop short at this stage simply for the want of the abovesaid resource, all the expenditure incurred in the past would have been wasted and the results of my experiments which are of considerable importance to the country would become inconclusive. To the extent to which my work is novel and attendant with results which are generally applicable, to that extent the department is saved the expenses of experimenting themselves. It is also open to the department to follow my method in other areas and improve upon them wherever necessary. The work I am now carrying on is a unique experiment over which any State aid would never be thrown away but would redound to the mutual advantage of the State and the people. I maintain that few educated men have done anything to the cause of agriculture on their own initiative in this country. I believe that mine is the only organization in the country. I submit that this small annual subsidy to a man who has done something for the cause of agriculture for the first time in this agricultural country on his own initiative is too modest a request.

12. As much depends upon the condition of the soil at the time of planting and as per Java methods a great deal has to be done by way of preliminary work to bring the land to the proper tilth, the work will have to be commenced early next year. In the circumstances I pray that early orders may be passed on my request.

ENCLOSURE II.

LETTER FROM S. V. RAMAMURTY, Esq., I.C.S., M.L.C., SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, No. 3583-III/30-4, DATED FORT ST. GEORGE, THE 18TH DECEMBER 1930.

In continuation of my letter No. 3583-III/30-2, dated 6th November 1930 (Enclosure I), I am directed to enclose copy of a letter from the Director of Agriculture, Madras, No. L. Dis. No. D./1871-30, dated 11th December 1930 (Annexure I) containing his remarks on Mr. Srinivasa Rao's application (Annexure to Enclosure I), a list of experiments proposed to be done by Mr. Srinivasa Rao (Annexure II) and his letter, dated 13th December 1930 (Annexure III) further explaining the details of his proposed experiments.

2. Mr. Srinivasa Rao's application together with the Director of Agriculture's letter, dated 11th December 1930 and other relevant papers was placed before the Provincial Agricultural Advisory Committee at its meeting held on 17th December 1930. The Committee has also been informed that this Government are at present doing work on sugarcane at the farms in Anakapalle, Samalkot and Palur on a small scale, that the Government of India have been doing work at Coimbatore Sugarcane Station in regard to the breeding of new varieties of cane suitable for North India and recently also for South India and that Mr. Srinivasa Rao's experiments are mainly on methods of cultivation. The Committee after carefully considering all the facts has come to the conclusion that, if the proposed experiments will be helpful not only to Mr. Srinivasa Rao but also to his neighbours, as admitted by the Director of Agriculture, they deserve help even if they are not "fundamental research" and decided that, as it is not possible for the Government at a time of financial stringency to give financial help for the experiments and as the help of the Imperial Council of Agricultural Research has not been asked for any departmental scheme of sugarcane research, the application for help from the Imperial Council of Agricultural Research should be supported. The Committee has considered that on the basis of 20 acres in the farm being used for sugarcane cultivation, help may be given by the Imperial Council of Agricultural Research at the rate of Rs. 300 per acre and accordingly recommended that a grant of Rs. 1,500 a year for five years may be given subject to the condition that if the Director of Agriculture on an examination of the work done recommends the stoppage of the grant at any time, the grant may be terminated then. I am to state that the Government of Madras agree with the Committee's recommendations.

ANNEXURE I.

COPY OF LETTER FROM THE DIRECTOR OF AGRICULTURE, NO. L. DIS. 1871-30, DATED THE 11TH DECEMBER 1930.

I have the honour to state that I have inspected Mr. Srinivasa Rao's holding and regret that I am unable to support his request for a grant from the Imperial Council of Agricultural Research.

Mr. Srinivasa Rao has 40 acres of land. Of this area about half is capable of growing sugarcane but ought not to be asked to do so more than once in four years. Assuming that the whole of this area is suitable for experimental work of which I am not certain, it is too small for the scheme of experiments he has proposed.

The experiments he has proposed to carry out are designed to give him information which he needs himself and which will be of value to his neighbours, but they cannot be regarded as fundamental research. With the exception of experiments 2 and 7 (Annexure II) Mr. Srinivasa Rao is not breaking new ground. Short planting of cane we are endeavouring to spread. Planting on the surface or in a trench depends on local conditions. In Godavari the former is better, in the Arcots the latter appears to be better. Planting in lines is one of our stock recommendations. Ratooning in any shape or form we endeavour to discourage. Earthing up is usually done more than once, but the usual conditions under which cane is grown on paddy land do not permit of earthing up a number of times, apart from questions of expense. Experiment 7 will be a difficult experiment to lay out and it will not be easy to measure the differences if any. Work on methods of growing cane so as to avoid propping of any sort is in progress at Anakapalle.

2. In order to carry out these experiments in a proper scientific manner it would be necessary for the Agricultural Department to station men on Mr. Srinivasa Rao's holding in order to keep the necessary records of observations and to see that the work was done just so. Each treatment would have to be repeated 6 times and not once as proposed.

3. Mr. Srinivasa Rao bought this land 2 years ago at an average cost of Rs. 40 per acre and in the interval has spent Rs. 15,000 in putting it in order, improving wells, erecting necessary sheds, purchasing dead and live stock and in cultivating the land. He has now come to the end of his resources and needs money to carry on. Had he spent his money a little more slowly and got some return for his spending as he went along he would not now be in this position. It is easy to be wise after the event, but that is the position.

4. We like Mr. Srinivasa Rao because he comes to us and enquires and because when we argue with him he does not quote his grandfather or throw himself on the will of God or alternatively say that the cultivator is a dull fellow and will never move and because we look upon him, if he will settle on his holding and try to make it pay, as an agency whereby we shall be able to get into touch with the cultivators of his locality. We would, therefore, like to help him, but some other way than through the Imperial Council of Agricultural Research will have to be found.

ANNEXURE II.

Details of experiments proposed.

<i>As done by the ryot.</i>	<i>Proposed experiment.</i>
1. Preparing setts from the whole cane.	1. Preparing setts from the short planted material.
2. Planting setts straightaway in the land.	2. First spreading the setts side by side at a distance of 3 inches in a nursery and covering it with moist straw and keeping it moist till the buds sprout and transplanting the sprouted setts before the formation of shoot roots.

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| 3. Surface and bed planting. | 3. Deep and line planting. |
| 4. Earthing-up once in the life-time of the plant. | 4. Monthly earthings-up for the first six months. |
| 5. Manuring along the trenches. | 5. Manuring in holes. |
| 6. Uniform irrigation. | 6. Judicious irrigation by the creating of soil mulch to prolong the period and have the drying appearance of the tops before 10 o'clock in the morning as an indication that the plant requires irrigation. |
| 7. Irrigation during the day. | 7. Irrigation during the night. |
| 8. Tying up canes to prevent falling down, or being laid and propping by wire. | 8. Allowing the natural growth. |
| 9. Stripping. | 9. Non-stripping. |
| 10 All the above practices followed. | 10. All the above practices followed. |
| 11 Fresh planting each year. | 11. Ratooning. |
| 12 Sett planting. | 12. Ratoon shoot planting. |

ANNEXURE III.

LETTER FROM A. R. SRINIVASA ROW, 14/2, SENGALANTE PILLAYAR, KOIL ST., MYLAPORE, MADRAS, TO THE SECRETARY TO THE GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT, FORT ST. GEORGE, DATED MADRAS, THE 13TH DECEMBER 1930.

With reference to your memorandum No. 3583-III/30-3,* dated the 5th December 1930, I beg to submit the following note in continuation of my application, dated 20th October 1930 (Annexure to Enclure I).

2. The experiments proposed hereunder relate to the cultural aspect of sugarcane and are intended either to increase the acreage yield or reduce the cost of cultivation. Anything that contributes to help the attainment of either of these two ends must appeal to the average ryot of this country and anything that demonstrates this truth can alone appeal to him.

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| (i) Preparing setts from the whole cane. | Vs. Preparing setts from the short planted material. |
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Short planting is now followed in Government farms solely for the purpose of multiplying setts. What bearing the short planted material as on the yield as such, as compared to the yield obtained, from whole canes has not been separately tried so far and this is a line which deserves research.

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| (ii) Planting setts straightaway in the land. | Vs. First spreading the setts side by side at a distance of 3 inches in a nursery and covering it with moist straw and keeping it moist till the buds sprout and transplanting the sprouted setts before the formation of shoot roots. |
|---|--|

Fifty per cent. of the problem in cane cultivation is uniform germination. Until the formation of shoot roots, the plants depend upon the food stored between the nodes of cane and so need not be buried in the ground for getting shoots. By planting shoots obtained by the proposed method the ryot is sure of the number of plants in the field, avoids the cost of filling up gaps, ensures a perfect stand, saves the irrigation bill for a period of about two months, has a chance of eliminating diseased or ill-developed plants and thus reduces the cost of cultivation. Though this experiment has nowhere been tried, it deserves research.

* Not received.

(iii) Surface and bed planting Vs. Deep and line planting.

Bed planting still persists in spite of the line planting advocated by the Department and its obvious advantages. Beyond explaining the advantages of line planting, the department have not demonstrated the comparative results in yield. The proposed experiment will supply that need.

As regards surface *vs.* deep planting, it may be argued that much depends upon the fact whether the soil is soft or hard and so different tracts require different methods. It is submitted that in either case, deep planting of one to one-and-a-half feet will be beneficial if the method of earthing up followed in Java is adopted as it would aid a well-developed root system which means a vigorous and healthy plant as also the prevention of the easy lodging of the plants by strong winds. I may state that as a result of this practice, not a single plant has been affected in our farm by the recent cyclone, whereas many of the canes of a lesser height have been laid low in the neighbourhood and consequently, a number of ryots have been visiting our farm to study our methods. Further, when heavy soils crack on the surface in the dry season the roots will be affected. Deep planting will spread the roots below the level of fissures. Deep planting need not affect tillering if the monthly earthing-up followed in Java is adopted.

(iv) Earthing-up once in the life. Vs. Monthly earthings-up for the first six months.

Here also it is believed that light soils require constant earthings-up and heavy soils do not. This is due to a misconception of the purpose of this operation. Earthing-up is not done solely for the purpose of giving the plant sufficient hold. As the tendency of the plant is to develop more lateral roots, with each earthing-up the root system develops well and ultimately produces a better growth (please see pages 115—123 of "The Cultivation of Sugarcane in Java" by R. A. Quintus). This has not been tried anywhere in this country for the purpose of demonstrating the difference in yield in the two methods.

(v) Manuring along the trenches Vs. Manuring in holes.

It will be argued that this is a costly method. If the holes are made as described in my article,* it is cheaper. As regards the utility of this method, this is what Mr. R. A. Quintus says in his book referred to above (pages 101—102):

"It is recommended to administer sulphate of ammonia in manure holes and not to scatter it in the furrow, because experiments in which the two methods were compared told decidedly in favour of the manure holes."

The Department have not tried this and proved it a failure.

(vi) Uniform irrigation. Vs. Judicious irrigation by the creation of soil mulch to prolong the period and having the drying appearance of the tops before 10 'clock in the morning as an indication that the plant requires irrigation.

No doubt this is done by the department in respect of their work. But, beyond that, no separate irrigation experiment has been conducted to show how less water and judicious use of water will reduce the cost and increase the yield. When the ryot grows cane in paddy fields, he allows water as he does for paddy because he could get it without any cost. The result of a special experiment conducted for the purpose would create a greater and lasting impression.

(vii) Irrigation during day Vs. Irrigation during night.

Sugarcane plants grow principally by night (see page 49 *ibid*). Any facility given to make the plant food available during the periodicity of growth must have a beneficent effect. No research has been made in this direction also.

(viii) Tying up canes to prevent falling down, or being laid: stripping and propping by wire. Vs. Allowing the natural growth.

* Not printed.

There is a school of thought that is of opinion that growing cane with these costly operations is not worth-while and opinion and practice in other countries also differ. The determination of the actual economic value of these operations is worth-while.

(ix) Cane as the only crop *Vs.* Cane as a mixed crop.

The possibility of growing special short duration economic crops between the furrows, such as radish and other vegetables or ground-nut and its effect on the yield of sugar has not yet been observed. If such short duration crops could be grown without detriment to the main crop, it will keep the land clean, well aerated and reduce the cost of cultivation.

(x) Fresh planting each year *Vs.* Ratoona.

In the following countries, Ratoons are common for a period extending from 2 to 15 years of continuous cane crops: China, The Phillipines, Spain, Cuba, San Domingo, Porto Rico, British West Indies, French Antiles, British Guiana, Peru, Brazil, Egypt, Natal, Mauritius, The Hawaiian Islands, and the Fiji Islands (please see the "World's Cane Sugar Industry" by H. C. Prinsen Geerligs). In Java ratoons are not grown owing to the peculiar conditions of land tenure. (Please see 'Cultivation of Sugar Cane in Java—page 13). In India, the departments do not advocate ratooning lest diseases will become widespread. There is no reason why the practice of burning the trash to kill the germs before allowing ratoons should not be adopted in this country. It will result in considerable saving of time, labour and money of the ryot.

(xi) Setts planting *Vs.* Ratoon shoot planting.

This is done nowhere. I have found it successful. If it is confirmed by further experiments, this will result in considerable saving of the initial cost.

3. The above proposals should be carried out side by side in strips repeating as many as possible, so that the total extent under each trial is not less than half-an-acre. The aggregate extent of strip trials in Government farms is always not much and the results when calculated on acreage basis look very attractive. This disadvantage must be avoided. If land is not found to be enough while observing rotation, we are prepared to acquire the fields adjacent to our farm.

4. Highly technical men are not necessary to carry out the proposed experiments and the resources of the State may be better utilised in more advanced experiments. Arrangements, however, can be made in our farm to maintain accurate records of progress.

5. The first two experiments referred to in my application previously were carried out on a small scale solely for the purpose of multiplying setts by rapid propagation and there was therefore no final harvest of mature canes as yet on the basis of which figures regarding receipts could be furnished.

6. The undertaking of the proposed experiments by the State would entail an expenditure of lakhs of rupees in the acquisition of land, construction of buildings, purchase of implements and live-stock, appointment of gazetted and non-gazetted officers, pensionary contributions, etc., etc. As the Syndicate has already its own organization and is willing to do the whole thing in consultation and co-operation with the Director of Agriculture, the course suggested is prudent and less expensive.

7. The Syndicate is willing to take as apprentices, in course of time, a small number of educated men with *bona fide* interest in agriculture to train them in practical agriculture, which is likely to be of great use to the sons of Mirasdars and other landholders, who may not have attained the necessary proficiency in education to secure admission in an Agricultural College, but yet anxious to get a training in practical agriculture.

8. As the attempt to improve the cultural methods, especially when those methods have nowhere before been tried in this presidency and are based on practices obtained in foreign countries, is novel and is attended with a certain amount of risk and as I have been "making an honest and whole-hearted attempt at agriculture on a practical scale" in the words of the late Director of Agriculture Mr. R. D. Anstead, I submit that I deserve every encouragement as being the first private individual who has begun to introduce novel methods in this agricultural country, on my own initiative. The local Government are not yet committed to a policy of encouraging private research nor is the present occasion

propitious for the consideration of such a policy in the present financial conditions of the province. The Imperial Council of Agricultural Research is already committed to such a policy and by encouraging me, they will be translating into action what so far remains a pious wish on paper, namely the encouragement of private research.

9. I therefore request the local Government to be pleased to strongly recommend my application to the Imperial Council of Agricultural Research for an early and favourable consideration to enable me to commence operations early next year and thus treat the matter as urgent.

ENCLOSURE III.

I understand that my scheme of sugarcane cultivation has been turned down by the Sugar Committee for the reason that the work outlined can neither be considered as research nor called an experiment. It is rather difficult to divine the reasons for the conclusion. It may not be research in the sense that the scheme did not contemplate conduct of fundamental research to arrive at preliminary scientific data or it may be that the Committee considered that my work proposed as it was to be conducted by one who has no scientific degrees could not be designated research. As regards the opinion that my work could not be regarded even as an experiment, I can only draw attention to the work which the department itself has been doing at one or two of its agricultural stations in this Presidency. Attempts made in those stations consist of trials with exotic varieties and selection of those which appear to respond favourably to the conditions of the Indian soil. If all this work has hitherto passed as research or experiment, I fail to see why the use of the same appellation as regards my work should be denied. It is, however, not my purpose to fight for words. I have no objection to my work being regarded simply as an attempt to improve cultural methods. Even here I cannot resist feeling that a work which is admittedly new and which in other countries has yielded satisfactory results cannot fail to be regarded as experiment. All that I stated in my application was that I wished to break new ground. The processes and methods being new to this country, the work was attended with a certain amount of risk and there was no prospect of the department taking up the work and solving those initial difficulties as an antecedent to the adoption of the methods on a field-scale. From the enclosed reprints (not printed) containing my observations and the Madras Agricultural Departmental reply on some of the problems to which I called attention as requiring immediate investigation, it will be observed that practically during all these years the department's work on sugar-cane has not reached a stage when it can be offered to the ryots for adoption with profit or certainty. The most important problem I set out to solve is said to be in the programme of the future. The exigencies of the departmental work may or may not admit of this work, which as a cultivator I regard as most important for immediate adoption, being given the first attention. I, therefore, still regard that my scheme of work is urgent and important if the cane cultivators are to take time by the forelock and utilise the temporary protection afforded to the industry to improve their canes, increase their yield and augment their earnings. The methods of cultivation is certain to revolutionise the practices that are now being adopted by the generality of cultivators in the country. Any work which immediately reflects on the earning capacity of the ryot cannot but be characterised as paramount in importance and deserving of the warmest encouragement and sympathy at the hands of the Government.

To turn to what should be done as regards my future work, I would request information as to whether it is the opinion of the Council that my work is not worth pursuing and whether it is unimportant or, if important, likely to receive the immediate attention at the hands of the Government themselves. As to the early prospect of a Government action in the matter there is as yet no indication and I should think that if a private individual like myself is encouraged it would and could be done more expeditiously and economically. As to my competency to pursue the work I need only refer to my past work on ground-nut and sugarcane and the opinion of the department on it. The plan of work which I submitted was not condemned by the local Agricultural Department as either chimerical or as unnecessary. I have brought this out very well in the analysis I have made in my letter to the Madras Government, dated the 13th December 1930 (Annexure III to

Enclosure II). If the Sugar Committee considered this scheme inadequate in any respect, it is only proper that I should be guided by their advice and suggestions so that the initiation of the work which has been admitted as urgent and important may not be delayed until such time as the department finds itself able to take it up in the future. I have done one year's work. I have gathered very valuable information and gained good experience. I have studied the defects and the continuance of the work for the next few seasons would place at the disposal of the public very useful data regarding what I call the Indianization of this particular Java variety. I am sure that the work could be done and the defects remedied if only the local Agricultural department and the Imperial Research Council take some more sympathetic attitude towards my work. Of course, it would have been better financially for me, looking back to what I have done, if I had simply followed the time-honoured practices. But my ambition was, as stated above, to improve on lines which in other countries have met with remarkable results, to the ultimate good of the country.

I would therefore request once again that some financial assistance should be rendered to me to complete what I have already undertaken, if not to enable me to undertake new or untried lines of work in future for the following reasons :—

- (1) that the local Government and the Director of Agriculture are convinced of the usefulness of the scheme of sugarcane work I have outlined ;
- (2) that such work has not hitherto been attempted and that this is the first attempt of a private educated agriculturist to venture in the experimentation of a practice though tested and found reliable elsewhere was still novel to this country ;
- (3) that this work was treated definitely as an item of experiment in Java itself before it was taken up on the plantations in general ;
- (4) that there is no nearer prospect of the department or any other body engaging itself in the solution of the problems involved in the work ;
- (5) that one year's work has already been done and valuable experience gained ;
- (6) that the work prosecuted to a successful conclusion is capable of yielding definite results superior to those obtained under the present methods of cultivation ;
- (7) that in this novel venture some monetary risk has already been incurred which should legitimately be borne by the department and which would justify assistance from funds constituted for the sake of encouraging and developing new agricultural practices ;
- (8) that there need be no apprehension that any help rendered to this pioneer work would prove an embarrassing precedent to the Council ;
- (9) that the opinion of the Committee is not helpful in that it has not given any constructive suggestions for adoption in, or prosecution of, a work which has been initiated and which if left unfinished would simply mean waste of valuable time and money already expended on it and that it behoves an expert body to give as much assistance as possible in matters of this kind and not simply reject a scheme as a pedagogue would dispose of the essay of a school-boy.

A. R. SRINIVASA RAO.

ENCLOSURE IV.

COPY OF A LETTER FROM MR. A. R. SRINIVASA RAO, TO DIWAN BAHADUR SIR T. VIJAYARAGHAVACHARYA, K.B.E., IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, DATED THE 18TH JANUARY 1932.

May I invite your kind attention to my last letter in which I expressed my willingness and preparedness to be present at the time of the meeting of the Advisory Board. Owing to certain unavoidable circumstances I am compelled to request that the consideration of my scheme of research on sugarcane cultivation be postponed to the next meeting of the Board.

APPENDIX XXXVI.

SUBJECT No. 29.

TRACTOR OPERATING COSTINGS. FORMS PREPARED BY THE BURMAH SHELL OIL STORAGE AND DISTRIBUTING CO., OF INDIA, LLD., BOMBAY. (ENCLOSURES I—X).

PROCEEDINGS OF THE COMMITTEE APPOINTED BY THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH TO EXAMINE THE TRACTOR OPERATING COSTINGS—FORMS PREPARED BY THE BURMA-SHELL OIL STORAGE AND DISTRIBUTING COMPANY OF INDIA, LTD., BOMBAY.

2. The following were present :—

Sir T. VIJAYABAGHAVACHARYA, *Chairman.*

Dr. W. McRAE.

Mr. C. P. G. WADE.

Mr. D. MILNE.

Mr. W. SAYER.

Mr. R. G. ALLAN.

Mr. D. R. SETHI.

Mr. T. F. MAIN.

Mr. S. V. RAMAMURTY.

Rai Sahib Malik CHARAN DAS, *Secretary.*

The following attended as visitors :—

Mr. JOHNSTON.

Mr. LIKHITE.

Mr. SANE.

The Committee sat from 3 to 4-30 P. M. on Monday the 18th July 1932.

3. Mr. Wade opened the discussion by referring to the experiments which the Burma Shell Company had been undertaking in various parts of India and the table of costings which they had circulated for opinion amongst the various tractor experimenting authorities in India and he then asked if there were any points which members wished to discuss further. Mr. Johnston produced a set of figures which he had published dealing with the original tractor experiments in Lyallpur in 1920. From these he showed that the average hours worked by a tractor were some 600 and as at the end of this time the tractor had been worked out. The period 12,000 hours stated by Mr. Wade as the probable working hours life of a tractor was quite impossible. He detailed the fact that they had had considerable trouble in the beginning from faulty designing of the tractor and pointed out the fact that the tractors at that period were nothing like so well designed as they were now.

4. Mr. Sayer said that as regards deep-ploughing with tractors the whole idea was quite wrong. If deep ploughing of the class that Mr. Wade was experimenting with was required, it was far better done by a light Diesel Engine set of cable tackle the capital and working costs of which had been reduced to such an extent that it now compared very favourably with the purchase and upkeep of a couple of big tractors.

5. Mr. Johnston pointed out that it was impossible to work any farm by cable tackle in the Canal Colonies because of the large road space required for the engines and the difficulty of getting over the irrigation channels. He pointed out that they lost some 15 per cent. of their acreage when using this class of tackle.

6. Mr. Sayer remarked that he was not referring to the old steamtackle sets with heavy engines but to much lighter sets which could be moved about with great ease over the land and were comparatively light when it came to transporting them across ditches. They were also quite safe in boggy land as one engine could always wind the other out. Mr. Wade said that they had considered this question but had been afraid that the capital

cost would be too high but in the light of what Mr. Sayer had said about the work, he considered that this was certainly a solution worth examining. Mr. Sayer said that the Diesel engines were much cheaper to work and much lighter to transport from place to place. If tractors were relieved of the excessively hard work of very deep ploughing, there was much greater chance of an economic hour life being obtained from those models which were suitably designed for Indian conditions. He considered that Mr. Wade's figure of 12,000 hours was far too long for any tractor and pointed out that in the last publication of the Ministry of Agriculture and Fisheries with reference to the tour made in the United States of America by three independent investigators sent out, the life of a tractor, if only running repairs were done, was said to be 3,000 hours and that of a tractor which was properly overhauled at intervals as taken at some 6,000.

Mr. Main said he agreed with Mr. Sayer in the question of deep ploughing and thought that the Diesel cable tackle was a much sounder way of tackling this particular side of the proposition. At Dharwar in the Bombay Presidency, a lot of ploughing had been done at 12" to eradicate Hariali grass.

Mr. Wade then gave some further figures which had been obtained from ploughing with a Caterpillar 30 H. P. tractor.

Mr. Allan said that in the Central Provinces they had tried deep ploughing on the heavy soils of the north, with 16-32 tractors and had failed entirely, and had taken to using cable tackle sets since when they had had less trouble and were able to do the work efficiently. The tractor had proved effective in 8" ploughing in Berar.

Mr. Sethi said that they had a large number of tractors working in the sugarcane tract in North Bihar and that in many cases these tractors, under proper management, had done 2,500 hours and were still in perfectly good condition.

Mr. Ramamurty said that they had little tractor work in Madras and that when they made enquiries as regards deep ploughing to be done by the Burmah shell, they were only able to get offers from one man to have his land ploughed at the rates charged by Mr. Wade.

Mr. Sane said that their experience in Baroda were rather varied. Several tractors have been bought in the State. They had one tractor used for demonstration purposes and there were several other tractors—McCormick Deering, John Diesel, etc., which were purchased by large landowners with advances at easy rate of interest from Government. He considered that 1,000 to 1,500 hours was the life of a tractor on deep ploughing. The Chairman then asked what the rest of the members thought of this estimate. Mr. Sayer with whom Mr. Johnston agreed said that he did not consider that the lighter class of tractor could be expected to do much more than 1,000 hours on really deep ploughing. It was finally suggested that the Committee might agree to a life of 5,000 hours being fixed for the lighter class of tractors employed on average agricultural operations while 2,000 was the figure fixed for deep ploughing with heavier tractors.

7. The discussion then centred around the costs of (a) high H. P. tractor solely designed for deep ploughing. Mr. Sayer pointed out that on all other operations except ploughing this tractor would be losing money. Mr. Johnston stated that the tractor should always be worked up to its maximum power as otherwise it would be increasing its running cost in proportion to the work done. Mr. Sayer said that the active life of a tractor consisted of a quarter ploughing, a quarter grubbing, a quarter disc-harrowing and a quarter other work, and that therefore 3/4 of a tractor's agricultural life was spent in doing other work than ploughing. It was therefore essential to keep these proportions in mind when choosing a tractor. Mr. Sethi agreed and pointed out that the McCormick Deering was the tractor in almost universal use all over the North Bihar cane tract. The Chairman asked if this tractor could do practically all work connected with sugarcane. Mr. Sayer pointed out that it was unable to work in the crop and that he was getting out a row tractor which would be able to intercultivate and ridge up the crop besides doing all outside operations.

Mr. Wade then explained the types of tractors with which the Burma Shell Company had experimented with and the results obtained. He pointed out that the 30 H.P. Caterpillar was able to do deep ploughing at a reasonable cost and when it was dismantled at the end of 900 hours, it showed very little signs of wear. He admitted that probably the Burma

Shell Company's supervision in these matters was better than that exercised by the average zeminder. Mr. Sayer pointed out that a tractor of this type in ordinary agricultural work would be extremely expensive in running costs for minor operations. Mr. Allan said that people would jump at having their land deep ploughed at from 20 to 25 per acre as to do a similar operation by hand labour would cost over Rs. 100 and that it was absolutely essential to give a figure of some kind for depreciation because anybody who was starting a contract to do a certain amount of ploughing required to know what figure would cover his work.

Mr. Sayer objected on the ground that we could not pin ourselves down to any figure which we had not actually worked out. Mr. Johnston agreed with this. Mr. Sethi endorsed his opinion.

Mr. Milne then suggested that the column showing 'the life of a tractor' should be left blank and the figures approximately suggested by the committee, *i.e.*, 5,000 and 2,000 should be placed in a foot note below with the explanation of the class of tractor to which they referred and the class of work done. In the Burma Shell Cost sheets it was suggested that the fuel used, the class of land worked and the number of bottoms pulled should be included. This was agreed to.

8. The question of spare parts and replacements was then taken up. Mr. Sayer gave the figures obtained at Pusa for all the classes of tractors which had been experimented with and showed that the cost of spare parts rose very rapidly with the amount of work done by a tractor after a certain period. In the earlier makes of tractors, where the design was frequently faulty, the cost of replacements rose with alarming rapidity until they became more expensive item than the running cost of the tractor in which case it was decided that the tractor should be scrapped as had reached a stage where it was too expensive to work. Mr. Johnston agreed with this and said that they calculated that when the cost of spare parts exceeded the cost of fuel and labour, the tractor was no longer worth working. Mr. Sayer said that the fitting of cylinder liners and better air filters coupled with the slower stroke of the Semi-Diesel engine all contributed to a longer life of the tractor.

Mr. Milne pointed out that the cost of spare parts was in many cases about 3 times as much as the cost of actual part built in the tractor. Mr. Sayer pointed out that one could under no circumstances give any enquirer a fair idea of the cost of ploughing an acre of land from the yearly cost of a tractor as the cost of spare parts rose with the length of life of the tractor and in consequence it was necessary to average the total cost, when the tractor became worn out, over the whole working life in order to get any reliable figures and that figures given to the public without this averaging were apt to be deceptive. He pointed out that the McCormic Deering Tractor during the first year's work at Pusa only cost Rs. 12 for spare parts and 42 in the second year and that these figures gave a totally false idea as to the total cost of ploughing an acre.

Mr. Wade then raised the question of the design of ploughs and said that they had had considerable correspondence with makers and had redesigned ploughs to produce more effective results from the tractors they were working.

Mr. Sayer pointed out that he was by no means in favour of firms who specialised in tractors being accepted as experts in ploughing designs.

Mr. Sane disagreed and pointed out that they had satisfactory results by implements designed by tractor firms.

Mr. Johnston and Mr. Sayer pointed out that the whole question of plough designs had better be left to the firms who specialised in this particular line and that in no circumstances could a plough be taken as part of the tractor; also that the choice of a suitable plough to work behind the tractor was entirely dependent on the local conditions and the soil on which that tractor was expected to work and therefore it was impossible to sell a tractor linked to any particular type of plough and say wherever the tractor did satisfactory work the plough would do likewise.

9. The discussion then turned on belt working.

Mr. Allan said that no work of this kind was done by a contractor who was solely interested in deep ploughing. Mr. Sayer pointed out that it was essential to find out what a

tractor could do on belt work as this was part of its useful occupation, when unable to get on the land. The Director of Agriculture, Madras, said that it would be very useful in a village where it could do other operations such as pumping, ginning cotton, hulling oilseed: so the cost of belt work was necessary. Mr. Allan then said that as this was light work it should be separated entirely from the field working life of the tractor and its cost should be maintained in a separate column.

Mr. Johnston agreed to this.

10. Mr. Allan suggested that it might be advisable if Mr. Wade's annual figures were not published. At the end of the trials it would be possible to supply these as relating to depreciation and stores most accurately. To this Mr. Wade agreed. Mr. Sayer, Mr. Johnston and Mr. Sethi were against any publication at present and the Committee concurred in this. But it was agreed that Mr. Wade's figures should be made available to all persons doing tractor experiments. Mr. Johnston pointed out that it was necessary to obtain a flat rate for the cost of fuel, lubricating oil, etc., and that mention should be made in all reports of the rates for local labour fuel and lubricants in order to clear up any misunderstandings which might arise as to higher costs in the same operations in different places where the soil was of the same class. Mr. Sayer pointed out that it would be a pity to publish any figures of general costs at present as the question of the lighter implements had yet to be further experimented with. He pointed out that implements like discharrrows, grubbers and drills were frequently of the same spread for all classes of tractors. He pointed out that he was experimenting with hinged implements by which the spread of the implement could be regulated to the power of the tractor by which it was being worked. He considered there was a wide field for investigation in this line and that a considerable reduction in costs could then be brought about in the minor operations. The Chairman thought the idea was a good one. Mr. Wade said that they were doing some experiments in this line in collaboration with local firms.

Mr. Sethi agreed. Mr. Sayer said that he had thought of coming up to the Imperial Council of Agricultural Research for a grant to further this work but he felt that the present was perhaps hardly the time to ask for money.

The meeting then concluded.

CHARAN DAS,
Secretary.

The 20th July 1932.

SUBJECT No. 29.

ADVISORY BOARD MEETING, JULY 1932.

The following note, which is accompanied by details of the costs incurred in working the Tractors which have been tried out by the Agricultural Section of the Agricultural Research Institute, Pusa, is drawn up to deal with some of the points which now arise in connection with the Tractor operating costings which have been so kindly furnished by the Burmah Shell Oil Storage and Distributing Company.

FORDSON.

A Fordson Tractor was purchased in 1919 at a cost of Rs. 4,361-10-0.

It was worked for 1,726 hours in the field and for 508 hours on belt work. Upto 1927 she had cost Rs. 2,058 in spare parts and was practically finished as regards heavy work.

In 1928 she was put to light work and has since worked for 393-5 hours and cost Rs. 682-8-0 in spare parts. She is still able to work with a seed drill.

Her cost of spare parts works out roughly at Re. 1 per hour worked, but it will be noticed that a marked increase occurs after 1927 and for this reason I am strongly in favour of a fixed period of say 5 years for depreciation.

In 1920 we purchased an Austin Tractor at a cost of Rs. 4,503.

She worked for 2,207 hours in the field and 816 hours on belt work and was taken off field work in 1927. She cost Rs. 2,476 in spare parts and was practically worked out in seven years.

In 1921 a Cletrao Tractor was purchased at a cost of Rs. 7,500. She worked for 1,246 hours and consumed Rs. 4,039 worth of spare parts upto the end of 1927, when she was taken off heavy field work.

These three tractors represent the initial stages of tractor work in India. They were too light for their work and had many other defects and they show quite clearly the extent to which the cost of spare parts ranks in the depreciation item when any defect in construction is in evidence. Later figures for such tractors as the McCormick Deering show to what an extent improvements in design have lessened the expenditure on replacements.

We have, however, still to find out the average life of a tractor on ordinary field work in order to calculate depreciation properly. Three thousand hours has been taken as a suitable figure in the latest official reports, but we have no data to confirm this. There is a steady rise in repair and replacement costs throughout a tractors working life and it is necessary to fix a period when it becomes too expensive to keep the tractor working. The improvements added lately, such as air filters and cylinder liners have materially added to the working life of tractors in the field and the slower stroke of the crude oil Semi-Diesel seems likely to be a very potent factor in lengthening the life of the Engine in this class of tractor.

In working out costings for tractors for any given year such as we publish annually at Pusa, we take the greatest care to see that spare part costs are distributed over the working life of the tractor to date. In the instance of the McCormick Deering, the first year's spare part costs amounted to only Rs. 12, the second year to Rs. 42. Such figures gave a totally false cost of operating this tractor throughout its life and no acre cost figures can be given with any accuracy until this figure can be averaged out and linked up with depreciation.

(Sd.) WYNNE SAYER.

The 9th July 1932.

Statement showing Output, Consumption and Cost of Cultivation by "Lanz Bulldog Tractor" for the year 1930-31.

Year.	Working hours.	Summary of work done by "Lanz Bulldog Tractor" for 1930-31.									Acreage per hour.			
		Ploughing.		Disc Harrowing.		Grubbing.		Drilling.		Total.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.
		Hours.	Acres.	Hrs.	Acres.	Hrs.	Acres.	Hrs.	Acres.	Acres.				
1930-31 ..	393-09	255-24	195-59	130	232-31	3-85	8-4	4	6-36	..	.77	1-78	5-18	1-59

Consumption.

Year.	Working hours.	K. Oil gallon.	Per hour gall.	Crude Oil gallons.	Per hour gallons.	M. Oil & Gear Oil Gallons.	Per hour gallons.	Grease lbs.	Per lbs.	Waste lbs.	Per hour lbs.
1930-31 ..	393-09	27-68	.06	677-74	1-72	60-25	.15	79	.19	27-37	.07

Cost.

Year.	Working hours.	Analysis of total cost.							Cost per acre.				
		Labour.	K. Oil.	Crude Oil.	Lubri-cants.	Miso. wages.	Spare parts.	Total.	Per hour.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1930-31 ..	393-09	95 11 8	20 1 9	242 2 6	173 10 10	11 3 3	115 4 3	658 2 3	1 10 8	2 2 8	0 14 10	0 12 1	1 0 9
									(1-67)	(2-17)	(-93)	(-76)	(1-05)

Statement showing output, Consumption and Cost of "Belt Pulley Work" by Lanz Bulldog Tractor for 1930-31.

Consumption.

Year.	Working hours.	K. Oil gallons.	Per hour gallons.	Crude oil gallons.	Per hour gallons.	Engine oil gallons.	Per hour gallons.	Grease lbs.	Per hour lbs.	Waste lbs.	Per hour lbs.
1930-31 ..	16.73	1.87	.01	14.11	.84	2	.01	1	.06	5	.03

Analysis of Total Cost.

Year.	Working hours.	Labour.	K. Oil.	Crude Oil.	Lubricants Grease, and Waste, etc.	Spare parts.	Total.	Per hour.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1930-31 ..	16.75	9 3 2	1 4 11	4 6 0	6 8 4	3 2 3	24 8 8	1.46

Statement showing Output, Consumption and Cost of Cultivation by "McCormick Deering Tractor" for the year 1930-31.

Year.	Working hours.	Summary of work done by McCormick Deering Tractor for 1930-31.									Acreage per hour.			
		Ploughing.		Disc Harrowing.		Grubbing.		Drilling.		Total.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.
		Hours.	Acres.	Hours.	Acres.	Hrs.	Acres.	Hrs.	Acres.	Acres.				
1930-31 ..	393.5	81.75	66	261.25	443.25	41	72.92	9.6	19	..	.80	1.69	1.78	2

Consumption.

Year.	Working hours.	K. Oil and Gasoline gallons.	Per hour gallons.	Engine and Gear oil gallons.	Per hour gallons.	Grease lbs.	Per hour lbs.	Waste lbs.	Per hour lbs.
1930-31	393.5	826.5 K. Oil 24 G. Oil	2.10 .06	34 E. Oil 23.5 G. Oil	.08 .06	61.5	.15	17.62	.04

Cost.

Year.	Working hours.	Analysis of Total Cost.							Cost per acre.				
		Labour.	K. Oil & Gasoline.	Lubricants.	Spare parts.	Misc. Wages.	Total.	Per hour.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.	
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1930-31 ..	393.5	93 2 8	632 15 11	138 7 9	46 15 1	12 2 5	923 11 10	2 5 7 (2.35)	2 15 0 (2.94)	1 6 2 (1.39)	1 5 1 (1.32)	1 2 8 (1.17)	

Statement showing output, consumption and cost of Belt Pulley by McCormick Deering Tractor for 1930-31.

Consumption.

Year.	Working hours.	K. Oil and Gasoline gallons.	K. Oil per hour gallons.	Engine and Gear oil gallons.	Per hour gallons.	Grease lbs.	Per hour lbs.	Waste lbs.	Per hour lbs.
1930-31	332	391.75	1.18	48.00	.14	57	.17	17	.05

Analysis of Total Cost.

Year.	Working hours.	Labour.	K. Oil and Gasoline.	Lubricants.	Spare parts	Total	Per hour.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1930-31	332	83 5 3	298 11 8	107 14 4	111 2 2	601 1 5	1 12 11 (1.81)

Statement showing output, consumption and cost of cultivation by "Vickers Tractor" for the years 1929-30 and 1930-31.

Year.	Working hours.	Summary of work done by "Vickers Tractor" for 1929-30 and 1930-31.									Acreage per hour.			
		Ploughing.		Disc Harrowing.		Grubbing.		Drilling		Total.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.
		Hours.	Acres.	Hours.	Acres.	Hrs.	Acres.	Hrs.	Acres.	Acres.				
1929-30 and 1930-31.	802.75	293.50	193.18	461.75	822.74	97.25	172.16	45.25	97.5	1285.58	.97	1.78	1.77	2.18

Consumption.

Year.	Working hours.	K.Oil and Gasoline gallons.	Per hour gallons.	Engine and Gear Oil gallons.	Per hour gallons.	Grease lbs.	Per hour lbs.	Waste lbs.	Per hour lbs.
1929-30 and 1930-31	802.75	2,199.5 K. Oil 80.25 G. Oil	2.74 .10	75.37 E. Oil 55.50 G. Oil	.09 .07	144.5	.18	53.48	.06

Year.	Working hours.	Analysis of Total Cost.						Cost per acre.				
		Labour.	K. oil & Gasoline.	Lubricants, etc.	Spare Parts.	Misc. Wages.	Total.	Per hour.	Ploughing.	Disc Harrowing.	Grubbing.	Drilling.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1929-30 and 1930-31.	802.75	186 13 11	1,780 9 2	362 9 9	777 5 1	71 13 2	3,179 2 1	3 15 4 (3.96)	4 1 3 (4.08)	2 3 6 (2.22)	2 3 10 (2.24)	1 13 5 (1.84)

Statement showing output, consumption and cost of "Belt Pulley Work" by Vickers Tractor for the year 1930-31.

Consumption.

Year.	Working hours.	K. oil and Gasoline gallons.	Per hour Gallons.	Engine & Gear Oil Gallons.	Per hour Gallons.	Grease. lbs.	Per hour. lbs.	Waste. lbs.	Per hour. lbs.
1930-31	249.75	518.50	2.07	58.50	.23	29	.11	17.25	.07

Analysis of Total Cost.

Year.	Working hours.	Labour.	K. Oil and Gasoline.	Lubricants.	Spare parts.	Total.	Per hour.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1930-31	249.75	80 0 8	386 7 7	109 4 5	28 6 4	604 3 0	2 6 8 (2.42)

ENCLOSURE I.

SUBJECT No. 29.

TRACTOR OPERATING COSTINGS.—FORMS PREPARED BY THE BURMAH-SHELL OIL STORAGE AND DISTRIBUTING COMPANY OF INDIA, LTD., BOMBAY.

Attention is invited to the attached copy of a letter from Mr. J. C. Reed, Burmah-Shell Oil Storage and Distributing Company of India, Ltd., Bombay, No. D./A./12, dated the 21st December 1931, on the subject of Tractor Operating Costings (Enclosure II). Criticisms on these statements which have been made by certain authorities in India and abroad together with copies of replies thereto will be found in Enclosures III-X.

The subject is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 13th June 1932.

ENCLOSURE II.

LETTER FROM MR. J. C. REED, BURMAH-SHELL OIL STORAGE AND DISTRIBUTING COMPANY OF INDIA, LTD., BOMBAY, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, NO. D./A./12, DATED THE 21ST DECEMBER 1931.

We now have pleasure in enclosing a series of statements showing the operating costs of each tractor unit that we worked last season. All previous statements that we had have been summarised and extended on to this new type of cost statement. We propose standardising on this form, and will in future produce it monthly for each operating unit, and at the end of the season a complete summary will be prepared on the same forms. We take this opportunity to explain why we have set out the information in this particular way.

Operation.—We think it essential to make it possible to differentiate between different operations, and you will note that although we actually provide for three depths of ploughing, any other operations, such as harrowing, can be substituted, and, in fact, the form, as it now stands, is equally suitable for tractors operating on contract road work.

Maintenance.—Charges under maintenance, we consider, should be divided against those on account of the tractor itself and those on account of the ploughs, or any other machine which is employed actually to cultivate or move the soil. It will be appreciated that maintenance of ploughs, under certain conditions, can be a very heavy charge; therefore it is essential that such charges are known and not confused with the ordinary maintenance of the tractor itself.

Transit.—When a contract undertakes agricultural work or road work, a good deal of his time is spent in going from one job to another. We therefore, think it essential that the costs incurred in this connection should be kept quite distinct from the actual operating costs.

General Charges.—Under this heading the contractor incurs considerable expense in canvassing, organising his units, idle time between contracts, moving from camp to camp, etc. We consider it necessary to keep these quite distinct, as such charges would not be incurred by a farmer owning his own tractor and working his own land. Further, such charges, if not treated separately are apt to give a false impression of the cost of working any particular tractor on any particular operation.

We have set out the costs under three headings:—

- (a) Direct Charges.
- (b) Owner-operator.
- (c) Contractor-operator.

The final costs are shown per hour and per acre (in the latter case the unit can be altered according to the type of work done).

(a) *Direct Charges.*—The figure here covers all labour, fuel, lubricants, materials, spare parts and repairs, and therefore represents the actual out-of-pocket expenses of working a tractor. This, we consider, is a very useful figure for purposes of comparing the efficiency of the various types and makes of tractors. Such information, we think will be welcomed by the tractor manufacturers as well as by the Agricultural Authorities.

(b) *Owner-operator charges.*—These figures take into account the interest and depreciation of the unit, and therefore represent the true cost of a farmer operating his own tractor/plough on his own lands. It is the figure which is most required by the Agricultural Authorities, Zamindars and others whom we are trying to interest in mechanical cultivation, and as it takes into account the interest and depreciation, it is also useful for making comparisons as to whether a low initial purchase price is advantageous or not.

(c) *Contractor-operator charges.*—These figures give the actual costs of the Burmah-Shell operations and should be a very useful guide to any Syndicate, Company or even Zamindar that proposes to set up as a contractor. The overhead expenses incurred by Burmah-Shell are probably rather higher than those that would be incurred by other contractors, because, being pioneers, we cannot afford to take the risk of having inadequate supervision and, further we have a very considerable amount of idle time owing to adverse working conditions and to this scheme being yet in its infancy, and because, owing to the low price of crops, we are unable to obtain work as regularly as it could be obtained if times were normal.

In addition to the cost summaries, we have included a table showing the consumption of fuel, lubricants and grease per hour and per acre for the various operations. This information, we consider, is most essential for everybody, in order that comparisons can be made, and to enable people to estimate costs for the different kinds of work with the different types of tractors.

The information given under the heading "Data" will, we think, be perfectly clear. You will note that we have changed the method of computing the depreciation, as we find it is the practice in America to work on a definite number of hours of life per unit, rather than fix an arbitrary percentage for depreciation irrespective of whether the unit is working or not. We have taken 12,000 hours as being a figure suitable to Indian conditions. This is based on the experience with tractors working in North Bihar, but it is conservative.

Owing to the system previously in force in regard to the collection of data, certain portions of these statements are incomplete, but this will not be so in the statements that will be submitted upon the present Season's work.

We should welcome your comments as to whether you consider the form we have now decided on is adequate in every way, and if you have any suggested amendments, please advise us as early as possible, so that we can make the change before the Season's work has progressed too far. We may say that the information summarised in these statements is made up from a series of field reports and other supporting statements, which we shall be pleased to send you if you are interested.

TRACTOR OPERATING STATEMENT.

Period: 20th February 1931 to 30th June 1931.

DIRECT CHARGES.										COST SUMMARY DIRECT CHARGES.				OVERHEAD CHARGES OWNER-OPERATOR.			COST SUMMARY OWNER-OPERATOR.		OVERHEAD CHARGES CONTRACTOR-OPERATOR.		TRANSIT & GENERAL.	FINAL COST SUMMARY CONTRACTOR-OPERATOR.			MEMORANDUM.		ITEM.	DATA.					CONDITION.	DESCRIPTION.	CONSUMPTION.								
FUEL-LUBRICANTS.					MATERIALS.		Allocation Maintenance Cost.*	Total.	Acres Ploughed or Cultivated.	Time Worked in Hours.	Cost per Hour.	Cost per Acre.	Interest.	Depreciation.	Total.	Cost per Hour.	Cost per Acre.	Supervisors' Salaries.	Supervision. Other Expense.	TOTAL		Cost per Hour.	Cost per Acre.	Rate per Acre per Hour.	Earnings.	Description.		Cost purchase Price Rs.	Estimated Life of Hrs.	Depreciation at Rate Amt. per Anm. or Rs. 479 per 5747/12000 Hr.	Interest at Rate 6% per Anm. of Rs. per month.	FUEL				LUB. OIL		GREASE.					
K. Oil Rate.	Lubricating Oil Rate.	Grease Rate.		Spare Parts.	Repairs and Sundries.	Rs. A. P.															Rs. A. P.						Rs. A. P.					Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Rs. A. P.	Gallons.	Rs. A. P.	Lbs.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	334-029	H. M.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	On the basis of 6 Ploughing months. Rs. A. P.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Lbs.	Lbs.						
1,065 2 4	122-97	187 15 2	103-13	51 9 0	687 1 10	753 14 11	2,402 1 5	528 5	4 8 9	7 3 0	245 9 7	252 14 6	2,900 9 6	5 7 11	8 10 11	306 0 2	114 13 2	1,034 5 5	4,355 12 3	8 4 0	13 0 8	8 0 0	2,672 3 9	5,108 14 0	12,000	252 14 6	245 9 7	2-44	3-86	..	..	..23	..37	..20	..31							
8 15 2	1-03	1 9 3	0-87	0 7 0	687 1 10	753 14 11	16 11 6						16 11 6			404 6 0	151 11 8							638 1 0	12,000																		
							461 8 3						461 8 3											5,746 15 0	..	252 14 6	245 9 7																
1,074 1 6	124-00	189 8 5	104-00	52 0 0	687 1 10	753 14 11	2,880 5 2	334-029	528 5		245 9 7	252 14 6	3,378 13 3			710 6 2	266 8 10	1,034 5 5	4,355 12 3				2,672 3 9	50 0 0	2 years.																		

LOSS: Rs. 1,683 8 6

For Burmah-Shell Oil Storage & Distributing Co. of India, Ltd.,
(Sd.) J. C. REED,
General Manager, Development Department.

Maintenance, Interest, Depreciation and General Charges are allocated Pro rata to No. of Hours employed on each operation.

CONSUMPTION.							
FUEL				LUB. OIL		GREASE.	
Kerosene		Fuel Oil		per Hour.	per Acre.	per Hour.	per Acre.
per Hour.	per Acre.	per Hour	per Acre.				
Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Lbs.	Lbs.
2.30	3.48	.07	.11	.26	.40	.17	.26

Burmah-Shell Oil Storage and Distributing Co. of India, Ltd.,

(Sd.) J. C. REED,

General Manager, Development Department.

ENCLOSURE III.

NOTE BY THE MINISTRY OF AGRICULTURE, LONDON.

The forms relating to the operating costs of tractors employed by the Burmah-Shell Oil Company seem excellent in every way and evidently great care has been exercised in their design to secure all the basal information necessary to give an intelligent analysis according to various circumstances.

There are only one or two points to which attention may be called. It is noticed that the life of the ploughs and other implements used with the tractors is taken to be the same as that of the tractors. In this country it would be usual to assign longer life to the implements than to the power machines.

It is also noticed that in depreciation and interest the tractor and implements are regarded as a unit, the charge being allocated as a composite figure. In this country a variety of implements is used with the tractor on which the charges do not all go to the same department. English practice, therefore, would keep the depreciation and interest of the power machines separate from that of the implements, and it would seem desirable from the point of view of the owner-operator, to keep the charges separate.

The methods used in depreciating implements and machines are the subject of a good deal of discussion. In England tractors are written down 22½ per cent. per annum on a diminishing value basis. This method has the advantage of depreciating more heavily in the early years of the life of the machine and probably brings the valuation more into line with realisation values.

All methods are arbitrary. The real figure can only be obtained after the machine is scrapped.

After deciding the rate of depreciation there are two methods used in this country. The first is to allocate the time taken in the operation and the second on the amount of fuel consumption. Both have their advocates but there is little to choose between them.

It would be interesting and useful in making the analysis of the data to give the age of the tractors or alternatively the number of hours of work actually accomplished prior to the year for which information is being recorded. Fuel and oil consumption as well as repairs will probably be heavier as the machines get older.

The cost summary of the Tractor operating Statements might be given in more detail to meet the convenience of persons who have not the time to go through the big sheets.

It does not appear that the Statements require any alteration. They are admirable for the purpose and have evidently been prepared by an experienced man.

If the Company desire to have an opinion on the costs themselves, this can be given, but at best it would be of very doubtful value because of differences in conditions.

Ministry of Agriculture,
10, Whitehall Place,
London, S. W. 1.

ENCLOSURE IV.

LETTER FROM MR. C. P. G. WADE, BURMAH-SHELL, BOMBAY, TO MESSRS. BURMAH-SHELL OIL STORAGE AND DISTRIBUTING CO. OF INDIA, LTD., LONDON, NO. D./A./1, DATED THE 9TH MARCH 1932.

We thank you for your letter Gen./B./9-32 of the 10th ultimo (not printed) enclosing a copy of the comments (Enclosure III) of the Ministry of Agriculture on the tractor operating statements prepared by us. We have read these comments with very much interest, and are much obliged to the Ministry of Agriculture for their comments and suggestions.

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We have the following further comments to make on the Ministry's note :—

Regarding the keeping of the Depreciation and Interest charges of the various implements separately, we agree that this is desirable, and our reason for treating the tractor and implement as a component unit in the past has been that we have only been carrying out deep ploughing experiments and therefore each unit consists of a tractor and a plough. We are, however, now carrying out some harrowing and seeding work and in future statements will show the Interest and Depreciation charges separately on the tractor and on the various implements.

Regarding the basis of Depreciation, we entirely agree that all methods are arbitrary. We are actually depreciating on the basis of a life of 12,000 hours for the tractor, but are now inclined to think that this life is too long and are proposing to reduce it to 10,000 hours.

We will, in future, give the number of hours of work actually accomplished prior to the period covered by the statement, as we agree this will be very useful for comparative purposes.

We also agree that the cost summary of the tractor operating statements might be given in greater detail to meet the convenience of persons who have not the time to go through the whole of the big statements. We are giving this matter our attention.

We do not think that an opinion on the costs themselves will be of any great value because of the differences in conditions in India and England as pointed out by the Ministry.

ENCLOSURE V.

FROM THE DEPUTY DIRECTOR OF AGRICULTURE, S. D., DHARWAR, TO THE DIRECTOR OF AGRICULTURE, B. P., POONA, No. C./24 OF 1932, DATED CAMP HIREKERUR, THE 16TH JANUARY 1932.

With reference to your letter No. 688/266 of 9th instant (not printed) I have the honour to return herewith the five statements together with the following remarks :—

- (1) The statement designed gives a clear idea of the cost of fuel and lubricants and is quite in order so far as the columns under this head, are concerned.
- (2) Under the head of materials it is not clear whether charges of spare parts and repairs are normal or due to accidents. It is desirable that they should be divided into two sections, normal and abnormal due to accidents. If this is not done, the charges may be normal in one case whereas abnormal in another and it is not possible to study the relative merits of different tractors.
- (3) Under the heads of interest and depreciation charges should be calculated only on the tractor and the particular implement used rather than all the implements purchased with the tractor as is done in the case of John Deere Tractor.
- (4) Drivers' wages and Supervisors' salaries during idla time should be divided into three parts as under :—
 - (a) Due to weather conditions being unfavourable for ploughing.
 - (b) Due to break down of the machinery.
 - (c) Due to want of land for ploughing.

This is necessary to enable the owner or contractor-operator to understand which is avoidable and which is not.

- (5) The column of supervision (other expense) does not give any clear idea but the charges under it are very heavy. The contractor-operator would like to know definitely and separately what other main expenses are so that he would see whether he could avoid or control them.

From the perusal of all the five sheets, I find that overhead charges of the contractor-operator are very heavy and prohibitive and it seems necessary that they should be divided to two classes, avoidable and unavoidable, as explained above.

I am sending a copy of this letter to Burmah-Shell, Bombay, as they have asked me also separately to offer my remarks.

No. C./25 OF 1932 DATED CAMP HIREKERUR, THE 17TH JANUARY 1932.

Copy forwarded with compliments for information to Burmah-Shell Co., Bombay with reference to their letter No. D.C.-D./A./12 of 21st December 1931.

ENCLOSURE VI.

LETTER FROM MR. C. P. G. WADE, BURMAH-SHELL, BOMBAY, TO THE DEPUTY DIRECTOR OF AGRICULTURE, SOUTHERN DIVISION, DHARWAR, No. D./A./17-B., DATED THE 20TH JANUARY 1932.

We thank you for the copy of your letter No. C./24 of 1932 of the 16th instant (Enclosure V) addressed to the Director of Agriculture. We have the following comments to make on your remarks:—

- (2) The report on the season's working will clearly show any spare parts and repairs that can be considered abnormal, and we do not think it desirable to subdivide the headings of materials further in our statistical statements. These statements should be considered as a whole together with the report we will be publishing on the season's work.
- (3) Under the system in force for this season's statistics, interest and depreciation charges will be calculated only on the tractor and the particular implement used therewith.
- (4) Although in theory we agree with your suggestion, in actual practice we think it would make the statement very clumsy if we were to make the further divisions suggested by you. We will endeavour, however, to bring out the points mentioned by you in our comments and report on the whole season's working. The supporting statements we receive in this office from the field give all the information required, and can be supplied to anyone who applies to us for the same.
- (5) In the statistics for the current season's working, the supervision charges will be allocated more accurately and in a more detailed manner to individual units.

We are much obliged to you for your comments on our statements and shall always be glad to have any suggestions you may care to make in connection with our tractor work and the statistics connected therewith.

ENCLOSURE VII.

NOTE BY MR. H. C. E. PETERSON, AGRICULTURAL ENGINEER, BENGAL, DATED THE 14TH FEBRUARY 1932.

With reference to your letter No. D/A/12 of 21st December 1931 (Enclosure II) from the Burmah-Shell Co. covering copies of Tractor operating statements, I beg to make the following remarks:—

I consider the system followed in drawing up the statements quite good but there should be a separate column showing the area ploughed by each tractor per hour against the depth. The total area ploughed and the total cost for such ploughing is shown as also cost per hour but not the area ploughed per hour, if this were also given, one could compare at a glance the capabilities of each machine. The horse-power at the draw bar of each tractor might be mentioned, also the number of furrows and width of each of the mould

board ploughs in use with each different machine, these particulars have not been stated in every case.

Whether the tractor is a crude oil, kerosene or petrol, might also be mentioned.

In conclusion I would be glad to learn why the cost of ploughing per acre at the same depth and with the same type or larger plough with a crude oil tractor working at a higher ploughing speed should work out higher than a kerosene or petrol tractor when the respective costs of the two latter fuels are so much higher than crude fuel oil and the quantity consumed per B. H. P. per hour of the fuel oil so much less ?

For instance, the Marshall Diesel costs Rs. 9-11-4 to plough an acre at a depth of 6" whereas against this performance is shewn the McCormick Deering which presumably is a kerosene tractor with only a two furrow plough costing Rs. 8-10-11 to plough the same area. Again a Caterpillar which is a petrol tractor with a 3 furrow plough costs only Rs. 4-12-6 per acre, this is difficult to understand and might be cleared up.

ENCLOSURE VIII.

LETTER FROM MR. C. P. G. WADE, BURMAH-SHELL, BOMBAY, TO THE DIRECTOR OF AGRICULTURE, BENGAL, No. D/A/12, DATED THE 1ST MARCH 1932.

We thank you for your letter (not printed) and enclosure No. 2269-11/4/32 of the 16th ultimo (Enclosure VII). We have read Mr. Peterson's comments with interest. It would be quite impracticable to show the area ploughed by each tractor per hour, as this would involve measuring up the land hourly. Actually in practice, measuring up the land each day after is a difficult matter, especially when more than one tractor is working on the same plot.

The total time worked is shown in hours, as also the total acreage, and it is therefore possible to obtain the average acreage ploughed per hour.

We agree that the horse-power at the drawbar of each tractor might be mentioned, also the number of furrows and the width of each of the ploughs, and we will arrange to do this in future statements. We will also state in the statements whether a tractor is a crude oil, kerosene or a petrol tractor. We enclose detailed working cost statements of the Marshall, McCormick Deering and Caterpillar tractors which will, we trust, make the position clearer regarding the points raised in the last two paragraphs of Mr. Peterson's note. We have the following comments to make in amplification of this statement :—

The Marshall tractor took two hours to plough one acre, whereas the McCormick Deering and the Caterpillar took 1½ hours and 1 hour respectively per acre with a smaller plough. We had numerous break downs with the Marshall.

Regarding kerosene consumption, the Caterpillar tractor has been used with a 3 and 4 furrow plough, so the outturn is greater resulting in the charges per acre being lower, whilst the McCormick Deering worked with a 2-furrow plough only, the cost per acre being therefore higher in the latter case. In the case of the Marshall, the Fuel charges are only Rs. 1-12-8.

Regarding Lubricating oil consumption of the McCormick Deering, there were constant leakages from the breather, which accounts for the high cost.

Maintenance charges depend more on the nature of the soil. The Caterpillar worked in Gadag, where the soil is more favourable for ploughing than in Sind, where the Marshall and McCormick Deering worked.

Regarding Interest and Depreciation charges, the cost per acre in case of the Marshall is higher because of its lower acreage. It worked for 49 hours in 41 days remaining idle for the rest of the period.

We are running the Caterpillar tractor on kerosene oil and not petrol, as stated by you.

Tractor Operating Statement Analysed.

Charges.	Marshall Diesel 15/30 H. P.				McCormick Deering.				Caterpillar.			
	Acres plough-ed.	Gals.	Total cost.	Per acre.	Acres plough-ed.	Gals.	Total cost.	Per acre.	Acres plough-ed.	Gals.	Total cost.	Per acre.
			Rs. A. P.	Rs. A. P.			Rs. A. P.	Rs. A. P.			Rs. A. P.	Rs. A. P.
Drivers' wages ..	23	..	34 2 5	1 7 9	334-029	..	343 8 0	1 0 6	21-34	..	14 11 8	0 11 0
Fuel Oil or Kero-sens.	..	90	41 4 0	1 12 8	..	1,290-17	1,065 2 4	3 3 0	..	55-81	52 3 4	2 7 2
Lubricating oil ..	..	9	10 11 9	0 7 6	..	112-97	187 15 2	0 9 0	..	2-51	5 0 4	0 3 9
Grease ..	..	11 Lbs.	5 8 0	0 3 10	..	103-13 Lbs.	51 9 0	0 2 6	..	2-80 Lbs.	1 0 10	0 0 10
Spare parts ..	..	..	..	..	..	..	..	..	..	..	..	..
Maintenance cost	..	..	39 1 8	1 11 2	..	..	753 14 11	2 4 1	..	..	11 7 11	0 8 7
Interest ..	..	..	70 3 2	3 0 10	..	..	245 9 7	0 11 9	..	..	3 1 8	0 2 4
Depreciation ..	..	..	22 5 8	0 15 7	..	..	252 15 6	0 12 1	..	..	14 6 0	0 10 10
Total ..	23	..	223 4 8	9 11 4	334-029	..	2,900 9 6	8 10 11	21-34	..	101 15 8	4 12 6

ENCLOSURE IX.

LETTER FROM W. McRAE, Esq., M.A., D.Sc., DIRECTOR, IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, TO THE GENERAL MANAGER, BURMAH-SHELL OIL STORAGE AND DISTRIBUTING CO. OF INDIA, LTD., DEVELOPMENT DEPARTMENT, ST. HELEN'S COURT, 40, BALLARD ESTATE, BOMBAY, No. 2517 OF 1932, DATED THE 25TH APRIL 1932.

I have the honour to acknowledge with thanks the receipt of statements showing the operating costs of tractor units worked by you last season, forwarded with your letter No. D/A/12, dated the 17th March 1932, and to say that I shall be glad to receive the field reports and supporting statements on which they are based. The costing form adopted appears to be adequate, and the only suggestion I have to make is that you prepare your accounts for an agriculture year, i.e., 1st June—31 May, to enable comparisons to be made.

2. The Agriculture Section of this Institute test all tractors for cost of operations, upkeep and work done on the land, and the forms in use are enclosed (not printed) herewith together with an explanatory note (Annexure) by the Head of the Section.

ANNEXURE.

NOTE BY THE IMPERIAL AGRICULTURIST.

The Agricultural Section here test all tractors for cost of operations, upkeep, and work done on the land.

Road Haulage costs are outside our sphere.

Our final report states what work a tractor will do, what it costs per hour to run, and how it lasts as regards running repairs and spare parts.

Operation.—Our forms provide for all operations on the land, class of land and depth worked, road work can come in under miscellaneous, if required.

Maintenance.—We do not deal with the maintenance of any agricultural implement under tractor heads—it is kept entirely separate, as we regard it as a different head of experiment of interest to a different class of manufacturer. The "Farm-all" is the only tractor where ploughs form almost part of the tractor body. We have no 'rotor' ploughs fitted to tractors under experiment.

Transit.—We only travel ordinary distance from field to field in the Estate and such charges go against the field travelled to.

General charges.—These we do not incur on the lines laid down in Burmah-Shell Co.'s letter.

Direct charges.—These are the important charges and are what we base our figures on. These are the figures buyers and manufacturers are equally interested in.

Owner operating charges.—Interest and depreciation we do not calculate. These figures can be worked out by any buyer on our final reports.

ENCLOSURE X.

LETTER FROM MR. C. P. G. WADE, BURMAH-SHELL OIL STORAGE AND DISTRIBUTING CO. OF INDIA, LTD., BOMBAY, TO THE DIRECTOR, IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA, BIHAR (B. AND N. W. RAILWAY), No. D/A/12, DATED THE 12TH MAY 1932.

We thank you for your letter No. 2517 of the 25th ultimo (Enclosure IX), and are much obliged to you for sending us the set of forms in use at your Institute which we have

read with much interest and on which we will be commenting, if necessary, later after these have been studied by our Agricultural Experts.

We are sending you herewith a complete set of field statements kept by us and from which the operating cost statements, already sent to you on the 17th March are prepared. We also enclose a list of the statements sent herewith (not printed), and these will be self-explanatory, but if there is any further information you require in connection therewith, we shall of course be very pleased to write to you further on hearing from you.

Regarding your suggestion that we should prepare our accounts for the Agricultural year, *i.e.*, 1st June to 31st May, to enable comparisons to be made, there will be no difficulty in arranging this, as we are only carrying out deep ploughing experimental work at present, and this of course only takes place during certain months of the year. We will close the statements we are preparing for the current season at 31st May.

APPENDIX XXXVII

SUBJECT No. 29 (A).

REPORT ON THE RESULTS OF TRACTOR WORK CONDUCTED DURING THE LAST SEASON (1931-32) BY THE BURMAH-SHELL OIL STORAGE AND DISTRIBUTING CO. OF INDIA, Ltd., BOMBAY.

At its meeting held in June 1930 the Advisory Board recommended that a Committee of Agricultural Engineers and Expert Agriculturists should be appointed to investigate the subject of mechanical cultivation. This recommendation was accepted by the Governing Body in July 1930. At its meeting held in May 1931, however, the Governing Body decided that the constitution of a mechanical cultivation Committee should be postponed till it could work under conditions more favourable than was then the case to the implementing of such recommendations as the Committee might make.

2. The Burmah-Shell Oil Storage and Distributing Co. of India, Ltd., Bombay, have been carrying on certain experiments in mechanical cultivation for some time. The report of their work in the 1930-31 season (Enclosure II) was placed before the Advisory Board in June 1931 in connection with an application from the Director, Pusa, for a grant of Rs. 10,000 for the purchase of a British Diesel Tractor. The company have now sent in their report (Enclosure I) for the last season (1931-32) which is now for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**The 7th July 1932.*

ENCLOSURE I.

MECHANICAL CULTIVATION.

At the meeting of the Imperial Council of Agricultural Research held in 1930, it was recommended:—

- (a) That a Committee of Agricultural Engineers and Deputy Directors of Agriculture be appointed to draw up a programme of co-operative experiments in mechanical cultivation,
- (b) To lay down the general lines on which further experiments should be conducted, and further
- (c) To examine the scope for mechanical cultivation, including the eradication of deep-rooted weeds.

As mentioned in our Report to the Council of 1931 (Enclosure II), my Company considered that we could best assist the agricultural development of the country by undertaking, in conjunction with Provincial Governments, experiments which would assist the Research Committee when formed. A resumé of the various experiments carried out by us was given in the Note circulated at the 1931 Council Meeting, and later in this Note, the results of the work carried out in the 1931-32 season are given. It will be seen that my Company has confined itself principally to work coming under section (c) above, that is, an investigation into the scope for mechanical cultivation including the eradication of deep-rooted weeds. Practically all the work undertaken so far has been in connection with deep ploughing for the eradication of weeds, as we have come to the conclusion, after considerable discussions with agricultural authorities all over India, that one of the most important problems in connection with the cultivation of the land, is the eradication of weeds, which are found in varying degrees all over India. An article on this subject which appeared in Capital is reprinted and circulated herewith (Enclosure III).

In conjunction with the deep ploughing experimental work, we have been generally experimenting on and considering the full scope for mechanical cultivation, and we consider

It is before any general turn-over to power from bullock can be accomplished in India, it will be necessary to show that a tractor can mechanically carry out the major portion of the various operations done throughout the year in farming land. These operations include *ploughing, both deep and shallow, harrowing, sowing, inter-culturing and irrigating.* There is no doubt that all these operations can be carried out, but it remains to establish the cost under Indian conditions, and this will receive our particular attention during the *coming season.*

In reviewing our work during the past two seasons, we can summarise the following as the primary reasons why power cultivation has been so difficult to introduce into India:—

- (1) The system of land tenure.
- (2) The backwardness and conservatism of the Ryot.
- (3) The low standard of productivity of the soil and soil conditions generally.
- (4) Litigation and debt.
- (5) Lack of experience and practical data relating to modern methods.
- (6) Lack of co-operative effort.

Items (5) and (6) are the only ones which we are able to tackle effectively, and we claim now to have very extensive practical data relating to all types of tractors employed for ploughing in India.

In Annexure "A", we give specifications of various types of tractors employed by us during our experimental work.

Ploughs.—The out-turn of work has been materially affected by the ploughs that have been imported into this country from America, and which, although successfully used in other countries, are, generally speaking, unsuitable for Indian conditions. So far all Engineering firms and their agents have imported into India one kind of plough bottom only for tractor use. The General Purpose Bottom, the general design of which has bluff curve in the centre, and the centre line from the middle of the breast to the tail of the board shows a slight concavity. The concave design appears to be ideal for American soils, where the soil conditions are such that a clean unbroken furrow slice can be cut and completely inverted, leaving a clean channel into which the next furrow can be laid. This clean channel leaves a clear track for the furrow wheel of the plough resulting in level and consistent work. It has now been proved that this type of mouldboard is of no use in the dry hard soils which are to be found in India during the hot dry seasons of the year. These soils dry hard so that when they are being ploughed deeply, large clods are turned up by the plough, and owing to the concavity of the mouldboards, these clods are apt to stick in the centre and are rolled along the face of the mouldboard by the pressure of the drawbar pull. Instead, therefore, of being turned over on the top of the last furrow slice, a large proportion rolls back into the open furrow channel and seriously interferes with the furrow wheel of the plough on its next round, rendering consistent ploughing difficult to attain. Some of the English manufactured ploughs for bullock power follow the correct design for India, but fail in certain other respects. We have given, and are giving, special attention to the question of a suitable design of plough and plough share for deep ploughing work in India, and the Cooper Engineering Works, Satara, have recently manufactured a new type of mouldboard in conjunction with us.

In the new design of mouldboard manufactured by the Cooper Engineering Works, the centre line from the breast to the tail has been made convex, amounting to $3\frac{1}{2}$ inches at the centre. Theoretically it should be impossible for clods to stick as they will either roll or slide along the convex plane, and as the tail end of the mouldboard has been feathered to about $5\frac{1}{2}$ inches, the clods should be thrown well over the previous furrow slice and should leave a clean open channel for the next furrow slice and the furrow wheel of the plough. Provision is made for attaching extensions to the tail of the mouldboard, and these will further ensure the clods being forced clear from the open furrow.

This design of mouldboard should be equally suitable for soils containing a large percentage of moisture. The ideal to be aimed at in ploughing is to leave a straight razor-edged unbroken crested furrow, and we consider this can only be attained by slightly convex mouldboard as, when the mouldboard is made convex, the furrow slice is broken up and pulverised, thus making cultivation after the ploughing easier with the implements at the disposal of the average ryot. This mouldboard has come through its preliminary trials successfully apart from a few minor changes, and we now hope will be manufactured on a commercial scale. To sum up, therefore, the type of mouldboard plough ordinarily imported into India results, as has already been mentioned, in far too much soil being returned to the furrow, and this in turn results in the grass weeds being crushed back into the soil by the driving wheels of the wheel-type tractor, and in the case of the track type tractor, the soil which is returned to the furrow causes the furrow wheel of the plough to ride, and this results in the inner plough share not working as deep as the other bottoms. We also found that the soil is returned to the furrow on account of the angles of the mouldboard being too straight, which results in the soil breaking instead of passing over the end. The straight formation of the mouldboard also results in the soil meeting it too squarely, and this causes an increase in the draft.

What we have aimed at producing, therefore, is a type of mouldboard plough which will give better inversion, and leave a clean furrow when working at a depth of 10 inches to 14 inches.

With the new type of mouldboard specially designed for Indian conditions, we have every hope of increasing the out-turn obtained last season by 20 per cent., and there will, therefore, be a corresponding reduction in the ploughing costs.

1931-32 Season.—At the beginning of last season, we decided to continue our experimental work, as obviously figures based on one season's working cannot be regarded as reliable. We included some Lanz tractors in our experimental work, under an arrangement with Messrs. Jessop & Co., Ltd., of Calcutta.

The two major ploughing schemes carried out by us in 1931-32 were in the Dharwar District and the Raichur District of H. E. H. the Nizam's Dominions. We now give brief comments on these two schemes:—

Dharwar.—The main problem being tackled here was the eradication of Harihali. Generally speaking, the work carried out in 1930-31 appeared to be satisfactory, and we received reports of increased crop yields from various landlords for whom we did ploughing work. The Bombay Agricultural Department received a large number of applications for work, and we originally arranged for six tractors to work on this project as follows:—

- 30 H. P. Caterpillar.
- 14 H. P. Mercedes Benz.
- 2—15 H. P. Lanz.
- 22/36 McCormick Deering.
- 14/22 John Deere.

Many difficulties were encountered, including very stony ground, and fields considerable distances apart, resulting in difficulties of transport of fuel and spare parts. During the season, the Mercedes Benz, the McCormick Deering, and the John Deere tractors were not used for various reasons, and on average two tractors only were working at a time. Our rate for 10 inches ploughing was Rs. 15 per acre, and for 12 inches ploughing Rs. 18 per acre. During the season 535 acres were ploughed at an average cost of Rs. 10-7-4 per acre for 10 inches ploughing and Rs. 10-15-0 for 12 inches work with Diesel tractors and Rs. 9-13-9 and Rs. 12-1-5 for 10 inches and 12 inches work respectively with a Kerosene tractor exclusive of supervision, interest and depreciation charges, but inclusive of drivers, fuel, spare parts, etc. Of this figure Rs. 1-7-6 per acre was in respect of spare parts over the season and Rs. 1-2-3 per acre for transport. The cost including our supervision charges is not given here, as these charges are naturally heavier in our case than in the case of a normal contractor.

The work we have been carrying out in the Dharwar District has resulted in a very considerable interest being aroused, and many enquiries for work, and enquiries regarding tractors, have been received. The real test of the success of the work will be shown in a year or two's time, when it can be seen whether the weed is growing again or not. The note in Enclosure "B"* by Mr. Salimath, Deputy Director of Agriculture, will be of interest as giving the views of an expert on our work and its possible results.

Raichur.—H. E. H. the Nizam's Government commenced tractor ploughing work in the Raichur District during the 1929-30 season. Their equipment consisted of four Lanz Diesel Oil Tractors and Mouldboard and Brushbreaker Ploughs. For various reasons, which it is unnecessary to detail here, we were approached by the H. E. H. the Nizam's Government to take over their tractor ploughing section for one season, which, after some negotiations, we did, using three Lanz tractors and one 22/36 McCormick Deering.† Details of the tractors are given in Annexure "A". During the 1931-32 season, 1,425 acres were ploughed to a depth of 10 inches at a cost of Rs. 11-15-8 per acre with Fuel oil tractors and Rs. 12-13-10 with Kerosene oil tractors exclusive of supervision, interest and depreciation charges, but inclusive of drivers, fuel and spare parts. Of this figure Rs. 2-13-7 per acre for Fuel oil tractors and Rs. 2-4-8 per acre for Kerosene oil tractors was in respect of spare parts over the whole season and Rs. 2-12-7 per acre in connection with transport and other allied charges. The scene of the ploughing operations varied from 50 to 80 miles from Raichur, which was the nearest railhead, so the transport charges for fuel were heavy and this figure cannot therefore be regarded as an average figure. Most of the work was carried out in black cotton soil in weed-infested areas, and there is now a very large demand for tractor ploughing from this district, which, it is hoped, H. E. H. the Nizam's Government will follow up and start a properly organised tractor ploughing section of their Agricultural Department. We have been asked by H. E. H. the Nizam's Government to continue working this scheme for one further season and this matter is now under discussion. We have every reason to hope for better results next season as a result of experience gained during the last season.

Summary.—We still have every hope of being able to reduce the actual cost of ploughing per acre, but it is only by experience that the most economical way of running large ploughing projects can be discovered. As ploughing Statistics form an item on the agenda of this meeting of the Advisory Board of the Imperial Council of Agricultural Research, this subject is not dealt with in this note.

My Company consider that there is an immense scope for tractor ploughing in India on a contract basis, and although it is realised that it may be impossible for Agricultural Departments to take up this work on a contract basis, it is hoped that commercial firms and individuals may take up this work on a commercial scale and that if this is done, they will receive the support of the various Governments. The benefit to the owner or the tenant of the land as well as to the country of freeing land from weed and bringing under cultivation hitherto uncultivated areas is great, and on the completion of next season's work, we should have sufficient data based on practical experience to satisfy the most searching enquiries regarding the suitability of tractors for certain types of work under Indian conditions.

C. P. G. WADE.

The 29th June 1932.

* Will be circulated as soon as received.

† This tractor is five years old.

ANNEXURE 'A'—PART I.

KEROSENE TRACTORS.

	Mo Cormick Deering.	Caterpillar.	John Deere.	Case.
Number of cylinders	4 (4 Stroke) ..	4 (4 Stroke) ..	2 (4 Stroke) ..	4 (4 Stroke).
.. .. .	4½"	4½"	6½"	3-7/8".
Stroke	6"	6½"	7"	5½".
Compression ratio..	Not stated ..	4.3 to 1 ..	Not stated ..	Not stated.
Crankshaft speed..	1050 R. P. M. ..	850 R. P. M. ..	800 R. P. M. ..	1050 R. P. M.
Lubrication ..	Gear Pump and Splash.	Force feed ..	Force feed, Gear pump.	Force feed.
Oil cleaner ..	Purolator ..	Own make ..	None	Filter.
Cooling	Pump and Fan ..	Thermo-siphon and Fan.	Tubular Radiator, Thermo-siphon and Gear driven Fan.	Radiator and Fan.
Cooling capacity ..	10 gals. ..	9 gals. ..	13 gals. ..	8-33gals.
Capacity of fuel tank.	15½"	37"	21"	
Clutch	Single plate ..	Dry plate master	12" Dry Disks locking in and out.	Disk. Petrol.
Advertised speeds..	2½ : 3½, 3½ M. P. H. 2½ M. P. H. Rv.	1, 7, 2-6, 3-6 M. P. H. 2. M. P. H. Rv.	2½-3½ M. P. H. .. 2 M. P. H. Rv.	2½, 3½, 4½.
Weight	6,720 lbs. ..	10,160 lbs. ..	4,917 lbs. ..	4,450.
Max. Pull in pounds —low.	3,030	5,560	4,462.5 lbs. ..	3,289.
Max. Pull in pounds —second.	2.10 M. P. H. .. 1,960	1.78 M. P. H. .. 3,520	2.4 Has only two speeds.	2.20. Has only two speeds.
Max. Pull in pounds —top.	3.08 M. P. H. .. 1,240	2.53 2,180	3,090 lbs. ..	1,525. ..
Max. H. P. Belt Pully.	4.09 M. P. H. .. 39.0	3.62 M. P. H. .. 38.2	3.57 36.98	4.97. 29.81.
Max. H. P. Draw- bar.	29.3	32.8	28.53	21.45.
Fuel lbs. per H. P. hour.	1.21	0.85	0.744	0.621.
Agents. (Rated load test).	Volkart Bros. ..	William Jacks & Co.	William Jacks & Co., Karachi.	Greaves Cotton & Co.
Price F. O. R. Bom- bay.	.. ..	.. ..	.. ..	.. ..
Type of engine ..	Kerosene (starting on petrol).	Kerosene (starting on petrol).	Kerosene (starting on petrol).	Kerosene (start- ing on petrol).
Track or wheel ..	Wheel	Tracks	Wheel	Wheel.

ANNEXURE 'A'—PART II
DIESEL AND SEMI-DIESEL TRACTORS.

—	Mercedes Benz.	Marshall.	Lans.
Number of cylinders ..	1 (4 stroke) ..	1 (2 stroke) ..	1 (2 stroke).
Bore	5·9"	8"	8·85".
Stroke	9·45"	10½"	10·2".
Compression ratio ..	15·6 to 1	15½ to 1	6·5 to 1.
Crankshaft speed ..	800 R. P. M. ..	550 r. p. m. ..	540 R. P. M.
Lubrication	Force feed	Force feed non-circulating.	Force feed.
Oil cleaner	Hirth	Visco	Own gauge.
Cooling	Fan and Pump ..	Fan and Pump ..	Fan and Thermosiphon.
Cooling capacity	10 gals.	12 gals.	13½ gals.
Capacity of fuel tank ..	9 gals.	12 gals.	13½ gals.
Clutch	Single Disc Dry ..	Multi-plate clutch ..	3 jaw clutch.
Advertised speeds ..	1·9—2·8—3·85 & 2·5 Rv.	1½—3·5 & 2½ Rv. ..	2—3½—4 & 2·1 Rv.
Weight	6,100	6,990	6,200.
Max. Pull in pounds—low.	2,500 lbs. @ 1·88 M. P. H.	4,270 lbs. @ 1·88 M. P. H.	4,050 lbs. @ 2·10 M. P. H.
Max. Pull in pounds—second.	1,980 lbs. @ 2·89 M. P. H.	2,300 lbs. @ 1·26 M. P. H.	2,980 lbs. @ 2·90 M. P. H.
Max. pull in pounds—top.	1,430 lbs. @ 3·26 M. P. H.	1,040 lbs. @ 5·40 M. P. H.	1,870 lbs. @ 4·17 M. P. H.
Max. H. P. Belt Pully..	23·9 H. P.	29·1 H. P.	31 H. P.
Max. H. P. Drawbar ..	13·9 H. P.	21·4 H. P.	23·2 H. P.
Fuel lbs. per H. P. hour	0·81 lbs. per H. P. hour D. B.	0·82 lbs. per H. P. hour.	0·86 lbs. per H. P. hour.
Agents	Duncan Stratton & Co.	Marshall & Son ..	Jessop & Co., Ltd.
Price F. O. R. Bombay	About Rs. 6,000 ..	About Rs. 5,000 ..	..
Type of engine	Fuel Diesel	Fuel Diesel	Semi-Diesel.
Track or wheel	Wheel	Wheel	Wheel.

ENCLOSURE II.

MECHANICAL CULTIVATION.

Last year at this meeting it was recommended that a Committee of Agricultural Engineers and Deputy Directors of Agriculture be appointed:—

- (a) To form a programme of co-operative experiments in mechanical cultivation;
- (b) To lay down generally the lines on which future experiments should be conducted; and further
- (c) To examine the scope for mechanical cultivation including the eradication of deep-rooted weeds.

My Company being of the opinion that mechanical cultivation, to a lesser or greater degree, will eventually have to come in India and that when such modern methods are adopted, they will increase the productivity of the land and tend to reduce production costs, thus increasing the purchasing power of the cultivators for all products, including our own, considered that we could best assist this development by undertaking, in conjunction with Provincial Governments, experiments which would assist the Research Committee when formulated. Prior to this meeting we had been carrying out a number of ploughing demonstrations in a more or less haphazard way in Bengal, Madras, Sind and certain Native States. After hearing the views of the Members of this Council, we decided it would be best to concentrate our activities, so far as tractor ploughing was concerned, to one or two areas and to certain definite problems in order to obtain data of value.

Sind: Sukkur Barrage Area.—Mr. Main's report on "Agriculture in Sind under the Barrage System" and conversations we had with other officials with a knowledge of this subject led us to think that we might serve a very useful purpose if we could demonstrate, by at least a year's working, what the cost of operating one or two of the better known types of tractors and ploughs were under various conditions in Sind, because, we thought, due to a lack of man and bullock power, without mechanical means, the Barrage area of Sind could not possibly be brought under cultivation for many years.

Contract Ploughing: Mirpurkhas, Sind.—We decided that to loan tractors to zamindars or give free demonstrations would do little to produce correct data or to popularise the purchase of tractors, as our previous efforts in this direction had led to little or no response.

The only alternative to taking up our own land (at this time out of the question for our Company) was to set up as ploughing contractors, but here again, we were up against a stumbling block as our previous work had indicated that Rs. 11 per acre for shallow ploughing was probably the lowest figure that would cover costs if the Interest and Depreciation on the equipment were to be taken into account and also good technical supervision provided; further, to work at rates below cost, we considered, would be likely to give a false impression of what tractors could do and mislead the cultivators and thus set back tractor development. We canvassed for work without success at Rs. 10 to Rs. 11 per acre; it was then thought that we might plough at actual costs of fuel and labour on a demonstration basis estimated at Rs. 6 per acre, explaining that this would not be repeated and that this charge was only covering fuel and labour. Accordingly we undertook contract work in the Mirpurkhas area at Rs. 6 per acre to the extent of approximately 600 acres between August and December 1930. For equipment we decided on a 15/30 Model (22/36 H. P.) McCormick Deering Tractor with a 3-furrow Mouldboard Plough and a 12/27 D Model John Deere Tractor with a 12-furrow Mouldboard Plough, these being the only types of tractors whose agents had any provision for service in this area that was likely to be effective.

Cost statements were kept making full allowance for Interest and Depreciation and mechanical supervision, and copies of these have been submitted to the Imperial

Council. Varying losses were experienced, but the nett result showed that the average cost of work done by each tractor was almost the same and was as follows:—

Actual Cost (Direct Charges).

						Per acre.		
						Rs.	A.	P.
Labour	..	..	..	..	..	3	0	7½
Fuel	..	..	..	..	..	3	8	0½
Lubricants	..	..	..	..	..	1	2	3
Spares	..	..	..	..	..	3	6	11½
Repairs	..	..	..	..	..	0	5	2½
Sundries	..	..	..	..	..	0	3	8½
Total						..	11	10 9½

(Indirect Charges.)

Depreciation and Interest	..	..	..	..	..	3	4	3½
Supervision	..	..	..	..	..	5	5	3
Total						..	8	9 6½
Grand Total						..	20	4 3
Transit	..	..	..	..	..	0	9	1½
Ploughing	..	..	..	..	..	19	11	1½
						..	20	4 3
Loss						..	14	4 3

The frequent stoppages for comparatively long periods for repairs and awaiting spares are responsible for the high cost which shows up particularly against Supervision Interest and Depreciation and Labour. The cost of spares was also unduly high due to our using the incorrect ploughs. The fuel consumption of both tractors was higher than we have subsequently experienced, and this we explain as being due to the uncleared state of the lands ploughed.

The chief features noticeable were:—

(a) The considerable mechanical breakdowns were responsible for the small acreage ploughed per day.

Although we had made arrangements for spare parts to be supplied by the Importers immediately on receipt of telegraphic advice, considerable delays in supply were experienced—sometimes ten days or more. Even the loss of one or two days' work throws out contractor's estimates because the overhead charges continue, whether ploughing or not, and thus immediately the cost per acre, goes up.

(b) Constant replacement of plough shares for the Mouldboard ploughs.

The cost of this reached such a high figure that we decided to try disc ploughs instead. It was found that in the Mirpurkhas soil, this type of plough was preferable as the elimination of the sharpening and replacement of the Mouldboard shares speeded up and cheapened

work. The conclusion, therefore, is that the sandy soil of Mirpurkhas area is unfavourable to be the use of Mouldboard Ploughs and therefore Disc type should be used.

(c) That mechanically there was no special defect apparent in either tractor other than the water injector system of the McCormick Deering Tractor, although fuel and lubricating oil consumption was a great deal higher than the makers' estimates; however, in this work we did not intend going into the technical advantages and disadvantages of the tractors.

Government Six-Farm Scheme: Sind.—While the above work was in progress, we were in touch with Mr. Jenkins, the Special Agricultural Officer, appointed for Sind. The Bombay Government had decided to open up six experimental farms in the Barrage area that were to receive water in March 1932; the problem with these was to clear, plough and dig the irrigation bunds by that date. After some negotiation, it was decided that the Bombay Government would give the ploughing to us on contract at Rs. 8 per acre, the clearing of land to be done by Government and also the transport of all our stores and baggage, and this figure we estimated should practically exactly cover costs. For this experiment, we decided that it would be as well to introduce a Diesel type tractor in order to make comparison with the better known McCormick Deering and John Deere Kerosene Tractors. We therefore arranged for the supply of a Marshall Diesel Tractor, which, owing to the Manufacturers' shipping delays, only commenced work in May.

At the same time we thought we should try a British plough, and in view of our experience in Mirpurkhas with mouldboard ploughs, we arranged for two Ransome "Dragon" disc ploughs.

The chief features noticeable so far are as follows:—

(a) *Soil Conditions.*—That the land on the farms, namely Dadu, tackled so far, probably owing to it not having yet had any water on it, is very difficult to plough due to the presence of a large number of soft sandy patches. Due to this, the ploughs designed for hard ground tend to bury themselves, thus overloading the tractor causing wheel spin and digging in.

(b) *Tractor Suitability.*—Where such soil conditions exist, the lightest possible tractor will probably be more successful, and it would be worth while trying the tract type tractor.

(c) *Plough Types.*—Where such soil conditions exist, only light type ploughs should be used, and so far our experience leads us to consider the disc most suitable. There is, we understand, a plough known as "J. M. 5 Stump Jump" which the makers recommend for such work, but we have no actual experience to back this.

Tractor Operating Cost Data.—While we have had monthly cost statements prepared for the work already done by each tractor, it is, in our opinion, too early yet to summarise these and draw definite conclusions as to costs. Meantime, we can say that we estimate that it costs approximately Rs. 9 per acre for six-inch ploughing in the area under review and that the average analysis of this estimate would be as follows:—

	Direct Charges.	Depth of ploughing 6" per acre.		
		Rs.	A.	P.
Labour (Drivers and Cleaners)	1	0	0
Fuel	2	12	0
Lubricants	0	9	4
Spares and Repairs	1	0	0
Sundries	0	0	4
		<hr/>		
		5	5	8
		<hr/>		

Indirect Charges.

					Rs.	A.	P.
Interest and Depreciation	--	--	--	--	2	0	0
Supervision	--	--	--	--	1	8	0
					<hr/>		
					3	8	0
					<hr/>		
Total	..				8	13	0
					<hr/>		

The figure for interest and Depreciation can be reduced in time when, with further experience, one is able to operate the tractors longer hours without frequent stoppages, and this equally applies to Supervision and Labour and when a tractor is operated by a landlord, this charge for supervision can be disregarded.

Deep Ploughing.—A problem that your Committee indicated as requiring investigation was the eradication of deep growing weeds by deep ploughing with motor tractors as opposed to the Cable type. We considered the various lands within our knowledge that were affected by such weeds, and decided, in view of the proximity to our Bombay and Belgaum Offices, to investigate the problem as it existed in the Dharwar District. After consultation with Mr. Main, Mr. Schutte and the Deputy Director of Agriculture of this area, a scheme was formulated, whereby the Bombay Government would grant a loan of Rs. 75,000 which could be drawn on by the cultivators for the payment of deep ploughing dues, to be repaid to Government within a period of five years. We again set up as ploughing contractors and, in consultation with the Deputy Director of Agriculture, prepared an estimate of rates for various depths of ploughing from 8-in. up to 15-in., and with the assistance of the Agricultural Department, canvassed for acreage and entered into contracts in different parts of this area.

We were anxious to try out different types of tractors to those that had already worked in the area. The opinion of the authorities was that a tractor of the power of the 22/30 H. P. McCormick Deering was insufficient for deep ploughing and eventually we decided to try a 30 H. P. Caterpillar. The 60 H. P. Caterpillar was also considered, but in view of the large initial outlay, the necessity of large holdings to operate it successfully, and the unlikelihood of any local contractor or zamindar being in a position to purchase one of this type; it was thought best to experiment with the 30 H. P. model. We made the fullest enquiries as to whether there was a tractor on the market, of a power between 30 and 60 H. P., but without success. At the same time, in view of the high operating cost of the Kerosene Tractor, it was considered worth while to experiment with a Diesel Tractor. The question of type was then considered, and at the time the only one available in India was the Lanz Bulldog Tractor, of which we had some prior experience, but which, unfortunately, had no service organisation at all in Western India. All British Manufacturers were approached, and it was found that no Diesel Tractor could be supplied in time to work this season, the position being as follows:—

The Aveling Porter and Blackstone of the Agricultural and General Engineers, Ltd., although used at the World's Agricultural Tractor Trials, would not be on the market for at least 18 months, and neither a McLaren Benz or a Marshall could be supplied in sufficient time for work this season. We had made previous enquiries in regard to the Mercedes Benz, and as one of this type was already *en route* to India, we decided to take this up. The power of this tractor is only 14 H. P. draw bar, and the Agricultural Authorities considered that it was unlikely to be a success. However, as it was the only one available, we thought it would be worth experimenting with it for medium deep ploughing of 10-in. with a 2-furrow plough and for greater depth ploughing up to 15-in. with a single-furrow plough. We therefore ordered a 2-furrow Mouldboard International Harvester Plough and a single-furrow Unitrac Ransome Plough. Work commenced with the Mercedes Benz Tractor in February and the Caterpillar Tractor in April. Accurate cost statements,

copies of which will be supplied to the Council, are being kept for all this work. The outstanding features produced so far by work done in this area are as follows :—

Data as to Depth of Ploughing necessary.

(a) It was popularly supposed that 10-in. to 16-in. ploughing was necessary throughout this area in both the Black Cotton Soil belts and the Red Soil belts; we now find that of the total area, only 10 per cent. requires 12-in. to 14-in. ploughing; here the "Harihali" is from 10-in. to 12-in. deep, but in the remainder of the land, from 8-in. to 12-in. ploughing suffices. The "Harihali" roots considerably exceed 14-in. in some small patches, but where this is so, in our opinion, it would be more economical to hand dig such small patches than to use deep ploughing motor tractor equipment even if a suitable type were found.

We have been guided by the Agricultural Department but we also have had to consider the wishes of landholders regarding the depth of ploughing required, and it will be seen next year whether the type of ploughing that we have undertaken during the current ploughing season has been sufficiently deep to cause an appreciable eradication of grass. We have, however, come to the conclusion that no ploughing for eradication of grass should be undertaken within a minimum of a month before the rains break, so as to allow the grass to perish before the rains start. We hope to obtain reports from the landlords, through the Agricultural Department, for whom we have deep ploughed during the present season as to the growth of grass after the rains, and a review of such reports will be given in the next general survey of our work.

Data on Types of Ploughs.

(b) There are at present no ploughs in India either Disc or Mouldboard capable of ploughing a clean 14 inches, and in consequence we had to re-construct our own Mouldboard ploughs and order a special large type Disc Plough. The former was done by welding on 4-in. extension pieces to the standard International Harvester Mouldboard ploughs and this proved quite successful. The Brushbreaker Plough was definitely found unsuitable at such depths as well as uneconomical.

The Results of Plough Tests at Dharwar.

The Disc Plough.—The Disc Plough appears to us to have the following advantages over the Mouldboard Plough :—

- (a) Due to the small cut of each disc, it leaves a better seed bed resulting in less air pockets which assures better crops in the event of short rainfall.
- (b) The soil is not left in such large sections—the larger the sections the more sun and heat required to kill off the "Harihali" roots.
- (c) Due to the even seed bed, the landlords can work the soil after disc ploughing better by bullock power than in the case of land ploughed by the Mouldboard Plough.

The Mouldboard Ploughs.—Appears to us to have the following advantages over the Disc Plough :—

- (a) In the event of early rains, there is less chance of the "Harihali" returning as the roots are not cut up into small sections as in the case of the land ploughed by the Disc Ploughs.
- (b) The Mouldboard inverts the soil better than the Disc.
- (c) Due to the land and furrow wheels being closer than in the case of the Disc Plough, more even depth of ploughing is obtained on uneven lands.
- (d) Due to the front furrow wheel and rear furrow wheel being closer, better results are obtained on rolling lands.

Both the Department and the Landlords in the Eastern Dry Track area of Dharwar are of the opinion that the Mouldboard gives better results than the Disc Plough; their opinion is not backed by any practical results and until such time as the results from this season's ploughing are obtained, we are not in a position to say which is the better plough for the work; at the same time, we have every reason to believe that the Disc Plough will

give better results on level fields during the months of December, January and February. After the middle of March, where the soil is in a very hard condition, it is almost impossible to get a Disc Plough into the ground and therefore from March on, in such soils we consider the Mouldboard is essential. In average light soils, the Disc Plough can be used throughout the year.

It remains to be considered whether the Mouldboard and/or the Disc is the most suitable type of implement to use for purposes of eradicating grass. One of the chief disadvantages of the Mouldboard or Disc Plough is that the grass is, in many cases, cut off above the root, and as result of the soil being inverted, the grass frequently takes root again and is not brought up to the surface, where it will be destroyed by the sun. To overcome this problem, we intend experimenting with the Cultivator type of plough, which has the following theoretical advantages over a Mouldboard or Disc :—

- (a) It should break up the soil rather than turn it over and drive out the weed to the surface. The points should become clustered with weed, which can then be released from the plough at the end of each circuit. As a result of this, all the acids, which we are told are necessary for young cotton, will be retained in the soil and not released, as is usually the case with a Mouldboard or Disc Plough.
- (b) Its outturn will be greater than a 4-furrow Mouldboard.
- (c) It is easier to operate.
- (d) A saving in replacement of parts should be effected since the points are the only wearing parts.

In our opinion, the use of the correct type and size of plough for the soil conditions and depth of ploughing required, taken in conjunction with the power of the tractor to be used, is more important than the actual power of the tractor, and the failures of tractors in the past have been mainly due to over-loading the tractor due to using the wrong plough, and in our opinion even the small tractors are capable of ploughing 12 in. deep with a suitable single furrow plough, but the question has yet to be proven whether this is an economic proposition at the rates the landlords can afford to pay. The Ransome Unitrac used by us will do all that is required, but as it can take a cut up to 16 in. wide to depths of 12 in. to 15 in., the tendency would be for the cultivator to overload it, and what is required is a single-furrow plough of maximum width out of 12 in. which will plough to a depth of 14 in. The manufacturers should be asked to produce a plough of this type, and then this opens the field of deep ploughing for small tractors.

Data on Tractors.—Subject to the above remarks, we see no reason why low powered tractors should not be used for this work, and the following are brief remarks on the tractors we have tried out here or of which we have first-hand experience in other areas, but the remarks are doubtless equally applicable to other makes of tractors of similar type and power :—

(1) *International Farmall Tractor.*—Draw-bar pull of about 2,500 lbs. Would work well with a single-furrow Mouldboard for 12 in. ploughing and a 2-furrow Mouldboard for ordinary 6 in. ploughing. This tractor offers more advantages than any other small tractor on the market for all round farming. Spares in stock in large Indian ports.

(2) *International 10/20 McCormick Deering Tractor.*—Draw-bar pull of about 3,000 lbs. Would have nice reserve power when working a single-furrow Mouldboard Plough to 12/14 inches. Spares in stock in large Indian ports.

(3) *Mercedes Benz.*—Draw bar pull of about 2,800 lbs. (World's Tractor, Trial tests should not be taken into consideration as the outfit worked in the rain and the wheel spin was about 22 per cent.) This tractor still requires many changes, but we understand the manufacturers are doing the necessary. Will work a single-furrow up to 12/14 inches with reserve power and a 2-furrow plough to depths of 10 in. and below. Spares not in stock now in India. Initial cost price high when compared with the above Kerosene Tractors.

This runs on Diesel Oil which means at to-day's market prices, the fuel cost per acre ploughed is just half that of a Kerosene Tractor doing similar work.

The above three tractors have the advantage of working without water injectors and have been tested in the black cotton soil belts.

(4) *Caterpillar 10 H. P.*—Draw-bar pull of about 2,700 lbs. Should work a single-furrow Mouldboard Plough to 12 in. but has not been tested out up to date. Spares may be obtained in India.

(5) *Caterpillar 30 H. P.*—This tractor will work 4-furrow to an average depth of 12 in. under most conditions and can take a 3-furrow under the hard-test soil conditions and to a depth of 14 in., no water injector, but the initial price is high when compared with other tractors that give only slightly less output per working hour. Draw-bar pull of about 7,500 lbs. Spares obtainable in India.

(6) *22/36 McCormick Deering.*—Draw-bar pull, when fitted with 42 in. wheel about 4,300 lbs. Works a 2-furrow Mouldboard to an average depth of 12/14 in. Suitable under all soil conditions if not over looked. Price reasonable and spares obtainable. The water injector is a great disadvantage in many villages where water, free from salt and lime, is hard to obtain.

(7) *John Deere "D" Model.*—Although not tested out in the Dharwar section, this tractor may work a 2-furrow Mouldboard to an average depth of 12/14 in. subject to the wheel spin being overcome by the use of a balance spring.

(8) *The Case Tractor Co.*—Have a new range of improved Kerosene Tractors of rated draw-bar H. P.'s of 17 to 26 at prices considerably lower than those ruling for other Kerosene Tractors. They have no water injectors and are lighter in construction than those of other makes of the same power rating. These tractors should be investigated.

Owing to the low price of the fuel for Diesel Tractors, further experiments should be made with these and the savings in fuel per acre should be carefully compared with increased cost of ploughing per acre due to the high initial outlay. The question of the high initial cost of the Diesel Oil Tractor should be taken up with the Manufacturers and the comparison above sent to them. It must be borne in mind that these tractors are hardly marked on a commercial basis as yet, and there is therefore probably room for considerable price reductions. We propose to take this point up with the British Manufacturers later.

Deep Ploughing Cost Data.—The contract rates that we decided on for work in this area are as follows:—

<i>Land previously cultivated.</i>							Per acre.
							Rs.
8"	--	--	--	..	--	--	13
10"	..	--	--	..	..	..	15
12"	--	--	--	..	--	..	20
14"	--	--	..	..	..	..	25

Virgin land subject to special quotation after examination.

We consider it is too early to examine in detail the cost data so far received, because the period of work is as yet too short to make a summary; we have had frequent stoppages on account of lack of spares, unsatisfactory labour and supervisors and breakdowns, but

on both the Mercedes Benz and the Caterpillar, we have had one really representative month's work, the results of which were as follows :—

					Acreage 115. Depth 8" to 10".		Acreage 106. Depth 12" (23 acres 6" and 8".)				
					Mercedes Benz. Caterpillar.						
					Rs. A. P.		Rs. A. P.				
<i>Actual Cost (Direct Charges).</i>											
Labour	—	1	6	4.4	1	2	9	
Fuel	—	1	8	2.7	4	9	7	
Lubricants	0	11	5.5	0	11	6	
Spares	0	1	11.3	0	3	6	
Repairs	..	—	0	0	9.2	..	..	..
Sundries	0	1	11.4	0	7	11	
Total					..	3	14	8.5	7	3	2
<i>Indirect Charges.</i>											
Depreciation and Interest	2	14	7.9	4	11	8	
Supervision, etc.	3	0	0.9	3	0	9	
Total					..	5	14	8.8	7	12	5
Grand Total					..	9	13	5.3	14	15	7
Transit	Nil	..	0	14	6	
Ploughing	9	13	5.3	14	1	1
Total					..	9	13	5.3	14	15	7

Both the above tractors being new, to be conservative an increased allowance against spares and repairs would be expected later in the life of the tractors.

Detailed costs with a complete summary and analysis will be prepared and circulated to those interested, in due course.

Shallow Ploughing.—For shallow ploughing up to 8" in red soils, we are now experimenting with a 6-furrow disc plough, *i.e.*, a 4-furrow and a 2-furrow disc plough joined, and although we have not carried out sufficient work of this type to report as to its success or not, we hope, as a result of the experiments, to be able to reduce considerably our rates for this type of work on red soil and medium black cotton soil. At present we are only undertaking this work during the off-season when deep ploughing is out of the question.

Harrowing.—We have carried out no harrowing up to date but have now concluded an arrangement with a landlord at Gadag in the Bombay Presidency, whereby we will harrow 400 acres of red soil earth at cost, and as a result of this experiment, we hope to be able to arrive at some accurate cost regarding an economical rate for this type of work. We have frequently received applications for harrowing work from landlords whose lands we are ploughing, and we hope to include harrowing as part of the normal contract work of our various schemes next ploughing season.

General Remarks regarding the Development of the Use of Tractors.

Possible purchasers of tractors are :—

- (a) Co-operative Societies.
- (b) Ploughing Contractors/Operators, pure and simple.
- (c) Landlords for use on their own lands and/or ploughing adjacent lands of other landlords or tenants.

(a) So far, co-operative efforts in regard to the utilisation of machinery do not appear to us to have been a very great success, and the present state of the Co-operative Societies does not encourage us to think that it is likely to be developed in the near future to any extent.

(b) A ploughing contractor, even when favourable prices are being received for crops, will necessarily work at certain disadvantages; for instance, he has to bear the cost of transport from village to village. He cannot usefully employ his plant on other work when there is no contract ploughing to be done. He has to place a high value on his services in supervising the tractor when at work. He must allow for Interest and Depreciation on a very conservative basis and also profit to his undertaking. He has to spend a considerable amount of time in canvassing work, measuring up lands, collecting dues, etc., and something must be allowed for the cost of these. The nett result is that the contractor's prices for ploughing land, at least for ploughing the small holdings that are usually come across, is bound to be higher than the figure at which a landlord could do his own work. As a consequence, contract work will not easily be obtained and the value of it to the farmer is less.

(a) In the first place, the ordinary cultivator, whatever the terms on which he holds his land, cannot be considered as a landlord in the strict sense of its meaning. His holdings, are too small for him to operate a tractor economically, apart from the fact that he will never have the funds to purchase one. We are therefore left with the large landlord who farms his own land, and unfortunately, not a great number of these exist. This class has the best opportunities for working tractors economically, in our opinion. If their holdings are sufficiently large and unfragmented, they have no problem in regard to transport from site to site. A farmer can use his tractor for ploughing, harrowing, sowing, pumping and other work, resulting in the hours of tractor working being twice those when the tractor is employed in ploughing only, and in consequence the Depreciation can be spread over a longer period of working and thus reduce the cost per acre ploughed. A farmer would not normally place a very high value on his services for supervising the working of his tractor, and he would utilise the driver/mechanics on other work in idle hours. No account of profit has to be taken and Interest and Depreciation can be spread over a longer period than a tractor operated by a contractor. The problem, therefore, seems to be to develop the use of a tractor which would appeal to the landlord owing 200/300 acres, and a high powered expensive tractor would not be a proposition for such and therefore this narrows the field to low priced small powered tractors, and in our opinion experiments should be continued and operating costs of them promulgated. The difficulty will be in preventing users from over-loading these tractors, and to do this, they must be prevented from using ploughs drawing too many and too wide furrows.

Mechanical Data on Tractor and Plough Designs.—We are now in the process of producing a technical report on both these features as applied to the various types of tractors and ploughs we have in use, and we propose to forward this report to all Manufacturers, their agents and any other interested parties.

J. C. REED.

Enclosure III.

Reprinted from "CAPITAL" dated 14th January 1932.

POWER FARMING IN INDIA.

ELIMINATION OF WEED.

BY

C. P. G. W.

The various problems facing anyone attempting to popularise modern mechanical methods of agriculture and land cultivation in India are well-known to those interested in the subject, but there are several uses to which mechanical methods of cultivation can successfully be put to the advantage of India and her people.

One of such uses will be considered in this article, namely, that of the eradication or removal of the deadly weeds and grasses growing throughout India wherever heavy soils are found, particularly in the Black Cotton and heavy dry belts. These grasses have various names and are of varying severity. "Harihali" and "Doob", a thin and deep-rooted growth, "Kans" and "Khanda", a thicker but equally deep-rooted weed, are the most known. They are found everywhere and cannot be kept in check by the primitive country methods still to be found in most parts of India. Let us consider for a moment what the growth means to the agriculturist.

First of all to the landlord it means a steady decrease in the value of his land, difficulty in letting his lands and diminished crop returns from his own lands and on his share of those portions rented to the ryots. In the second place to the cultivator it means crops gradually getting poorer and poorer, with the resultant reduced standard of living, and eventually it will be impossible for them to cultivate their land. To Government it means decreased land revenue. This is no exaggeration, as the observant traveller will know, but it will come as surprise to most people when they realise that the greater portion of the land, which they pass in their cars or in trains, and which appears to be lying fallow, is probably unfit for cultivation because the grass or the weed has obtained so strong a root-hold.

In many parts of India, such as the Northern part of the Central Provinces and the South-Western part of the Bombay Presidency, vast areas of hundreds of thousands of acres of good soil are being slowly suffocated by this pernicious growth. The writer was told by a senior and experienced member of the Indian Agricultural Service that in some cases tenants were actually refusing to pay existing rents on the ground that "Harihali" weed was slowly making their lands unfit for cultivation. It is generally admitted that any agricultural problem in India is of vital importance, and there are few matters, the solution of which would help more directly both the land-holding and the agriculturist classes, than this difficult problem of grass growth.

Can power be used for this purpose, and if so, is its use satisfactory and economical? These are the two important questions, and experiments carried out recently enable some authoritative answer to be given to them.

In considering the suitability of power for this purpose, it is essential to keep in mind the all-important question of costs, since there is obviously no soil condition in India which could not be successfully cultivated by modern mechanical means, provided sufficient power is paid for. The term "mechanical means", however, is a broad term and includes the very smallest tractors costing a few pounds to steam cable and other tractors costing many hundreds of pounds. Therefore it is necessary to arrive at some conclusion regarding the ability of the cultivator to pay for the plant necessitated by modern methods of cultivation. The simplest way to do this is to consider the existing costs and methods of grass eradication. It has already been said that no country plough is strong enough to remove this grass once it has become deep-seated, and the cultivator is therefore faced with the necessity of hand digging. This is an expensive operation, and the area that can be hand-dug is obviously very small and is restricted by the availability of labour. The cost of hand-digging varies largely from district to district, and a fair minimum and maximum would be Rs. 20 to Rs. 50 per acre. Can a tractor, which is within the purchasing power of the larger land-holders, carry out the work as efficiently and as cheaply as manual labour? There is no doubt regarding the question of efficiency provided deep enough

ploughing is carried out, and the figures next given will show that the cost of tractor ploughing with a medium powered tractor is considerably less than the average cost of hand-digging:—

Working for 26 days in medium black cotton soil, and average of 12.31 hours per day, a 15 H. P. Diesel Tractor ploughed 115.35 acres to an average depth of 10 ins. The cost per acre for actual working was Rs. 5-12, and if Interest and Depreciation (spread over 4 years) is included, the cost per acre was Rs. 8-10-8. The cost of digging land by hand in this case would have been Rs. 20 per acre. It must be noted that no charge for supervision is included in the above figures, and in the case of a contractor, a further incidence of Rs. 5 per acre must be added to cover his profit, and the cost of a paid supervisor, in case the contractor does not supervise his own work.

A 30 H. P. Kerosene Tractor, working under the same conditions, ploughed 105 acres in 21 days, working an average of 11 hours daily, at a cost of Rs. 7-3-2 for working costs only, and of Rs. 11-14-10, if Depreciation and Interest is included.

A more powerful tractor could naturally produce a bigger outturn, but on the other hand, the working costs and Depreciation and Interest would be greater and the cost would probably be beyond the pockets of most potential purchasers. At the present time, the number of land-holders able to buy tractors is very small, and therefore, generally speaking, high-powered tractors are out of the question.

The question of power is often given quite undue importance and consideration, and the real point to be considered is the most suitable and economical equipment to use with a tractor. In other words, the plough is of equal importance to the tractor. Provided the tractor is not over-loaded but is given a load which utilises to the full its power, the most economical results will be obtained. The number of bottoms or discs to be used and the speed at which the tractor should be worked are all very important factors, on which the success and economy of the work will be dependent.

Opinions vary regarding the average depth of ploughing required for the removal of the various grasses, and each district should be surveyed and carefully considered by experts before any definite decision is arrived at. When work was being considered in the Dharwar District during the early part of this year, the Agricultural authorities frequently stated that ploughing up to a depth of 14 ins. would invariably be necessary, but actually at the end of the season it was found that the very great proportion of the ploughing done was to a depth of 10 ins. only. A survey of the land ploughed in the Dharwar area shows that, generally speaking, there is no sign of the grass growing again, and in those patches—generally in nallas and small depressions—where the plough has been unable to penetrate properly and where moisture is retained, the grass is invariably deeper than found elsewhere. An example of this was found in a large 50-acre field between Dharwar and Gadag, which was ploughed last January to a depth of 10 inches and which was very thickly covered with "Harihali" grass. On being inspected in July, it was found that the field was practically clean except for three patches of grass, all in slight dips in the ground. The moisture was retained here and the plough shares did not penetrate to the full 10 ins., with the result that some grass was left rooted and some others were uprooted by the plough, but took root again owing to the moisture of the ground. On being dug out one piece of grass measured 16 inches. In these cases the cultivator must have such portions hand-dug. The charges for ploughing a field of 50 acres were Rs. 750 and in addition he had to pay Rs. 40 for hand-digging the small patches. A clean field free of grass was therefore obtained for Rs. 790, whereas for hand-digging, the cost would have been over Rs. 1,000 based on the local rates ruling at the time of ploughing. It is very doubtful, moreover, if the full 50 acres could have been all hand-dug in one season, owing to shortage of labour.

It cannot be expected nor is it claimed by any reasonable man that a tractor can perform miracles, and provided that at least 90 per cent. of the grass definitely eradicated, the tractor can be said to have done its work successfully. It is only by means of tractors that the growth of weed can be arrested, and when this is realised, considerable progress can be expected as far as the introduction of modern machinery is concerned.

Reprinted from "CAPITAL" dated 19th May 1932.

COLLECTIVISATION FOR INDIA ?

A PLAN FOR AGRICULTURAL CO-OPERATION.

BY

C. P. G. W.

Co-operation, as ordinarily understood, implies the formation of an agency through which agriculturists can dispose of their produce, and obtain credit or goods in return. Throughout India Producer's Co-operative Societies are gradually being built up—particularly in some of the cotton districts. So far there has been no general move to form co-operative associations for the co-ordination of labour and means of production. Soviet Russia has taken the lead in co-operative agricultural organisation, and even to those, who are opposed to the Communist policy of pooling land and produce, there is much food for thought in the most elementary forms of collective farms now found in Russia. Brief mention must first be made of the three forms which the organisation of collective farms now takes in Russia :—

- (1) Societies for joint tillage.
- (2) Agricultural Artels.
- (3) Agricultural Communes.

In the booklet entitled *Agriculture in Soviet Russia*, by Miss J. Beauchamp, published by Messrs. Gollancz, the Society for joint tillage is described as the simplest and most elementary form of collective farm, in which there is no general pooling of property, and the Association is based only on the joint working of arable land. Only labour is socialised—when the means of production remain individual property and each family's share of the product is based on the size of its land-holding, but at any convenient time in the operations it is open to any peasant to withdraw from the Society, taking his land with him and start farming again on the old individual basis. In Russia the origin of this simple form of collectivism grew up round the tractor depots set up by the co-operative associations, for it is obviously impossible for tractors to operate in the tiny strips into which in Russia, as in India, the individual holdings were divided. The Society of joint tillage next developed into the Artel, which is the next highest form of collective farm. In the Artel—now the most usual type of collective farm in Russia—all the needs of production become joint property and to a certain extent the produce itself, whilst in the third and the highest form—the Commune—everything is socialised. The agriculturists live in the Commune and do not even own separate houses or gardens.

Brief mention has been made of the Artel and the Commune, but it is not suggested that such extreme forms of Socialism or Communism would ever be suitable to or acceptable by the people of India. Certain features of the joint tillage societies and the Artel do, however, give serious food for thought to those interested in Indian Agricultural conditions. In reality a Society for joint tillage is almost suitable form of co-operative society for India and the need for some such organisation is urgent. The wastage of labour—both manual and animal—is enormous, and the productivity of the land suffers from the low standard of animal labour generally found in India. No one can object to the principle of the Societies of Joint Tillage and the Artel, so far as they involve no sharing or pooling of individually owned property, but merely the pooling of available labour and means of production in order to minimise wastage. Under such a system the agriculturist with a few bullocks and excessive labour will, in example, be able for to transfer his surplus labour to others and obtain in return the additional bullocks he requires. Separate societies or groups will have to be formed for each area ; all the available labour and implements of every type will then be pooled and work will be carried out under a pre-arranged and agreed programme. The produce of the land will go to the owner and his share will therefore be based on the actual size of his holding. The agriculturist at any time can withdraw from the Society and take with him the labour he has contributed to the pool, starting again on his own individual basis. The advantages of such a system, if properly organised, even in those districts where only country methods of cultivation are known, would be great in

that it would minimise the waste and enable every agriculturist to obtain the use of all the available labour. It would also obviate the necessity for a man keeping implements which are only used a short time each year. It is, however, in the future, and when considering mechanical methods of cultivation, that such societies would be of even greater importance.

It has been already mentioned that in India, as in Russia, small holdings predominate, making tractor ploughing by an individual impossible even though he may wish to have his lands tractor-ploughed. The advantages of mechanical cultivation are now known so generally and have been stated in this journal so recently that no further repetition of them is necessary in this article.

A tremendous future, with benefits to all agriculturists, will await agriculture in India, if co-operative societies for labour and means of production are formed, thus enabling mechanical cultivation to be adopted on a scale at present impossible. Each group or each society will have its own tractor, which will plough the land of each member of that group or society. Land now unable to be cultivated will be brought under cultivation, crop yields will improve, the number of bullocks required will be less, reducing fodder expenditure. It is further suggested that a portion of each season's produce—say 5 per cent.—might be set aside and stored against famine, drought and other calamities. This will mean that each group will be self-supporting in times of distress and will not be dependent upon Government—a point which will surely find favour in the eyes of the Indian agriculturists who, it is claimed by the Congress, naturally prefer to be self-dependent rather than dependent upon Government. There is a further point, however, in connection with this suggestion, which will bring greater benefits to the agriculturist. At the present moment all Provincial Governments are laying aside large sums—either in money or in kind—to meet the needs of famine years. If the suggestion made above is adopted, Provincial Governments will then have surplus funds, and these could be spent in the purchase of tractors and mechanical implements either for hire or sale on easy payment terms to the co-operative societies and groups, which will be formed.

There is not space in this article to deal in any detail with the proposal, but it is urged that some form of co-operative societies based on the above suggestions would meet the needs of the present day and would result in benefits to India and her people, which cannot be secured by the present organisation of the Agricultural Departments. These departments will, however, co-operate fully with each society of group and, in conjunction with them, will carry out trials, cattle-breeding experiments and all those other works which the Agricultural Departments are now carrying out with a view to improving the lot of the ryot.

In this article, it will be noticed that certain features of the Artel have been included in the proposal for India inasmuch as the means of production, such as bullocks, agricultural machinery, etc., have been included in the property to be pooled in the co-operative societies. This has been done because, due to the peculiarities of the holdings of India, many cultivators would be unable to purchase their own machinery and other means of production, and therefore the pooling of labour only will be of little use. It must be emphasised that in this scheme each individual retains his ownership and rights in his own property and draws his share of the produce from his own land. He is free at any time to withdraw from the society and retain his individuality and his citizenship. Herein lies the essential difference between the suggestion for India, and the scheme as carried out in Soviet Russia, for, in the Artel, once a cultivator joins it, he cannot take out his land again, although, if he wishes to leave the Artel, he will be provided with land outside, which may be many hundreds of miles away. Even the Society for joint tillage is merely a step towards complete Communism in Russia.

This suggestion is not claimed to be a solution—or even a partial solution—of the Indian agricultural problems, but it is claimed to be a progressive step—a step which will avoid waste—a step which will facilitate the introduction of machinery, which, it must be admitted, is essential to India's agricultural advance and which will result eventually in an increase in the prosperity of India's agricultural millions.

APPENDIX XXXVIII.

SUBJECT No. 32.

APPLICATION FROM THE GOVERNMENT OF THE PUNJAB FOR A GRANT OF RS. 38,800 SPREAD OVER A PERIOD OF FIVE YEARS FOR A SCHEME FOR THE IMPROVEMENT OF THE TEA INDUSTRY IN THE PUNJAB.

Attention is invited to the attached copy of a letter from the Government of the Punjab, No. 6-D.(S.), dated the 19th May 1932, on the subject of a scheme for the improvement of the tea industry in the Punjab. The scheme, which is for a period of five years from the first instance, involves in so far as the Council is concerned a total expenditure of Rs. 38,800.

The scheme is for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

25th May 1932.

COPY OF A LETTER FROM THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, ROCK HOUSE, SIMLA, S.-W., No. 6-D.(S.), DATED THE 19TH MAY 1932.

Scheme for the improvement of the Tea Industry in the Punjab.

I am directed by the Punjab Government (Ministry of Agriculture) to forward for consideration by the Council at its next meeting a scheme (Annexure) for the improvement of the tea industry in the Punjab, which has obtained the approval of the Punjab Council of Research. Details of this scheme are contained in the note attached, 100 copies of which are being sent to you under separate cover.

2. On consideration of the scheme the Punjab Government have decided to omit the post of Assistant to record observations on fungal diseases and insect pests on tea bushes, as Mr. Carpenter, Chief Scientific Officer, Indian Tea Association, Calcutta, does not think that such an appointment is of primary importance. This will reduce the total cost of the scheme from Rs. 51,300 proposed to Rs. 38,800 over a period of five years.

3. It will be observed that it is proposed to utilize an area of 50 acres of land already planted with tea bushes at Palampur, and valued at Rs. 50,000, which it is proposed the Punjab Government shall make available for this scheme. No reference has been made in the scheme to the disposal of the income which will be derived from the land under the scheme. At present it is understood that the income in respect of tea leaf from the existing bushes is practically nil. During the first year they will be very severely pruned and, according to the results obtained on other tea estates, after pruning very little leaf will be obtained in the following year. It is expected, however, that the yield of leaf will increase gradually from the second year onwards. It is not proposed to manufacture the green leaf, after plucking, into tea but to sell it as green leaf to some of the neighbouring factories. In these circumstances it is very difficult to make any really close estimate of the probable income from the sale of leaf during the period of the scheme, but the Punjab Government will credit the proceeds to their own revenues and in return will contribute an annual amount towards the scheme equal to the income actually derived therefrom.

4. It is regretted that under the present financial conditions this Government is unable to make any further contributions towards the cost of the scheme, and I am to express the hope that in view of the large grants given to other provinces for their schemes, the Council will agree to provide the funds required.

ANNEXURE.

SCHEME FOR THE IMPROVEMENT OF THE TEA INDUSTRY IN THE PUNJAB.

In the Punjab tea is grown extensively in the hilly tracts of the Palampur and Kangra tehsils of the Kangra district. The main tea-growing is close to the town of Palampur itself, which is situated at an altitude of about 4,200 feet above sea level.

2. The cultivation of tea appears to have been first introduced in this locality about 1849, but was taken up in earnest from about 1860 when various lands were sold for tea cultivation to individuals, mostly British Officers. In 1892 the area under tea was 9,537 acres and reached 10,000 acres in 1907. Since then there has been a small reduction and since 1919 the area has been steady at about 9,700 acres.

3. In the early years the cultivation of tea appears to have been satisfactory, but as the tea estates in North-East India developed, the effect of competition was felt severely by the Kangra estates and appears to have reached a serious state during the slump in the tea market about 1900. Owing to this and other causes many of the original owners and managers left the district after disposing of their estates to persons who appear to have taken little interest in the maintenance of tea on these estates and who in many cases have remained absentee owners. Most of the tea areas in the district have, therefore, been planted from 60 to 70 years ago and it is doubtful if any appreciable area of tea has been planted during the last 30 years. Meantime, the comparative neglect of many of the tea plantations has resulted in a great falling off in outturn and poor prices are also being obtained, possibly from faulty processes of manufacturers.

4. With a view to ascertain the present position and to obtain expert advice on its causes and the methods by which this industry can be revived, the Punjab Government in October, 1929, obtained on deputation the services of Mr. P. H. Carpenter, F.I.C., F.C.S., Chief Scientific Officer, Indian Tea Association, Calcutta, who visited the Kangra tea-growing locality. In his report Mr. Carpenter considers that whilst tea bushes as they grow older lose their early vigour and whilst it is by no means so easy to renovate old tea as young tea, age is only a minor factor and there are other factors connected with tea cultivation which play a more important part in the general debilitated conditions of tea in the Kangra district.

5. Amongst the causes responsible for the poor crop Mr. Carpenter finds that the following are important:—

- (a) *Neglect of proper cultivation.*—In tea culture the main factor of cultivation is the suppression of jungle growth rather than stirring of the soil. It has been clearly demonstrated on the experimental plots at Tocklai (Assam) that any form of light cultivation is sufficient provided it suppresses this growth. The cultivation given at present in the Kangra tea-growing localities is insufficient to achieve this object and many areas become smothered in a heavy growth of grass.
- (b) Practically no manuring is done and only small quantities of farmyard manure are available. There is no information obtainable of the effect of systematic and continuous annual applications of natural or artificial fertilisers.
- (c) Bushes are pruned every year and each individual shoot is cut. This pruning is unsatisfactory for no effort is made to maintain the bushes at a uniform height or to keep the pruning at the same level, so that not only do the bushes vary greatly in size in any one area, but each individual bush is uneven. Also no attention is given to the cutting back of a bush when an accumulation of non-yielding twiggy wood has developed on the top. Little or no attention has been given to developing large framework bushes. The sides have been cut away and no attempt is made to save and develop the growth of lateral branches. A definite scheme of pruning is necessary and this requires careful consideration and study. Pruning is now done during the cold weather, but little growth is allowed to develop before plucking starts, as every endeavour is made to pluck a big spring crop, since this makes good tea. It would be desirable to know whether pruning could be done more

profitably in May or June than in the cold weather, as at present is the case, so as to allow of obtaining a maximum crop during the early part of the year. This system of pruning in May and June is practised in some tea gardens situated in districts having a dry hot May and early June. It would also be desirable to know whether tea could be advantageously left unpruned for one year, the pruning being done once in two years, instead of annually as at present. If this could be done, the cost of pruning during two years would be much less than at present, but the thickness of the pruning wood would be increased.

- (d) Plucking as at present practised is unsatisfactory. Shoots are plucked from all parts of the bush, whereas a level top surface should be obtained and shoots only plucked from it. To allow the bush to develop a side growth all shoots growing on the sides below this level should be allowed to remain on the bush.

6. The stage when the plant is ready for picking is also important. Before picking commences shoots must be allowed to grow for a certain length, so that after two leaves and a bud are plucked there still remain about four inches of new growth below the plucking mark, thus providing the necessary wood for the next pruning. No consideration is given to such important questions under existing condition.

Manufacture.—The green tea made in the Kangra district is generally of very poor quality and realises about 6 annas per lb. in the Amritsar market where most of the crop is sold, when Cachar green tea is selling at Re. 1-5-0 a lb. and Ranchi tea at Re. 1-3-0 per lb. Mr. Carpenter considers that, whilst much could be done to improve the Kangra teas first by careful attention to growing the bushes, so as to ensure a growth of soft succulent shoot the quality of the tea produced can also be substantially improved by attention to many defects in the subsequent process of manufacture. He draws attention to the very great importance of preventing the oxidation of the tannin in the leaf after picking and the harmful effect of the custom of partially withering the fresh leaf before steaming and panning which is the most important of all the processes in green tea manufacture.

7. Mr. Carpenter advises that for the present attention be concentrated on green tea, although this tea does not find ready consumption in the Punjab and is mostly exported to Kashmir, Afghanistan and Central Asia, whilst black tea is consumed locally. Black tea is made at present in small quantities in the Kangra district, but its quality is very poor indeed. The manufacture of black tea requires a more careful technique and the processes involved seem to be so little understood by the factory and garden staffs that he considers green tea should get first consideration.

8. The managing staff of the tea estates in the Kangra district, according to Mr. Carpenter's view, cannot be called satisfactory for they are ignorant of the technique of tea culture and manufacture. Possibly this may be due to lack of opportunity for obtaining greater knowledge. Mr. Carpenter considers that the poor technical knowledge of the staff is one of the main causes of the unsatisfactory condition of the Kangra tea industry at present.

9. After a careful study of the industry Mr. Carpenter finds that one of the first requirements towards improving it, is the provision of a small area where experiments can be carried out and where the results obtained can be demonstrated suitably to those interested. As the tea industry in the Punjab is not organised under any definite association such as exists in North-East India and in South India, such a farm must be maintained by the Agricultural Department of Government. The present scheme is, therefore, submitted in pursuance of Mr. Carpenter's advice.

10. It is proposed to obtain temporarily an area of 50 acres already under tea plantation besides Palampur. The improvement of the crop would be carried out in two directions :—

- (1) An improvement in the quantity and quality of leaf from old existing tea bushes (such as form the entire crop in the district) by scientific pruning, manuring, cultivation and picking.

(2) The introduction of new varieties of tea and its cultivation by proper methods from the beginning.

Within less than a mile of Palampur land is available from the area of the Holta Tea Estate purchased by Government at about Rs. 1,000 per acre as a site for a model town. It is well covered with tea bushes and is rented out at present from year to year until it is required for the purpose for which it was purchased. It is considered that 50 acres of this area will be sufficient. The land is very conveniently situated along the main road to which it has very easy access.

11. The student who obtained first place in the B. Sc. (Agri.) degree examination from the Punjab Agricultural College in 1930 was sent by Government to the Tocklai Experimental Station, Assam, on a two years' course of Post-graduate study on tea cultivation and manufacture by arrangement with Mr. Carpenter and the Indian Tea Association. It is intended to utilize the services of this Assistant on his return, in connection with the tea research scheme now proposed.

12. The scheme has been worked out for a period of five years in the first instance. Since in the first year after severe cutting back for rejuvenation of wood, tea bushes do not give any yield of leaf, the results obtained from these experiments would only cover a period of three years. Again, when tea is grown from seed a period of about five years elapses before the bushes begin to produce leaf for picking and they are about ten years old before they attain their maximum production. Consequently, the period of five years will be insufficient to obtain final results and it will be necessary to extend the scheme for a further period of five years at least.

13. It is proposed to limit the scheme in its first period of five years to the agricultural aspect of the problem, as this the first requirement, and to defer the investigation on the improvement of the manufacture of tea to the second period. Accordingly, the average expenditure proposed during the first five years and which the Imperial Council of Agricultural Research is requested to finance is as follows :—

	Rs.
One "A" Class Agricultural Assistant with special training in Tea Cultivation and Manufacture	1,680 per annum.
Two Mukaddams (grade Rs. 17—1—30/2—50) ..	480 ..
Labour	3,500 ..
Manures	1,000 ..
Contingencies	500 ..
Rent of buildings	600 ..
	<hr/>
Total ..	7,760 ..
	or Rs. 38,800 for five years.

APPENDIX XXXIX.

SUBJECT No. 33.

REPORT OF THE FRUITS SUB-COMMITTEE.

Proceedings of the Committee appointed by the Imperial Council of Agricultural Research to examine the Fruit Schemes.

The Committee sat at Rock House on Tuesday, the 19th July 1932 from 3 P. M. to 5.45 P. M.

2. The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA (*Chairman*).
2. Mr. R. G. ALLAN.
3. Mr. A. G. BIRT.
4. Mr. P. H. CARPENTER.
5. Dr. G. P. HECTOR.
6. Mr. T. F. MAIN.
7. Mr. S. V. RAMAMURTY.
8. Dr. W. McRAE.
9. Mr. D. R. SETHI.
10. Mr. G. T. TAIT.

Rai Sahib Malik CHARAN DAS, *Secretary*.

The following attended as visitors :—

1. Dr. G. S. CHEEMA.
2. Mr. W. H. HEAD.
3. Mr. C. V. SANE.

3. The Chairman suggested that the Committee might take up first the United Provinces Plains (Annexure VI to Enclosure VI) scheme which was recommended by the Committee at its last meeting subject to the omission of certain items of non-recurring expenditure, but the consideration of which was postponed by the Advisory Board at its meeting held in January 1932. The Chairman accordingly called upon Mr. Allan to introduce the scheme. In doing so Mr. Allan said that the reductions suggested by the Committee at its last meeting were in the main justified and their necessity was recognized by his local Government. In view of the fact that it has been decided that only one fruit scheme was to be left to each province and that the U. P. Plain scheme as it now stood was difficult of early fulfilment and was in any case too small while that of the Bihar and Orissa Government was also much too small to be effective by itself he would favour a combination of the United Provinces Plains scheme with the Bihar and Orissa scheme if the two Departments of Agriculture could combine; the object being to prevent duplication of work. Mr. Carpenter in supporting this idea expressed the view that the proper course in such cases was to take up investigation of one problem at one place and another at another place instead of investigating one and the same problem at more than one place. Mr. Allan suggested that certain mango problems might be dealt with at one centre and others at the other. Bihar and Orissa could take up jitchi and the U. P. possibly papaya, peaches and plums. Mr. Sethi agreed to this proposal. In the course of discussion it was pointed out that the Fruit Schemes fell into two main parts, viz., (a) propagation and cultivation of fruits and (b) their nomenclature and classification. It was realised that (a) could be taken up together for the two provinces but that (b) was a local matter for each Province to deal with. Mr. Ramamurty suggested that the Provincial Agricultural Departments should do the classification work and then an all-India officer to be appointed by the Government of India or the Council should do common classification for all India. This was agreed to and in order to see that this was done and not lost sight of the Committee recommended that such of the Provincial Departments

as received a fruit grant should be asked to include a paragraph in their reports showing the action taken in this direction. It was then agreed that the scientific part of the United Provinces and Bihar and Orissa schemes (Annexure VI to Enclosures VI and VII) should be combined and the work carried out at the Bihar and Orissa station subject to the following :—

- (i) Bihar and Orissa to have at least 40 acres of land for the fruit work. This includes 16 acres of already planted orchards at Sabour State.
- (ii) In place of a Botanical Assistant on Rs. 80-5-100 provided for in the Bihar and Orissa scheme a good Botanist in the Provincial Service scale (250-20-750) to be appointed, the Public Service Commission through whom recruitment will be made to have discretion to offer such suitable salary within the scale as it may consider necessary to get a good Plant Physiologist.
- (iii) Provision for Travelling Allowance in Bihar and Orissa scheme to be raised from Rs. 500 per annum to Rs. 1,500 per annum and that for contingencies from Rs. 1,500 per annum for 5 years to Rs. 4,000 per annum for that period.

4. United Provinces Hills scheme (Annexure II to Enclosure VI).

Mr. Allan in introducing the scheme stated that apples from Australia and South Africa were put in the market in better form and at cheaper rates than local apples. The former were, however, not better than the latter except in appearance and this was due to the fact that they in the United Provinces did not have good knowledge about the various matters relating to their fruits and for this purpose, investigation was necessary. The original scheme which was estimated to cost about Rs. 200,000 had now been cut down to Rs. 159,000 and he commended it to the favourable consideration of the Committee. Mr. Carpenter raised the point whether the scheme would be of benefit to provinces other than the United Provinces. He had grave doubts if the scheme was not a purely provincial one. Mr. Allan said that the results of the work would be applicable to the fruit industry in the Punjab and that the question of producing fruit which could compete successfully with the fruit imported from Australia and South Africa was an all-India one. It was finally agreed that the scheme could be regarded as an all-India one and of more than Provincial interest.

The Committee agreed to the scheme in principle. Discussion then centred round the scales of pay proposed for the gazetted staff provided in the scheme but these were allowed on being explained that the officers would have to work for most of the year on their own initiative and responsibility. The following two modifications were then made in the cost of the scheme :—

- (a) The scale of pay of a Mali provided for at Rs. 50-2-60 was reduced to Rs. 30-1-35.
- (b) The amount under annual laboratory equipment was increased from Rs. 1,200 to Rs. 1,800 p. a.

Mr. Ramamurty suggested that in sanctioning schemes the Council should adopt a general principle that receipts, if any, from the schemes should be credited to the Council's funds. The Chairman replied that the principle was being generally followed now. As to the present case, Mr. Allan explained that while he had no objection to the receipts being credited to the Council that would necessitate an increase of the provision for maintenance of orchard which had been reduced from Rs. 40,000 to Rs. 9,000 in consideration of the receipts remaining with the Local Government. Taking all things into account the Committee decided not to press the point in this case and recommended the scheme subject to the two modifications named above and to a note being kept of the principle regarding receipts for observance in future as far as possible.

5. Assam Scheme.—(Enclosure VIII).—Mr. A. G. Birt introduced the scheme. The Committee thought that the orange industry in Assam was a very important one and was of more than provincial importance. But the scheme as drawn up was rather designed to assist three existing Provincial farms and was not suitable for help from the Council. It was decided to suggest to the Assam Government to consider a revised scheme for citrus fruits.

6. *Bombay Cold Storage Scheme* (Enclosure III).

Dr. G. S. Cheema in introducing the scheme narrated the previous efforts made in this connection and stated that markets for good mangoes existed in Great Britain, Paris and Germany and that the cost of the scheme was insignificant as compared with the results that were likely to follow. The Chairman enquired as to why Poona had been selected for the location of the scheme in preference to Bombay. In reply Mr. Main explained that as the headquarters of both Dr. Cheema who was to be in charge of the scheme and the agricultural Engineer were at Poona that station had been selected for reasons of economy as well as of better supervision and control. The scheme was considered a very sound one but the Committee decided that it should be enlarged so as to cover mangoes from other provinces especially Madras and the United Provinces and Bihar. Mr. Main and Dr. Cheema agreed to this and stated that about 20,000 mangoes would be required each year from each province during the period of three years. Mr. Ramamurty agreed to supply this number while Mr. Allan said that the United Provinces would be able to send only half that number. Mr. Sethi agreed to supply about 7 to 8 thousand mangoes. The Committee agreed to the scheme and requested Dr. Cheema to prepare and submit an estimate* of the additional cost required to enable the scheme to include mango varieties from other Provinces in the investigation.

CHARAN DASS,

*Secretary.**The 20th July 1932.*

*Enclosure XI.

ENCLOSURE I.

APPLICATION FROM THE GOVERNMENT OF BOMBAY FOR A GRANT OF RS. 72,064 SPREAD OVER THREE YEARS FOR A COLD STORAGE RESEARCH SCHEME FOR FRESH FRUIT EXPORT.

Attention is invited to the attached letter (and enclosure) from the Government of Bombay, No. 4369-A/28, dated the 9th July 1932 (Enclosures II and III) forwarding a cold storage research scheme for fresh fruit export. The scheme involves a non-recurring expenditure of Rs. 30,875 and a recurring expenditure of Rs. 43,689 or a total expenditure of Rs. 74,564 spread over a period of three years. Out of this the Local Government are prepared to meet the cost of Rs. 2,500 required for making incidental structural alterations. The net amount required from the Imperial Council is therefore Rs. 72,064.

2. In this connection it may be stated that the Vice-Chairman while in England, in 1930, took the opportunity of visiting the Low Temperature Research Station and discussing this question with Dr. Barker in company with the Deputy Indian Trade Commissioner and a copy of a note by the latter is attached (Enclosure IV). Dr. Barker's note (Annexure to Enclosure IV) clearly shows that work in India on four points is necessary, namely, (1) suitable varieties for export, (2) maturity at time of picking, (3) storage temperature during transit, and (4) methods of packing. If arrangements can be made for this work in India, it is probable that the assistance of the Low Temperature Research Station can be secured through the Empire Marketing Board.

3. It may be considered necessary to approach the Empire Marketing Board with a request to meet a share of the expenditure involved.

The scheme is now for consideration.

SIMLA, S. W.,

CHARAN DASS,

*The 13th July 1932.**Secretary.*

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ENCLOSURE II.

COPY OF LETTER No. 4369-A/28, DATED 9TH JULY 1932, FROM THE CHIEF SECRETARY TO THE GOVERNMENT OF BOMBAY, REVENUE DEPARTMENT, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Cold storage research scheme. Imperial Council of Agricultural Research. Grant-in-aid from, for—.

With reference to the correspondence ending with your telegram No. 1641-Agri. dated 6th July 1932, I am directed by the Government of Bombay (Transferred Departments) to forward the cold storage research scheme for the export of fresh fruit, which has been revised by Dr. G. S. Cheema, Horticulturist to Government, and to state that the original scheme was placed before the Provincial Agricultural Research Committee and was approved by it. Though the scheme has since been revised, it differs only in points of detail from the scheme commended by the Committee. The Government of Bombay strongly recommend the revised scheme for the favourable consideration of the Imperial Council of Agricultural Research. The total cost of the scheme is estimated at Rs. 74,564 which is made up of Rs. 30,875 initial expenditure and Rs. 43,689 recurring cost, spread over a period of three years. The provincial contribution towards the cost of the scheme will be limited to the supervision to be exercised by the Horticulturist over the scheme and the facilities for housing the plant at the Ganeshkhind Botanical Gardens. The Government of Bombay will also be prepared to meet the cost of Rs. 2,500 required for making the incidental structural alterations. Beyond this, it is not possible for them under present financial conditions to make any further contribution towards the cost of the scheme.

2. I am to add that the Manager, Government Central Press, has been instructed to send 100 printed copies of the scheme direct to the Council.

*Not printed.

ENCLOSURE III.

COLD STORAGE RESEARCH SCHEME FOR FRESH-FRUIT EXPORT.

Introduction.

It is commonly held that, apart from the Himalayas, India is a disappointing country as regards fruit. There are many factors in the plains of India, which are favourable to fruit production, but high class fruit is rarely found in large volume. It seems probable that the difficulties wrapt up with marketing are, in large measure, the cause of this unsatisfactory state of affairs. It was recently pointed out by the Bombay Presidency Fruit Growers' Association that—

- (a) 71 per cent. of the retail price of fruit is taken by the middleman,
- (b) 18 per cent. is absorbed in freight, etc., and
- (c) 11 per cent. only goes into the pocket of the producer.

After making a careful study of the London and Paris fruit and vegetable markets the Horticulturist to the Government of Bombay has written a pamphlet† on this subject with a view to stimulating public interest and creating public opinion upon the need for marketing reform, if the producer is to be adequately encouraged and the consumer adequately catered for. So much for the Home (Indian) market, but it is necessary to take cognizance of the fact that it is the Export Market which has brought prosperity to producers in many fruit-growing countries like Palestine, California and South Africa. This applies particularly to those countries which can produce one or more kinds of fruit of the highest excellence. To secure a good place in the Export Market it is essential that the fruit should be of high quality, especially where there is world competition. But in some cases there is the factor of monopoly of production. The country which possesses both a high class article and a monopoly of production commands an exceptionally strong position, and it would be surprising if, in such circumstances, the export market remained undeveloped. India, however, provides an excellent example of this remarkable phenomenon. Notwithstanding the possession of a virtual monopoly of the production of at least one high class fruit the mango, there is no export trade in fresh fruit. It is, therefore, a matter of economic importance to determine the reasons for this lack of develop-

*Not printed.

*In the Press.

ment. The explanation appears to lie in the fact that an export trade cannot be developed in the absence of a regular supply of fruit of standard quality. All this means organization, and it is here that India has failed in the past. The Indian mango crop is thrown on the market haphazardly without any regard to grade or uniformity of quality. Hence the would-be exporter cannot readily obtain the material required, and so the Transport Agencies have not been strongly pressed to provide facilities for fruit-export, and consequently nothing has been done; and the vicious circle remains unbroken.

The Bombay Department of Agriculture has been giving special attention to the grading of fruit and the organization of growers; and the time has come when it would be possible to make available a large quantity of high class fruit for export, if the overseas markets could be opened up. Before this can be done it is necessary to investigate a series of problems underlying the technique of export. Preliminary investigations, carried out under makeshift arrangements, indicate that the export of superior varieties of mango has been brought within the range of practical politics. For several years experimental consignments of mangoes have been sent to England by the Bombay Department of Agriculture, with encouraging results as may be gathered from the following report, dated 22nd August 1930, from the Low Temperature Experimental Station, Cambridge:—

“The experiments must be considered most successful since they show that mangoes shipped from India by steamer can arrive in England in excellent marketable condition and remain marketable at least for a week.”

During these experiments when the fruit was considered a novelty these mangoes fetched as much as 40 francs per fruit in Marseilles and 3/6 per fruit in London. In 1931-32 large scale export trials have been organized with the aid of a grant of Rs. 4,000 from the Imperial Council of Agricultural Research. Once a week from April to June the Department has despatched a consignment of 85 boxes of mangoes (each box containing a dozen); and the cable report upon the first two consignments (recently to hand, 28th May 1932) reads as follows:—

“First two shipments of mangoes arrived good condition. Selling at 1 to 2 Shillings each.”

These boxes were carried to London by sea in the Purser's Cool Room in which the temperature is round about 36°-45° F. On the other hand the third consignment reached London in very ripe condition with some of the fruit spoiled. This shows what an important part the maturity stage of the fruit at the time of export taken together with the temperature in the cool room plays in governing the success of the operation.

With the aid of an Empire Marketing Scholarship, obtained through the Imperial Council of Agricultural Research, the Horticulturist to Government spent about six months in England in 1931, studying the problem, at that end, and the Research scheme submitted below has been prepared in the light of the knowledge so obtained, especially from such sources as the Low Temperature Research Station at Cambridge where Sir William Hardy gave every assistance and much valuable advice, and Covent Garden where Messrs. George Munro and Company, the well-known Fruit and Vegetable Firm, enabled this officer to secure a full insight into the commercial aspects of the importation of fresh fruit.

As regards the available supplies of mangoes in the Bombay Presidency it may be pointed out that the orchard area exceeds 15,000 acres, while the number of trees not included in systematic plantations, is legion. The Konkan Division alone sends to market mango fruit of the value of Rs. 20 lakhs per annum in a good year. Gujrat is also an important mango tract, while there is practically no part of the Presidency which does not grow the mango. All the fruit is, of course, not of high quality, but certain localities are associated with the production of famous varieties like the Alphonso and the Pairi. There is, moreover, a definite tendency to increase the area under this fruit, and the potential crop is unlimited, if remunerative prices can be obtained. This stipulation applies with particular force to the superior varieties, because they are by nature shy-yielders. Even the hardy varieties do not, on the average, yield as much as is sometimes inferred from

the gorgeous inflorescence and the countless fruits that are occasionally seen upon a tree. In practice the common mango tree produces in the course of three years—

- (1) one full crop,
- (2) one partial crop,
- (3) one failure.

On this basis the average yield is only about half of what is obtained in a good year. Moreover should the crop in the good year meet with disaster from a storm or disease the average income is still further reduced. There is also the further consideration of the irregular supply to the market. To compensate the mango-grower for these losses and to make the industry profitable it is necessary to improve marketing generally and to open out the export market in particular. Too often during the mango season there is either a scarcity or a glut in the market. At present there is no means of holding over a surplus supply or of meeting a deficit supply; the ready fruit has got to be marketed or thrown away. Hence, although, the wholesale price of superior varieties of mangoes may be Rs. 8 to Rs. 10 per 100 (which is not bad, considered in the abstract) the actual return, under existing circumstances, from an acre of grafted mangoes is less than that from most other fruit-trees. If, however, the supply could be regulated through storage at the optimum temperature (as distinct from the frozen condition) the problem of marketing, both in India and abroad, would be greatly simplified, as regular supplies are a pre-condition of organized marketing. If this were done it might reasonably be assumed that the production of high class mangoes would become a different economic proposition to what it is to-day in the Presidencies of Madras and Bombay and the Mysore State. In order to achieve this object it is not necessary to secure the fancy prices obtainable when the fruit was a novelty, but it seems not unreasonable to expect a price of nine pence per fruit in the luxury class and six pence to seven pence in the superior class. In this connection we have the experience, before us, of the American grape-fruit which originally, in England, was a luxury fruit, sold at a fancy price, but is now in common use at a reasonable price. Moreover it should be borne in mind that America does not possess a monopoly of the grape-fruit, so that India is in a stronger position with the mango. Before however, the export of mangoes can be placed on a satisfactory basis it is necessary to replace the empirical shipping arrangements, hitherto adopted, by a plan which provides the optimum conditions for successful export. At present we know that mangoes placed in the Purser's Cool Room having a temperature of 36° to 45° F. have arrived in Europe in satisfactory condition, but we do not know whether this temperature is the most suitable with reference to (1) the condition of the fruit on arrival, and (2) the length of time the fruit will remain in good condition after being exposed to atmospheric temperatures in England or elsewhere. It is also necessary to ascertain the precise stage of ripeness required in the mango which is to be preserved in cool storage for 3 weeks or a month. It is to be anticipated that some varieties will prove more suitable for this treatment (indispensable for export) than others and these require to be determined. In the past sundry cold storage investigations have been conducted. First of all an attempt was made to preserve the mango in the Cold Store of the Crawford Market in Bombay when it was found that the mango kept well for about a month at a temperature in the range 38° to 40° F. It was not, however, found practicable to control the temperature as the store was opened several times a day. Subsequently some experiments were carried out at the Low Temperature Research Station at Cambridge through the co-operation of Sir William Hardy but without, at first, achieving much. In 1930, however, more light was obtained through two consignments of mangoes forwarded to Cambridge Accompaniment I gives a full report upon this work from which it will be seen that experiments upon the ripening of the fruit which arrived, in an immature condition, at Cambridge were carried out and that the following broad conclusions were arrived at:—

- (1) the most suitable type of mango for export requires to be determined in India,
- (2) the most suitable stage of maturity at which to ship mangoes from India requires to be worked out in India,
- (3) experiments within the range of temperatures 34° 40° F. should be conducted in India to determine the best storage temperature during the sea-voyage for consignments of mangoes.

These recommendations make it abundantly clear that a carefully planned cold-storage research scheme is an essential preliminary to the launching of a sound export scheme for fresh fruit from India.

A scheme which is described in the following section has accordingly been framed for favourable consideration of the Imperial Council of Agricultural Research.

The next consideration is the shipping facilities which are likely to be available for the transport of fresh fruit from Bombay to Europe. During the current season (1931-32 crop) the P. & O. S. N. Company have, for experimental purposes provided space in the Purser's Cool Room at the rate of Rs. 64 per ton of 40 cubic feet, but the available accommodation is naturally small. However, in response to a recent demand from a business firm in Bombay for accommodation for 50 tons of mangoes makeshift arrangements were made to keep a part of the upper-hold of the ship cool through the use of iced-cylinders and fans.

This is a very important development as indicating the readiness of the shipper to respond to the exporter's demand. We have also the experience of the importers of fresh fruit into India. In this case the shipper has provided facilities for transporting fruit from South Africa, Spain and Palestine to this country.

With this experience before us it seems safe to assume that the shipper will be prepared to provide adequate facilities at a reasonable cost if an organized export trade is likely to develop.

The importance of developing an export trade in fresh fruit cannot, however, be measured merely in terms of the actual exports, which may materialize. The stimulus thus given to the producer would, presumably, result in large quantities of high class mangoes, of standard quality, being produced in India; which is the pre-condition of the establishment of a prosperous canning industry. If such an industry could be brought into existence the market for high class mangoes, in the preserved condition, would become world-wide and the area under this crop might be expected to extend on a large scale.

From the enquiries which have been received from the United Provinces and Madras and other places it is obvious that this export problem is not a Provincial one, peculiar to Bombay, but is of All-India interest. Moreover, this export problem is not confined to mangoes. For example, there is the Santra orange which has special qualities, which should enable it to secure a place in the British market. The Director of Agriculture, Central Provinces, has expressed a desire to have the analogous problems bearing on the export of this fruit worked out in the same manner as proposed for the mango. The cold storage plant described in the following pages could conveniently be utilized for this investigation because the mango and orange seasons do not coincide.

THE RESEARCH SCHEME.

This scheme purports to solve a group of problems bearing upon the "Commercial storage life" of fresh fruit, the solution of which is a pre-condition of placing the export of fresh fruit (mangoes, etc.) on a scientific basis, which alone enables such an enterprise to be successful.

The mango will be the principal fruit used in this research scheme, but it is hoped to include the orange also, with the co-operation of the Central Provinces Department of Agriculture.

The problems to be solved may be summarized as follows:—

- I. What are the optima temperatures in the cool chamber for ensuring the longest "Commercial storage life" of fruit picked at different stages of maturity?
- II. Which varieties yield fruit possessing the longest "Commercial storage life"?
- III. Which localities produce fruit possessing the longest "Commercial storage life"?
- IV. To what extent is the "Commercial storage life" of fruit affected by exposure to different atmospheric temperatures?

V. To what extent is the "Commercial storage life" of the fruit affected by the use of different wrappers and packing materials?

As regards Problems I and II it is proposed to conduct intensive investigations upon the Alphonso mango and two or three other varieties, including the Pairi and Totapuri, while a large number of varieties, possibly 20, will be put through less rigid tests in order to obtain a general knowledge of their export value. Fruit will be placed in the cool chambers at temperatures ranging in the first instance from 34° to 60° F. and later at temperatures within a narrower range, probably 34° to 40° F. In this way the optimum temperature for each variety will be determined. Each variety will be sub-divided into the four stages of maturity tabulated below for the Alphonso variety :—

- (a) green,
- (b) light green,
- (c) light green with blush,
- (d) ripe.

The fruit will be placed in trays, each containing about 20 mangoes, and the number of trays will be such as to ensure reliable results. The first examination will begin on the expiry of three weeks from the date of placing the fruit in the cool chamber, and subsequent examinations will be at intervals of a week. Records of wastage will be maintained; and when the loss reaches 10 per cent. of the material under investigation the observations will be stopped, and the time noted as the "Commercial storage life" of the variety, stored at a given stage of maturity, at a given temperature.

As regards Problem III the investigation will be conducted with fruit of a few varieties each obtained from several localities, including Kolaba, Thana, Ratnagiri, Dharwar and Poona. The optima stages, of maturity and temperatures as worked out under Problems I and II, will be adopted for each variety. This investigation is expected to throw light upon the influence of the environment of production upon the commercial storage life of the mango.

As regards Problem IV an investigation will be conducted to ascertain the effect upon the subsequent commercial storage life of a variety of mango, of withdrawing the fruit from the cool chamber, after storage for 4, 10, 16 and 20 days, and exposing it to atmospheric temperatures for varying periods of time. The fruit will be put back into the cool chamber and its "life" will be compared with fruit not so exposed. The object is to ascertain the period of exposure which can be given to fruit without fear of injury.

As regards Problem V an investigation will be conducted with fruit wrapped and packed in different materials. In this case all other factors such as temperature and stage of maturity will be optimum.

It is anticipated that if the staff and equipment mentioned below is provided it will be possible to complete all these investigations in a period of three seasons.

Special care will be taken to maintain a very full series of records, and observations, and for this purpose printed forms will be drawn up and maintained.

Similarly care will be taken to ensure the value of the work by taking suitable precautions, such as—

- (a) As far as possible care will be exercised in selecting uniform fruit for each lot. The fruit will be of a desirable quality.
- (b) A portion of the stem will be kept with each fruit.
- (c) The fruits will be carefully examined for bruise or damage.
- (d) The chambers will be opened once or twice a day only and not more frequently.
- (e) The full history of the trees from where the fruit is picked will be preserved.
- (f) Care will be taken to put fruits in the chambers within two days of their picking.
- (g) As far as possible the number of fruits in each tray under each treatment will be high. If the required number of fruits cannot be had then and then alone the available supply will be made use of.

- (k) The joints will be tested from time to time and the leakage prevented.
- (l) Each lot of fruit will be weighed before it is kept in the tray and weighed at the end of the experiment.
- (j) The brine will be tested from time to time and its required specific gravity will be maintained. Importance will be given to this point in the engineer's log.

This research scheme will be required to run for a period of three years and it will be located in a building in the Ganeshkind Botanical Gardens, near Poona.

ESTIMATES.

The scheme requires the provision of a group of cool chambers, in each of which the temperature is under control. As a series of problems have to be tackled and the work conducted upon a scale which will entitle the results to be accepted with confidence it has been computed that the minimum size of a chamber should be 500 cubic feet made up of the following dimensions :—

$$7' \times 9' \times 8'.$$

This will enable about 40 trays (each tray containing 20 mangoes) to be accommodated in each chamber. It will thus be realized that a battery of Frigidaires or Kelvinators would not provide sufficient storage for this scheme. There is also the technical difficulty that the temperature in a Kelvinator cannot be accurately controlled or kept uniform on different shelves, the upper being colder than the rest. Moreover, it is necessary to provide an air-lock so as to preserve the temperature of the chamber when the door is opened for the purpose of taking observations upon the fruit. The air-lock will take the form of a corridor from which there will be access to each chamber.

The refrigerating plant will be of the Ammonia Compressor type described in the tabular statement, containing the detailed estimates, attached, hereto. The size of this plant has been selected with reference to the size of the cool chambers, the air of which has to be cooled to varying temperatures. These temperatures will be automatically controlled through the use of thermostats. The plant will be worked by electricity to be supplied by the Poona Electric Supply Company, the rate being one to two annas per unit (Kilowatt).

The recurring expenditure upon electricity and stores and most of the establishment is based on the assumption that the plant will be worked for six months per annum, but two members of the staff will be engaged for the whole year as this personnel cannot be changed for technical reasons.

This research scheme will be under the direction of Dr. Cheema, Horticulturist to the Government of Bombay, and it is proposed to provide him with the following staff :—

		Ra.
One Senior Assistant on	.. .. .	245—15—275 per mensem
One Junior Assistant for six months per annum on	.. .. .	150 ..
Two Laboratory Assistants for six months per annum on	.. .. .	50 per mensem each;
One Senior Machanic on	.. .. .	150—10—170 per mensem
Two Junior Mechanics for six months per annum on	.. .. .	75 per mensem each.
Three coolies for six months per annum on	.. .. .	30 ..
Open peon on	.. .. .	18 per mensem.
One boy-peon for six months on	.. .. .	11 ..

On this basis the detailed estimates of recurrent expenditure contained in the attached tabular statement have been worked out for a period of three years from which it will be seen that the total cost of the scheme is estimated at Rs. 74,564 made up of—

Rs. 30,875 initial expenditure, and

Rs. 43,689 recurring expenditure over three years.

The following items are excluded from the estimates—

- (1) the supervision of Dr. Cheema, and
- (2) the housing facilities for the plant at Ganeshkhind Botanical Gardens, except the incidental structural alternations.

and this is the contribution which, in the present circumstances of financial stringency, it is possible for the Government of Bombay to make towards the cost of the scheme.

T. F. MAIN,

Director of Agriculture, Bombay Presidency,
Poona.

DETAILED ESTIMATES.

Capital Expenditure.

Items.	Description.	Cost.
		Rs.
1	One Ammonia Compression Refrigerating Plant consisting of No. 2 Size Vertical Single Acting "Wembley" enclosed type electrically driven Compressor, one Tubular Condenser, one Tubular Evaporator, 2 Centrifugal electricly driven Brine Pumps, 7 Propeller type Fans, one for each cold room, directly coupled to an Electric Motor of 1/8 H. P. each complete with automatic control, automatic water valve to control the condenser water supply, automatic regulators for the Ammonia Circuit, 7 electrically operated brine valves each complete with a Thermostat to be placed in each room, etc., etc. c.i.f. Bombay	8,492
2	One Stand-by Compressor, similar to above, complete with electric motor, control gear, piping, etc. c.i.f. Bombay	1,862
3	First Charge of Ammonia including Flask and Calcium for mixing sufficient brine for the entire circuit. c.i.f. Bombay	168
4	Nine Insulated Doors constructed on a strong pine framing, packed with 6" Compressed Cork Slab c.i.f. Bombay	2,394
5	Seven Thermographs for recording Temperature with 100 charts each c.i.f. Bombay	833
6	One Circulating Water Pump with condenser pipes	203
7	Seven Cold Chambers each measuring 7' x 9' x 8' at Rs. 690 each exclusive of doors c.i.f. Bombay	4,830
8	Shelvage 840 square feet at 120 square feet per room, at Rs. 122 each room together with 280 trays each measuring 17" x 22" x 3" and costing Rs. 2	1,414
9	Cost of assembling and erection including foundations	4,000
10	Cost of accessories such as—	Rs.
	(a) 7 Spare Thermographs at Rs. 119 each	833
	(b) Thermometers	140
	(c) Electric heating arrangement for each room at Rs. 168 each	1,176
	(d) 4 Ceiling Fans at Rs. 55 each	220
	(e) 16 Lights at Rs. 15 per point including wiring, switches, etc.	240
	(f) Wiring and switches for fans	60
	2,869	2,869
11	Cost of clearing the machinery at Bombay harbour and transporting it to the site including everything	1,000
12	Cost of conversion of the Verandah into Machinery Shed, including new frame work, raised roof, side walls and ceiling with Celo-tex, etc.	2,500
13	Electric connection from the nearest pole to the Machinery house	510
		30,875

Recurring Expenditure.

Name of head.	Budget estimates.		
	1st year.	2nd year.	3rd year.
<i>Pay of establishment.</i>			
	Rs.	Rs.	Rs.
1. One Senior Research Assistant in the grade of Rs. 245—15—275	2,940	3,120	3,300
2. One Junior Research Assistant on Rs. 150 per mensem for six months	900	900	900
3. One Senior Mechanic in the grade of Rs. 150—10—170	1,800	1,920	2,040
4. Two Junior Mechanics on Rs. 75 per mensem each for six months	900	900	900
5. Two Laboratory Assistants on Rs. 50 per mensem each for six months	600	600	600
6. Three coolies on Rs. 30 per mensem each for six months	540	540	540
7. One peon on Rs. 18 per mensem	216	216	216
8. One boy peon on Rs. 11 per mensem for six months	66	66	66
Total	7,962	8,262	8,562
<i>Allowances and Honoraria.</i>			
Travelling allowance	1,000	1,000	1,000
<i>Contingencies.</i>			
Purchase of fruits as under :—			
(a) Mangoes	1,180	855	850
(b) Oranges	300	250	250
Upkeep and running of machinery as under :—			
(a) Electric power for working the plant for 6 months including the following :—			
(1) The Compressor.			
(2) The Brine Pump.			
(3) The Water Circulating Pump.			
(4) The 7 Fans for cool chambers.			
Total H. P.—6·5			
Total units 3,539·7	1,402	1,402	1,402
(b) Electric Power for lights and ceiling fans	587	587	587
(c) Ammonia Cylinders 2 at Rs. 65 each	130	130	130
(d) Lubricating oil 48 gallons at 8 gallons per month at Rs. 2-12-0 a gallon	132	132	132
(e) Calcium Chloride for Brine	70	70	70
(f) Stores repair and sundry expenses	500	500	500
Purchase of books	1,000	500	500
Office expenses and miscellaneous (including telephone rent)	585	585	585
Total	5,886	5,011	5,006
GRAND TOTAL	14,848	14,273	14,568

C. G. PARANJPE,

Assistant to the Agricultural Engineer to Government,

Bombay, Poona.

ACCOMPANIMENT I.

Report regarding the Experimental consignments of mangoes in 1930 received from the Low Temperature Station, Cambridge.

In continuation of the experiments begun in 1929 on the export of mangoes from India to England, two experimental consignments have been sent in 1930. The experiments were initiated by the Horticulturist to Government of Bombay, Poona, and the fruit was consigned to Cambridge for examination.

FIRST EXPERIMENT.

In the first experiment, one box of Alphonso mangoes was shipped by Mail Steamer from Bombay on the 17th May in the Purser's Cool Room. This fruit arrived at Cambridge on June 12th after a period of 26 days from Bombay.

The mangoes were markedly over-ripe. They were of a deep orange-yellow colour, often discoloured by dull brown patches; some were split, and all except two were very soft. In two fairly large firm mangoes, the flavour of the flesh was good, and it therefore appeared that consignment had ripened normally but had become over-ripe.

SECOND EXPERIMENT.

In the second experiment made nearly three weeks later two cases of mangoes were shipped, one in the Purser's Cool Room, and one on deck. The period from Bombay was in this case 21 days.

(a) *Purser's cool room.*—On arrival the 24 mangoes in this case were all sound and unripe. Three wore a golden yellow colour, and were slightly soft, though not fully ripe, the flesh being light in colour and rather acid. Eight were firm and green, while thirteen were yellow-green.

To ascertain how the fruit would ripen, half was put at 50° F. and half was kept at the ordinary temperature of about 66°—70° F.

After three days the green fruit kept at the ordinary temperature was coloured, and when cut, the flesh was found to be fully coloured and no longer acid. The flavour was excellent.

At this stage eight of these fruits were despatched to Covent Garden Market. The price realized, namely 3s. per mango, is very high for this fruit, and bears excellent testimony to their very fine appearance.

The remaining fruits kept at Cambridge at the ordinary temperature remained sound in appearance for another week, but towards the end of this period a white band of acid tissue had developed in the flesh.

The fruits placed at 50° F. remained green for seven days when they were removed to the ordinary temperature. They then ripened rapidly and were fully coloured in three days. Though excellent in appearance, however, their condition was not so good as in those allowed to ripen immediately at ordinary temperature. In a proportion the occurrence of the acid tissue, noted above, was observed.

(b) *On deck.*—The 24 mangoes carried on deck were all soft, fully coloured and badly shrivelled on arrival. The flavour of the flesh was good. These fruits, like those of the first experiment, appeared to have ripened normally, but to have become over-ripe.

DISCUSSION.

The experiments must be considered most successful, since they show that mangoes shipped from India by steamer can arrive in England in excellent marketable condition and remain marketable for at least a week.

It is difficult, however, to point to the factors which contributed to success, since no information has been forwarded from India, either, as to whether more than one type of mango was used, or as to the maturities of the three experimental boxes at the time of picking. With the information available in India, the results can be closely analysed.

As far as can be judged without further information, the maturity of the mango at the time of picking and the type of mango appear to be the most important factors. The temperature during transport, as recorded by the Shipping Company, was similar in both experiments, and the over-ripeness of the fruit in the first experiment must therefore have been related either to picking too late, or to the use of a variety of mango of shorter storage-life than that used in the second experiment.

In further experiments it is clearly desirable not only to try to repeat this year's experiments, using the stage of maturity at picking which was so successful in the second experiment, but also to try several types of mangoes, and with each *to ship* fruit of different stages of maturity. If possible, the samples of different maturity should be picked at the same time, and shipped on the same steamer.

As regards the temperatures of carriage, the results clearly show that 40° F. does not harm the fruit but that carriage on deck is inadvisable. If the export of mangoes is to be progressed, it seems desirable to conduct trials at once to ascertain whether 34° F. should give better results than 40° F. If 34° F. does not injure the fruit, then its use would allow riper fruit to be shipped, since, the rate of ripening would be slower at 34° F. than at 40° F. The comparison of these temperature is probably not possible on the mail steamers, and would have to be done on land.

If such storage temperatures were available on land, then information as to the best stage of maturity at picking and the most suitable forms of mango for storage, would be speedily obtained and would greatly assist the experiments of export to England.

The package used in the experiments is unsuitable and a tray made of piece of wood of the dimensions given below is recommended. Twelve fruits would be packed in this tray, each fruit wrapped in paper, and some form of packing material is, of course, essential. If wood-wool is not available dried leaves could be used.

Dimensions of wood for tray package.

Bottom (two pieces) each	..	..	..	..	18" × 5½" × ⅜"
Top (two pieces) each	..	..	..	..	18" × 5½" × ⅜"
Sides (two pieces) each	..	..	..	..	18" × 2⅞" × ⅜"
Ends (two pieces) each	..	..	..	..	11½" × 2½" × ½"
Battens (two)	..	..	..	..	11½" × ½" × ½"

ENCLOSURE IV.

COPY OF NOTE BY MR. S. N. GUPTA, I.C.S., DEPUTY TRADE COMMISSIONER, DATED 13TH NOVEMBER 1930.

Sir T. Vijayaraghavacharya and myself visited Cambridge on the 5th instant and inspected the Low Temperature Research Station, which is under the joint management of the University and the Department of Scientific and Industrial Research and under the direction of Sir William Hardy. Professor Hardy was unfortunately away from Cambridge on the 5th, but we were shown round by Dr. Barker, the Superintendent. We saw various experiments being conducted on several kinds of fruits in the cold chambers of the station. Indeed we spent a most interesting time there.

We then had a long talk with Dr. Barker about mangoes and the question of their importation to this country. He explained that Dr. Cheema, Government Horticulturist at Poona, had, in the course of the last two years, sent there consignments of mangoes. Dr. Barker has now kindly sent us a copy of the report (accompaniment I to Enclosure III) sent to Dr. Cheema on the two mail steamer consignments sent during 1930. The consignment sent in 1929 came by air mail and the mangoes were very over-ripe. This result, I think, rules out the suitability of the air mail for carrying mangoes intended for experimental work here. The results of the two steamer consignments are fully set out in the report to Dr. Cheema and furnish very valuable data for further experimental work.

Dr. Barker has kindly sent a note (Annexure) on the subject of the export of mangoes which gives his views as expressed to us in the course of his talk with us at Cambridge.

In his view the four main problems are :—

- (i) Suitable varieties for export.
- (ii) Maturity at time of picking.
- (iii) Storage temperature during transit.
- (iv) Methods of packing.

He is definitely of opinion that work on these problems must be carried out in India. Cambridge can only help by way of observing the condition of the fruit on arrival in this country. Dr. Barker thinks that it should be possible to arrange with commercial firms in Bombay for the storage of fruit at temperatures of 40° F and 34° F. Problems (i) and (ii) must necessarily be correlative with problem (iii). When these problems have been satisfactorily settled by experimental work in India and suitable methods of packing have been arranged, the Indian authorities should then send forward a series of mango consignments to this country, which would be observed and reported on by Cambridge. After these reports has been duly taken note of by India, the way would then be clear for the export of mangoes from India under optimum conditions and on a commercial scale.

ANNEXURE.

The Export of Mangoes from India to England.

During the last two years three experimental consignments of Mangoes have been forwarded to England by the Horticulturist to the Government, Bombay. The first consignment was sent by air mail, and was marked over-ripe on arrival. The second and third consignments were carried on the mail steamer, some cases being in ordinary stowage, and some in cool storage. The former were again over-ripe, but of the samples sent in cool storage, one lot picked less ripe than the other, arrived in excellent condition. These preliminary experiments thus showed clearly the great importance of the two factors, namely the temperature during transport, and the maturity at time of picking. The desirability, however, of improvement in the method of packing was also evident.

Temperature during Transport.—The comparison of carriage in ordinary stowage and in cool storage on the mail steamer has shown that cool storage temperatures used was 40° F, it is possible that even better results might be obtained by using a still lower temperature, such as 34° F. Provided 34° F was not injurious, it would be preferable to 40° F since the fruit could be picked riper.

It is accordingly desirable that experiments should be made to compare the results of storage at 34° F and at 40° F. This comparison is probably not possible on the mail steamers, and should be done in India.

Maturity at time of Picking.—The third experimental consignment has shown the correct maturity at picking for the Alphonso mango, when shipped at 40° F. If then further experimental consignments are sent at 40° F the fruit should be picked at this same stage of maturity. If 34° F is used the fruit could probably be picked riper.

Other varieties of Mango.—Different varieties of mango probably vary considerably in the periods for which they will remain sound in storage, and trials are desirable to ascertain the most suitable types for export. In such trials different stages of maturity would, of course, be tested.

Method of Packing.—The package used in the experimental consignments is unsuitable since not only is it of little value in preventing bruising, but the trade prefer a less bulky type of package. A tray made of pieces of wood of the dimensions given below is recommended. Twelve fruits would be packed in this tray, each fruit wrapped in paper, and some form of packing material is, of course, essential. If wood-wool is not available, dried leaves could be used.

Dimensions of Wood for Tray Package.

Bottom (two pieces) each	.. ..	18" × 5 3/8" × 3/16"
Top (two pieces) each	.. ..	18" × 5 3/8" × 3/16"
Sides	.. ..	18" × 2 3/16" × 3/16"
Ends	.. ..	11 1/2" × 2 1/2" × 1/8"
Battens (Two)	.. ..	11 1/2" × 3/8" × 3/8"

Since mangoes cannot be obtained shortly after picking in England, no special research work on mangoes can be undertaken at Cambridge. All that can be done to assist in building up an export trade in mangoes from India is to observe the condition of experimental consignments. Various suggestions which can be tested by experimental consignments have been made above. It should be pointed out, however, that much more rapid progress would be made if in addition to sending experimental consignments to Cambridge, storage trials were also carried out in India. If storage temperatures of 34°F and 40°F were available in India, then the most suitable forms of mango for storage, would be speedily obtained, and would greatly assist the experiments on export to England.

(Sd.) J. BARKER.

ENCLOSURE V.

PROVINCIAL SCHEMES OF FRUIT RESEARCH :

- (a) UNITED PROVINCES (ENCLOSURE VI AND ANNEXURES).
- (b) BIHAR AND ORISSA (ENCLOSURE VII).
- (c) ASSAM (ENCLOSURE VIII).

At its meeting held in January 1931 the Advisory Board decided that a fruit committee should be constituted to sift schemes of fruit research and to make proposals. The Chairman of the Board accordingly appointed the undermentioned Committee for this purpose.

- (1) Sir T. Vijayaraghavacharya, Chairman, *ex-officio*.
- (2) The Agricultural Expert, Imperial Council of Agricultural Research.
- (3) Director of Agriculture, Madras.
- (4) Director of Agriculture, Bombay.
- (5) Director of Agriculture, Bengal.
- (6) Director of Agriculture, United Provinces.
- (7) Director of Agriculture, Central Provinces.
- (8) Director of Agriculture, Assam.

Secretary, Imperial Council of Agricultural Research, Secretary, *ex-officio*.

2. The Committee met for the first time on the 26th January 1932 to consider the Madras, Bombay, Bengal, United Provinces, Punjab and Assam schemes which had been received by them. The Committee recommended the Madras, Bombay, Bengal and Punjab schemes subject to certain modifications in the case of Madras, Bengal and Punjab schemes. In the case of the United Provinces the Committee recommended the Plains scheme subject to the omission of certain items of non-recurring expenditure amounting to Rs. 42,500 but as regards the Hill scheme the Committee decided that it should be revised and put up again (*vide* Enclosure IX). Finally, as to the Assam scheme the Committee felt itself unable to deal with this in the absence of a representative from that province to explain the scheme.

3. The recommendations of the Committee were then placed before the Advisory Board at its meeting held on the 29th January 1932 when Messrs. Coleman and Main said that they had certain points of criticism to make on the programme of research proposed in the United Provinces Scheme but did not wish to do so in the absence of a representative from the United Provinces. In the result, the Board recommended all the provincial

schemes for sanction except the United Provinces and the Assam schemes which were postponed till the July meeting of the Advisory Board to allow representatives of these provinces to be present.

4. The United Provinces Government have now forwarded (Enclosure VI and Annexures) a revised Hill Scheme and a Plain Scheme costing respectively Rs. 1,59,100 and Rs. 1,05,160 spread over a period of five years. In this connection it may be pointed out that the costs of the Plains Scheme (which is the same as was examined by the Committee last January) was reduced by the Committee to Rs. 62,660 spread over five years (Enclosure IX). The Local Government have not, in forwarding the scheme now, taken into account the reductions made by the Committee.

5. The Bihar and Orissa Government have also sent in now (Enclosure VII) a scheme for work on mangoes, litchies and papayas at the Sabour Estate. The scheme involves a non-recurring expenditure Rs. 6,000 and a recurring expenditure of Rs. 41,890 or a total of Rs. 47,890 spread over a period of five years.

6. The Assam Scheme (Enclosure VIII) involves a non-recurring expenditure of Rs. 24,500 and a recurring expenditure of Rs. 54,156 or a total of Rs. 78,156 spread over five years.

The United Provinces, Bihar and Orissa and Assam schemes (Enclosures VI to VIII) are now for the consideration of the Committee.

The Committee will meet on the afternoon (2-45-P.M.) of the 19th July 1932 at Rock House, Simla, S.W.

CHARAN DAS,

Secretary.

The 30th June, 1932.

ENCLOSURE VI

LETTER FROM P. M. KHAREGAT, ESQ., I.C.S., SECRETARY TO GOVERNMENT, UNITED PROVINCES, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, S. W., No. 785/XII-A-66, DATED ALLAHABAD, THE 11TH JUNE 1932.

In continuation of the correspondence ending with this Government's letter No. 40-A., dated January 15, 1932 (not printed) I am directed to enclose herewith a modified application from the local Government for a grant of Rs. 1,59,100 (Rs. 19,200 non-recurring and Rs. 1,39,900 recurring) spread over a period of five years for researches into the development of fruit industry in the hills of the United Provinces (Annexure II), together with an extract (Resolution No. 8) from the proceedings of a meeting of the United Provinces Agricultural Research Committee held at Lucknow on May 3, 1932 (Annexure I). The original Hills scheme (not printed) forwarded with Mr. Mehta's letter No. 7-A., dated January 5, 1932, has been further revised as desired by the fruits sub-committee of the Imperial Council of Agricultural Research, and the modified scheme has the approval of the local Government.

2. I am also to enclose another modified application for a grant of Rs. 1,05,160 (Rs. 47,960 recurring and Rs. 57,200 non-recurring) spread over a period of five years for researches into the developments of the industry in the plains in this province (Annexure VI). The fruits sub-committee considered the original Plains scheme (not printed) forwarded with Mr. Mehta's letter (not printed) mentioned in paragraph 1 above and recommended a grant of Rs. 61,000 to this province for this scheme, but it has not yet been sanctioned by the Advisory Body of the Imperial Council of Agricultural Research. This modified scheme too has the approval of the local Government.

3. I am accordingly to request that both the modified applications may please be placed before the Advisory Body of the Council for favourable consideration at its next meeting to be held from July 18 to 22, 1932.

4. One hundred printed copies of each of the applications are being sent separately under registered cover.

ANNEXURE I.

OFFICE OF RESOLUTION No. 8 PASSED AT THE 6TH MEETING OF THE UNITED PROVINCES AGRICULTURAL RESEARCH COMMITTEE, HELD IN THE COUNCIL HOUSE, LUCKNOW, ON MAY 3, 1932, AT 11 A.M.

AGENDA.

8. Consideration of the revised application from the United Provinces Government to the Imperial Council of Agricultural Research for a grant of Rs. 1,92,880 (Rs. 19,350) non-recurring and (Rs. 1,75,530) recurring spread over 5 years for researches into the development of fruit industry in the hills.

RESOLUTION.

8. Resolved that the modified scheme be passed and sent up to the Imperial Council of Agricultural Research.

ANNEXURE II.

APPLICATION FROM THE GOVERNMENT OF THE UNITED PROVINCES, TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, FOR A GRANT OF Rs. 1,59,100 (Rs. 19,200 NON-RECURRING AND Rs. 1,39,900 RECURRING) SPREAD OVER FIVE YEARS FOR RESEARCHES INTO THE DEVELOPMENT OF FRUIT INDUSTRY IN THE HILLS OF THE UNITED PROVINCES. (SUPPORTED IN GENERAL OUTLINES BY THE UNITED PROVINCES AGRICULTURAL RESEARCH COMMITTEE IN RESOLUTION No. 8. PASSED AT THEIR 6TH MEETING HELD ON MAY 3, 1932.)

I.—THE FRUIT INDUSTRY OF KUMAON HILLS.

Introduction.

The fruit industry of Kumaon dates back to about 1870 when the Government orchard at Chaubattia was started. Following this a number of other orchards were started as private enterprise in various parts of Kumaon. Subsequently interest appears to have died down and many of the existing orchards deteriorated badly. In more recent years the industry has shown fresh life more or less coincident with the taking over of the Government orchard by the Department of Land Records and Agriculture in 1915. The difficulty of getting fruit to railhead undoubtedly militated against successful fruit growing specially in small orchards. With the coming of cheap and quick motor transport this difficulty has been greatly reduced, and at the present time some of the large orchards are being extended and many small orchards are being started.

Although started so long ago it is only comparatively recently that real development has begun to take place. The industry is still in its infancy, and it is at this time that research work will be of most value in developing it along right lines. Much useful work has already been done at Chaubattia but much remains to be done if the industry is to be firmly established on a sound footing.

India presents a vast and at present almost untouched market for hill fruits. Already Australia, South Africa and the United States are making efforts to capture this market. There appears to be no reason why the Indian demand should not be met entirely by fruits grown in the hill tracts of India itself, and in such a development Kumaon should play a large part.

FITABILITY OF THE GOVERNMENT ORCHARD AT CHAUBATTIA FOR A RESEARCH STATION.

To study effectively the various problems connected with fruit growing in the hills it is necessary to have both old and young orchards. The renovation of old orchard cannot be studied except in an old orchard. Insect pests and fungus diseases are more prevalent in an old orchard than in a young one, in fact some kinds may be entirely absent in a young orchard. A young orchard is desirable to test various cultural methods, and additional land is necessary for the introduction and trial of new varieties, stock trials and other special experiments it may be desired to carry out. Further, it is very essential that the orchard should be Government-owned so that the officers carrying out research

work can have full control, a state of affairs which cannot be expected in a privately owned orchard.

The Government orchard at Chuabattia fulfils all these conditions. It is a Government owned, there is both old and new orchard, and there is forest land included in the property which can be cleared for any necessary extensions. In addition, this orchard already possesses a very large collection of all varieties of hill fruits. It also possesses a number of buildings and although some alterations and additions will be necessary the cost will be trifling compared to that required for the erection of new buildings. It is accessible a motor road passing within five minutes' walk of the office and main buildings of the orchard.

Its central position along the Himalayan slopes, its easy accessibility, its ability to provide for orchard investigation in all stages of orchard growth, its varied collection of varieties probably the biggest in India, its situation in the heart of one of the largest if not the largest fruit growing district in India, the manifold soil variations in its close proximity and last but by no means least its present freedom from the San Jose Scale which has made its appearance in Kulu and the fruit areas to the North-west, undoubtedly make it an ideal centre for organized research on the basic factors governing hill orcharding in India.

BRIEF HISTORY OF THE GOVERNMENT ORCHARD.

The orchard was started in 1869-70 by the Forest Department which were fortunate in obtaining the services of a trained gardener, Mr. Craw, who was resident in the district to look after it and he continued in charge until his death 21 years later. From the commencement the garden was used for the propagation of both fruit and forest trees. Good varieties of fruit trees were obtained from Europe, propagated and planted out in the orchard. When trees began to bear fruit the result was so successful that the local Government laid down that "the chief object in view in the upkeep of this garden was the free distribution of the finer varieties of such fruit trees as would thrive in the climate and soil of the outer ranges of the Himalayas, to show practically the best methods of culture for the various species and to prove what could be done in the outturn of excellent fruit under proper treatment."

During the 21 years that Mr. Craw remained in charge 1,25,000 fruit trees and 2,50,000 forest trees were grown and distributed free to all who asked for them. The result of this distribution, especially among villagers, has been disappointing.

The death of Mr. Craw proved a great loss to the orchard which subsequently passed through a period of administrative uncertainty. In 1892 an attempt was made to lease the orchard but this was not successful for want of a suitable offer. In 1893 the Forest Department suggested, and Government agreed, that the orchard should continue to be maintained by the department but that a catalogue should be drawn up and fair prices charged for young trees offered for sale. This policy was subsequently followed except for an unsuccessful attempt in 1896 to sell the orchard as a going concern for Rs. 20,000.

The foregoing information is culled from a report on the orchard in 1906 by W. H. Lovegrove, Deputy Director of Forests.

The Government orchard continued to be maintained in more or less poor condition till 1914 when, under G. O. No. 2544/I—321, dated October 16, 1914, it was handed over to the Director of Land Records and Agriculture, Mr. Gill, who was then Superintendent, of the Kumaon Government Gardens, was placed in charge and continued to hold charge till 1923, since when several garden superintendents have been in charge. In 1925 the orchard was leased for a period of seven years.

DESCRIPTION OF THE GOVERNMENT ORCHARD.

The Government orchard is situated on the Ranikhet-Chaubattia hill between the elevations of 6,100 feet and 6,700 feet and is about $2\frac{1}{2}$ miles distant from Ranikhet by forest path and about five miles by motor road. It is about $\frac{5}{8}$ miles by motor road from rail heads (Kathgodam). The general aspect of the orchard is north which is the best for fruit growing. The soil is mostly a fairly stiff clay though considerable variations occur. It is generally sufficient in depth. The slopes vary but are in most cases not very steep.

A few springs are present but are scarcely sufficient to supply the staff and the nurseries. The rainfall is about 50 inches. The shade temperature varies from about 23° in winter to about 90° in summer. During April and May hailstorms are not infrequent and often cause considerable damage to the fruit crops. The area of the orchard is 142 acres which includes 50 acres of old orchard, portions of which have in recent years been planted with young trees, about 30 acres of new orchard, all the trees in which are young, and about 62 acres of forest.

According to the orchard records the number of trees in bearing is 4,698 while the number of young trees which have not yet come into bearing is 5,359. The average annual yield of all kinds of fruit for the past 15 years is 59,000 lb.

The old orchard would appear to have been planted in small blocks of one variety each but subsequent planting to repair casualties was of a haphazard nature with the result that varieties are very scattered and there are more trees of a culinary type than is desirable. Recent planting both in the old and new orchards has been in lines or small blocks.

The collection of varieties at the present time includes about 190 which were in the orchard when it was taken over in 1915, about 125 imported by Mr. Gill up to 1922, about 100 imported by me in 1923-24 and about 20 imported since.

The Chaubattia orchards carry capital assets valued at Rs. 68,970 and a sum of Rs. 6,010 was spent annually on their maintenance by the United Provinces Government before they were leased out.

SUGGESTED PROBLEMS FOR THE RESEARCH STATION.

(1) *Renovation for rejuvenation of old orchards.*

(2) *Prevention of young orchards becoming worn out, or at least lengthening the productive life of orchards.*—The problem of renovation is an urgent one in the case of old orchards and in course of time will become urgent for all other orchards unless some method can be discovered under which the productive life of an orchard can be more or less indefinitely prolonged. The application of manure in sufficient quantity is, of course, an obvious remedy, but for most of the orchards' manure is not obtainable in sufficient quantity and with an extension of the fruit growing industry sufficient quantity will be still less obtainable. Another obvious remedy is to abandon the old orchard and start a new one, but this will be beyond the financial capability of most fruit growers and, in any case, with the extension of the fruit industry, suitable land within reasonable distance of railroad will become more and more difficult to obtain. If, therefore, the fruit industry is to be placed on a firm footing the solving of these problems is a necessity.

(3) *Catch crops to make young orchards pay before the fruit trees come into full bearing.*—One of the main difficulties to be faced in starting an orchard is the fact that except for the first two or three years when good crops of potatoes can be grown there is little or no income from the orchard for some years, while maintenance charges have to be met and the owner and his family have got to live. The solving of this difficulty would do much to popularize fruit growing especially among men of small capital.

(4) *Introduction of new varieties for trial.*—This is very important to the well-being of the fruit industry as the average small orchard owner cannot afford to import new varieties on the chance that one or more of them may prove to be desirable acquisitions. The Government orchard has already done a lot of work in this direction and possesses what is probably by far the best and most representative collection of hill fruit trees in India. New varieties, however, continue to be evolved in Europe, America and Australia, and it is in the interest of the fruit industry that these varieties should be introduced and tested under Kumaon conditions and those that prove worthwhile propagated and distributed.

(5) *Keeping properties of fruits.*—

(6) *Shipping qualities of fruit.*—These two problems are somewhat related to the former (No. 4).

The most important crop grown is the apple, in many orchards forming more than half of the total crop of all kinds of fruit. The bulk of the apple crop ripens in September

and October and if it were all placed on the market then there would be a glut and prices would be so low that marketing the fruit would result in loss to the growers rather than profit. Fortunately some varieties of apples have good keeping properties and under suitable conditions may be kept till March or April. From trials already carried out it would appear that the reputation of varieties for keeping properties in other countries is not a sure guide for Kumaon. Investigations to ascertain the best varieties for keeping and for how long it is safe to keep each variety will be of great value to fruit growers.

The foregoing experiment might also include some research into the best methods of storage and also a cheap form of storage room.

The shipping qualities of fruit, by which is meant the ability of fruit to travel long distance and arrive at its destination in good condition, is another important point. Good size, colour, flavour and heavy cropping propensity in a variety are not of much value unless combined with good shipping qualities, as without the latter sales must be confined to local markets which, for most orchards, are small or non-existent. Investigation into this problem will, therefore, be of great benefit to the fruit industry as it will enable advice to be given which will prevent the planting of apparently attractive varieties which will be of little market value.

(7) *Crop records.*—The fruiting propensities of the different varieties is a very important question in the planting of orchards. There is, of course, some general knowledge of the subject but definite knowledge is lacking. After eliminating varieties known to be unsuitable for marketing for one reason or another a collection of the other varieties, three trees of each, might be planted and records of the crops from each tree for a period of five years maintained, and if possible some record also of the prices obtained for the fruit. Such records, combined with those of keeping and shipping properties, will enable the Government orchard staff to give most valuable and reliable advice to fruit growers regarding the most paying varieties to grow.

(8) *Stocks.*—This is very important phase of fruit growing in the hills about which very little is known. Most of the budded or grafted fruit trees at present being grown in Kumaon are on some form or other of imported paradise stock or on locally raised mixed seedling stock. Two or three years ago, the Deputy Director of Gardens imported some varieties of apple, plum and cherry stock from East Malling. These are now being experimented with but it is desirable that the experiment should be carried out on a much larger scale. Much information of great value to the fruit industry may result from stock experiments, as for instance, better cropping properties, greater resistance to dry conditions during the hot weather, greater immunity to Woolly aphid attack.

(9) *Grading, packing and marketing of fruit.*—Under modern conditions no fruit which is not properly graded and packed can command good prices in the open market. In India so far as hill fruits are concerned this is becoming more and more important with the increasing imports from South Africa, Australia and the United States. A few of the more up-to-date orchardists in Kumaon are alive to the importance of good grading and packing but the majority are not. During the years immediately previous to the leasing of the Government orchard grading and packing received due attention but since the orchard was leased these operations have been done in a slipshod manner. Grading and packing are carried out on well defined principles in Europe and America and it should not be difficult to evolve a system on similar lines which will be suitable to Indian conditions. When a suitable system has been worked out short instructional classes could be given, free of charge, to all interested in the fruit industry who cared to attend. Some years later it might be possible to enact a law, as has been done in some parts of the United States, making it compulsory for all fruits to be properly graded and packed.

Closely related to the questions of grading and packing is that of marketing. To dispose of fruit to the best advantage involves considerable knowledge of the requirements of the various markets. Much could doubtless be done in this direction in collaboration with the marketing officers who have been or will be appointed. A simple system of accounts in connection with marketing might also be worked out.

(10) *Best kinds of fruit for various soils.*—Under the conditions obtaining in the hills the nature of the soil is liable to vary considerably and except in the case of very small orchards, no orchard is likely to have soil of the same quality throughout its area. It is

therefore, important to be able to advise fruit growers what are the best kinds of trees to plant in the various kinds of soil in their orchards. Experiments along these lines will, therefore, be of value.

(11) *Cultural problems.*—Among these may be mentioned pruning, ringing, manuring, mulching, propagation of stocks, etc.

Pruning is a much debated subject and there are many systems in vogue. What is required is to ascertain which system or combination of systems is best suited to Kumaon conditions. This will of course, vary with each kind of fruit.

Ringing is a method adopted to bring young trees into bearing more quickly than they would otherwise do. Very little is known about it in Kumaon.

Manuring experiments would be worth while to ascertain the best combinations and most economical quantities, and the best times for applying them, for each of the different kinds of fruit trees.

Mulching appears to be likely to be a useful cultural practice, but little is known about it at present.

To obtain reliable stocks vegetative propagation is necessary. Very little of this has been done in Kumaon and experimental work is necessary to find out the best methods.

(12) *Profitable utilization of surplus and inferior fruit.*—There is always likely to be some fruit which, owing to glut in the market or to inferior quality, it is difficult to dispose of profitably. The obvious methods of dealing with such fruit are by canning, preserving and evaporating. Owing to the scattered locations of orchards and their distance from railhead, it is doubtful if canning and preserving are likely solutions of the problem. They and other methods are, however, worth investigation.

(13) *Insect pests.*—Insect pests are responsible for heavy losses in orchards in all parts of the world and Kumaon and other hill districts are not exceptions to this rule. Among the commoner ones may be mentioned Woolly aphis, borers, caterpillars and beetles. To ascertain the most effective methods of control it is necessary to study the life histories of the insects and this requires frequent observation throughout the year. This is, doubtless, the reason why so little research work in connection with the hill orchard pests has been carried out in India, no trained entomologist having been stationed in the hills until the recent appointment of one at Ramgarh. Although the research work of other countries is available and is of assistance in controlling pests in this country, it is not sufficient. In some cases the pests may be different but even where they are the same the conditions vary and other methods of control may be found cheaper or more effective.

(14) *Fungus diseases.*—While not nearly so numerous as insect pests there are several fungus diseases which cause much damage in hill orchards.

The immediate problems in this connection are :—

- (1) Cankers.
- (2) Root rots.
- (3) Silver leaf disease.
- (4) Leaf curls.
- (5) Blights.
- (6) Storage rots, etc., etc.

The Plant Pathologist to the Government suggests a thorough survey of the prevailing diseases and the life histories of the casual organisms and to work out control measures.

(15) *Chemical aspects.*—

(1) *Soil.*—The terraced soils of the hills are very varied in nature. A thorough chemical and mechanical examination of soils and sub-soils of the fruit growing areas will be essential, as on this rests the effective solution of many of the causes leading to the great variability in evidence in the behaviour of different stocks and varieties and in no small measure, the means of effective fungoid and insect control.

(2) *Manures and fertilizers*.—Analysis of these will also be necessary before their application.

(3) *Trees*.—The growth of trees, their fruit bearing capacities and their resistance power of diseases seem to have a marked relation with the type of soil on which they are grown. All this needs a thorough investigation.

(4) *Fruits*.—The flavour, colour, and keeping qualities of the fruit are very important commercially. These qualities are governed by the presence of certain definite chemical compounds in the fruits. Chemical analysis of fruits at different stages of growth, ripening and storage will thus form a necessary item of chemical investigations.

A soil chemist is an essential part of any scheme of lasting nature for carrying on necessary preliminary work of soil analysis. Corelation of chemical data with soil conditions suitable to particular fruits is the only way to obtain information of permanent value upon which future development of the industry can safely depend.

METHOD OF OPERATION AND CONTROL.

The experimental work of the orchard will be controlled by a body consisting of 5 persons, *viz.*

The Director of Agriculture.

The Agricultural Chemist.

The Mycologist.

The Entomologist, and

The Deputy Director of Gardens, U. P.

This body will be responsible for the policy governing the work, the experimental layout and the work to be carried on by each expert assistant in relation to the others and on his own. The experts constituting this Board will be fully qualified to judge the effectiveness of the work done in their respective sections, to guide the workers and to identify inefficiency and slackness.

Under this constitution the salaried staff will consist of—

1. *An Orchard Superintendent.*

He will be engaged in the actual work of the orchard, maintenance of trees, reclamation of land, general organization and control of labour and estate funds. He would provide all the labour and field supplies required by the experts, though the control and supervision of experimental treatment would rest with them.

In cases of large scale planting and experimental treatment the work will be done under the guidance of the Horticulturist but controlled by the Orchard Superintendent. He would, in short, be responsible for the adequate running of the orchard as a whole but would have nothing to do with recording of experimental data and with the detail fulfilment of experiments in progress, except in as far as these entail large scale farming control.

He would in conjunction with the Horticulturist be responsible for experiments pertaining to marketing.

2. *One Horticulturist.*

He would be engaged in the arrangement of stock trials and new variety plantings under varying soil conditions, the maintenance of records of the plant's response and fruiting under varying conditions; in the designing of cultural treatments in conjunction with other officers and in records of the tree response.

3. *One Entomologist.*

Work as outlined in the note.

4. *One Soil Chemist.*

Work as outlined in the note with special reference to the importance of the last para. and the need for soil survey.

5. *One Mycologist.*

Work as outlined in the note.

6. *One Horticultural Assistant.*

Work under Orchard Superintendent.

Establishment.

One clerk under Orchard Superintendent.

One store and record keeper.

Three laboratory or field assistants. One for each scientific officer including Horticulturist.

Three laboratory attendants. One for each scientific officer.

Two malis.

Five peons. One for each officer.

Annexure III. Gives revised financial statement.

Annexure IV. Gives a comparative statement with that put up before and shows the reductions effected in the demand made on the Imperial Council of Agricultural Research with causes leading thereto.

Annexure V. Gives a complete statement of cost with the relative contribution of the Imperial Council of Agricultural Research and the United Provinces.

It indicates conclusively that the scheme is a genuine one to which the Province is contributing substantially and which it is quite unable to take up on its own initiation at the present time. The scheme is one of all Indian or certainly all Northern India importance. Under these circumstances the demand made on the generosity of the Imperial Council of Agricultural Research cannot be said to be extravagant.

ANNEXURE III.

NON-RECURRING.

Orchard and Horticultural.

	Rs.	Rs.	Rs.
Cleaning, terracing and preparation of new orchard ..	5,000		
Fruit Storage experimental	1,000		
Alterations of buildings	900		
Equipment	700		
Miscellaneous including stocks and plants	1,000	8,600	

As affecting science sections.

Alterations to buildings	3,600		
Equipment	6,000		
Hot house inoculation experiments	1,000	10,600	

Total .. 19,200

RECURRING.

Salaries.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	(15,000) Rs.
<i>Orchard Superintendent.</i>			Provided	by U. P.		
Horticulturist Rs. 200—25—600.	2,400	2,700	3,000	3,300	3,600	15,000
Chemist Rs. 200—25—600	2,400	2,700	3,000	3,300	3,600	15,000
Entomologist Rs. 200—25—600.	2,400	2,700	3,000	3,300	3,600	15,000
Mycologist Rs. 200—25—600	2,400	2,700	3,000	3,300	3,600	15,000
Horticultural Assistant Rs. 110—10—150.	1,320	1,440	1,560	1,680	1,800	7,800
	10,920	12,240	13,560	14,880	16,200	67,800
1 Clerk Rs. (75—5—100)			Provided	by U. P.		(5,100)
1 Store keeper and records (Rs. 60—5—100).	720	780	840	900	960	4,200
3 Laboratory or field assistants (Rs. 25—24—40).	900	990	1,080	1,170	1,260	5,400
3 Attendants (Rs. 16—1—20).	576	612	648	684	720	3,240
2 Malis— 1 at Rs. 50—2—60 .. 1 at Rs. 20—1—25 ..	840	876	912	948	984	4,560
4 Peons at Rs. 15 each ..	720	720	720	720	720	3,600
	3,756	3,978	4,200	4,422	4,644	21,000
<i>Allowances.</i>						
Travelling Allowance ..	2,400	2,400	2,400	2,400	2,400	12,000
Hill allowance on salaried staff; that of 'Establishment' being allowed for in pay.	2,160	2,160	2,160	2,160	2,160	10,800
<i>Supplies.</i>						
Additional maintenance of orchard.	1,800	1,800	1,800	1,800	1,800	9,000
Expenditure Manures, Stocks, e'c.	1,000	1,000	1,000	1,000	1,000	5,000
Books and periodicals ..	300	150	150	150	150	900
Annual laboratory equipment.	1,200	1,200	1,200	1,200	1,200	6,000
Freight	80	80	80	80	80	400
Sundries at Rs. 100 each	400	400	400	400	400	2,000
General Estate contingencies.	400	400	400	400	400	2,000
Field expenses 3 officers..	600	600	600	600	600	3,000
	5,780	5,630	5,630	5,630	5,630	28,300

ABSTRACT.

						Rs.	Rs.
Non-recurring	..	..	..	..	..	19,200	19,200
Recurring—							
Pay of staff	..	..	..	..	..	88,800	
Supplies and Services	..	..	..	..	..	28,300	
Allowances (Hill)	..	..	..	..	..	10,800	
Allowances (T. A.)	..	..	..	..	..	12,000	
						<u>1,39,900</u>	<u>1,39,900</u>
							1,59,100

Approximate average Rs. 32,000.

ANNEXURE IV.

Comparison between Original and Revised Schemes.

Section.	Original.	Revised.	Addition	Reduction.	Net Reduction.	Notes.
	Rs.	Rs.	Rs.	Rs.	Rs.	
<i>Non-recurring.</i>						
Orchard Section ..	10,000	8,600	..	1,400	1,400	Apparatus supplied by U. P. from Headquarters.
Science Section ..	16,000	10,600	..	5,400	5,400	
	26,000	19,200	..	6,800	6,800	
<i>Recurring (salaried staff).</i>						
Horticulturist ..	66,000	66,000	..	} Rs. 15,000 met by U. P.
Orchard Superintendent.	..	(15,000)	..	..	..
Horticulturist ..	18,000	15,000	..	3,000	..	
Chemist ..	18,000	15,000	..	3,000	..	
Mycologist ..	18,000	15,000	..	3,000	..	
Entomologist ..	18,000	15,000	..	3,000	..	
Horticulturist Assis- tant.	..	7,800	7,800	..	..
	1,38,000	67,800	..	..	70,200

ANNEXURE IV.—contd.

Section.	Original.	Revised.	Addi- tion.	Reduction.	Net Reduction.	Notes.
	Rs.	Rs.	Rs.	Rs.	Rs.	
<i>Recurring—contd.</i>						
<i>Establishment.</i>						
Clerk	5,100	(5,100)	..	5,100	..	Paid by U. P.
Storekeeper and Record Clerk.	5,100	4,200	..	900	..	
Laboratory and field assistants.	7,200	5,400	..	1,800	..	
Laboratory Attendants	3,240	3,240	..	..	..
Malis	4,560	4,560	..	..	..
Peons	4,500	3,600(900)	..	900	..	One U. P.
<i>Allowances.</i>						
Travelling	25,000	12,000	..	13,000	..	Reduced as exaggerated and as in part debitabie to U. P. Estimated Rs. 40 on 4 salaried officers and one assistant, that of Orchard Supdt. being met by U. P.
Hill (allowance) for salaried staff others being allowed for in pay.	..	10,800	10,800	..	..
	25,000	22,800	..	..	2,200
<i>Supplies.</i>						
Maintenance Orchard	40,000	9,000	..	31,000	..	Normal cost by U. P.
Experimental field requirements Manure, stocks, plant treatments.	10,000	5,000	..	5,000	..	
Books and Periodicals	2,000	900	..	1,100	..	
Annual Laboratory requirements.	7,500	6,000	..	1,500	..	
Freight	300	400	100	..	..
Sundries at Rs. 100 each on 4 officers.	1,500	2,000	500	..	..
General Estate and Office Contingencies.	2,500	2,000	..	500	..	
Field expenses 3 officers.	3,750	3,000	..	750	..	
	67,550	28,300	..	..	39,250
Recurring Gross ..	2,60,250	1,39,900	..	..	..
Non-recurring ..	28,000	19,200	..	..	..
Total Demand ..	2,88,250	1,59,100	..	..	1,27,150

ANNEXURE V.

Total cost of the scheme.

	Contributed by U. P.	Requested from Council.	Total.
	Ra.	Ra.	Ra.
Non-recurring	68,500	19,200	87,700
Recurring	56,900	1,39,900	1,96,800
Grand total			2,84,500
Proportion of cost debited to U. P.		44.08 per cent.	
Proportion of cost debited to Imperial Council of Agricultural Research.		55.92 per cent.	

*Detail of U. P. contribution.**Non-recurring—*

	Ra.	
Existing orchard and buildings at book value.	68,500	
Apparatus and fittings	5,400	
		73,900

Recurring—

Salaries and pay	21,000	
Allowances	4,900	
Garden maintenances 5 years	31,000	
		56,900
Grand total		1,30,800

ANNEXURE VI.

AN APPLICATION FROM THE GOVERNMENT OF THE UNITED PROVINCES, TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH FOR A GRANT OF RS. 1,05,160 (RS. 47,960 RECURRING AND RS. 57,200 NON-RECURRING) SPREAD OVER FIVE YEARS FOR RESEARCH INTO THE DEVELOPMENT AND IMPROVEMENT OF FRUIT CULTURE IN THE PLAINS IN THE UNITED PROVINCES.

There are large areas in the plains of the United Provinces where both the soil and climate are suitable for the cultivation of a wide variety of fruits. A fair quantity of fruits is already grown, especially in such centres as Saharanpur and Lucknow. The extension of this industry is very desirable. Advice on cultural questions with visits to private orchards free of charge is being carried out by the staff of the garden circle and this will no doubt be of great assistance to fruit growers. There are, however, many problems connected with fruit growing which it is necessary should be solved if the best is to be got out of the land planted with fruit trees and the growing of fruit thus made more popular. To carry out the necessary experimental work effectively a large area will have to be devoted to this purpose in which the main object will be the solving of problems connected with fruit-growing and not with making revenue, though some revenue will naturally be obtained.

EXPERIMENTAL WORK.

Mangoes.—To plant out a collection including varieties from all parts of India. If varieties which are known to be decidedly inferior are excluded the collection may perhaps

be limited to about 250 varieties. Three plants of each variety are essential, five of each would be preferable. Such collection will be of great value in several ways :—

- (1) To eliminate some of the confusion in mango nomenclature by enabling accurate, detailed description of the varieties to be prepared. Owing to the variation in shape and colour of mango fruits, even on the same tree, it is necessary to select average fruits for detailed descriptions and also to state what variations from this are likely to occur. This can only be done if the whole crop of a tree can be examined.
- (2) To maintain records of the flowering periods of each variety in relation to cropping properties.
- (3) To maintain records of the ripening periods of each variety.
- (4) To maintain records of the keeping properties and shipping qualities of each variety.
- (5) To maintain records of the crop of each variety to ascertain the best varieties for commercial purposes.
- (6) To enable hybridization work to be carried out for the production of improved varieties.

If only three trees each of 250 varieties are obtained and these are planted at 50 feet apart an area of 42 acres will be required. If five trees of each variety are planted about 70 acres will be required.

Citrus.—A collection of oranges (malta and *santara*), limes, pomelos and grapefruits, including varieties already in the Government gardens and others which may be imported, to be planted to ascertain which are the varieties most suited for commercial purposes. Records would, of course, have to be kept of the crops.

One hundred and twenty varieties, five trees of each, planted at 20 feet apart will require about $5\frac{1}{2}$ acres.

A trial of orange stock to ascertain the best stock for maltas, *santaras* and grapefruits (1) for cropping, (2) for longevity.

If 15 stocks are tried with five trees each for three types of citrus there will be 225 trees. At 20 feet apart these will require a little over 2 acres.

Citrus will therefore require about 8 acres.

Ber.—*Ber* is a fruit which has been much neglected. A collection to ascertain the best varieties for size, flavour and cropping properties will be well worthwhile. It might also be possible to ascertain if the fruits of any varieties are immune to maggot attack.

Forty varieties, five trees of each, 25 feet apart, will require about 3 acres.

Peaches.—A small collection of about 20 varieties, five trees of each, may be planted so that records of crops can be maintained and the best varieties for commercial purposes ascertained.

One hundred trees at 15 feet apart will require about half an acre.

Plums.—A small collection of about 20 varieties, five trees of each, may be planted so that records of crops can be maintained and the best varieties for commercial purposes ascertained. One hundred trees at 15 feet apart will require about half an acre.

Shareefas.—*Shareefas* are grown from seed and there is little doubt that many of the trees that are sold for planting have been raised from inferior types. A collection of *shareefas* from various parts of India where they are reputed to do well will be worthwhile to enable a selection to be made of those that produce fruits of good quality and have good cropping properties. A really good strain could thus be worked up. Experiments in budding the *shareefas* have just been started.

About 400 trees at 15 feet apart will require about 2 acres.

Papilas.—These are also raised from seed. Some goods strains are already being grown in various parts of the province. If, however, a really big effort were made to get

together a representative collection of all the best strains available, propagation continued each year from selected fruits of the highest quality only, a really fine strain could be developed. Work along these lines is already being done but on a small scale which can never attain the same results.

Papitas can be grown in between other fruit trees while the latter are young so no extra land will be required.

Loquats.—A collection of these, five trees of each variety, may be planted to ascertain which are the best market varieties. Two acres would probably be sufficient and would allow room for new varieties which may be imported.

Miscellaneous fruit trees.—A plot should also be reserved for miscellaneous fruit trees such as *leechis*, *aonlas*, *jamuns*, bananas, grapes, jackfruits, guvas, persimmons, etc., to ascertain the best varieties for commercial purposes. Even in kinds where there are few varieties, such as *aonla* and *jamun*, an effort to collect good types might quite likely result in the discovery of an improved variety.

A plot of 10 acres in extent would probably be sufficient for these miscellaneous kinds.

Crop records.—For all kinds of fruits records should be maintained of the yearly crops of each variety and, if possible, of each tree. Records of average selling prices should also be maintained. These records, together with records of maintenance costs for each plot, will make it possible to work out with a fair amount of accuracy the probable expenditure and receipts for each kind of fruit crop for each year. This is information which every prospective fruit grower would like to have and which the department should be in a position to give.

Manurial experiments.—While a good deal is known about the manuring of fruit trees very little has been done in the way of definite experiments in the United Provinces. Such experiments must, of course, include artificial manures and green manuring. At least 50 trees of each of the more important kinds of fruit trees should be grown solely for manurial experiments and should give valuable results. For this purpose about 10 acres should be sufficient.

Catch crops.—These might include other quickly maturing fruit crops such as *papita* and *phalsa*, agricultural and vegetable crops. The long period which elapses between the planting of the more important kinds of fruit trees and the trees coming into full bearing is probably one of the main reasons why fruit growing has not been taken up more largely especially among the landowners of small capital. Any assistance which can be given in this direction will undoubtedly tend to popularize fruit growing.

Grading and packing.—Practically no grading is done at present. Packing methods are unsatisfactory. In the Saharanpur district, and possibly in other districts, boxes, usually kerosine oil boxes, are gradually replacing baskets, and although somewhat crude, represent a definite advance. Much, however, remains to be done. Suitable containers for each kind of fruit must be worked out. For the home market good grading and packing will result in better prices as they have done for temperate fruits in other parts of the world. If the United Provinces is to obtain a share in the export trade of mangoes, which now seems certain to develop, good grading and packing will be absolute essentials.

Insect pests and fungus diseases.—As a result of research work at Pusa, Cawnpore and elsewhere much is known about insect pests and fungus diseases. In a large, young orchard such as that contemplated much work of a practical nature could no doubt be done to ascertain which methods of control are the best and most economical.

LOCATION OF EXPERIMENTAL ORCHARD.

The experimental fruit orchard should be located in a district known to be suitable for fruit-growing. There are several good fruit districts in the United Provinces. Of these according to the Deputy Director of Gardens, Saharanpur would be the best. It is already a large fruit-growing district, the number of kinds of fruit trees that can be successfully grown is probably larger than in other districts, there is a resident Superintendent of Gardens who could take charge of the experimental orchard, and there is a Botanical Garden maintained by the United Provinces Government with a capital outlay of Rs.1,29,117

and an annual expenditure of Rs. 19,500 on its maintenance. It is also the headquarters of the Deputy Director of Gardens, United Provinces.

In a venture of this kind in which the useful life of the trees will vary according to variety, from 10 to 50 years, it is not desirable to plant them on rented land unless on a lease of at least 50 years. It will be still better for the orchard to be located on Government land, either transferred from some other department or purchased for the purpose. It should be irrigated either by canal or by tube-well. The latter method would be preferable as there would be less trouble from weeds, more accurate records of water required for the trees could be maintained, and it would demonstrate the possibilities of fruit-growing on land not irrigated by canals. The location should be easily accessible to encourage visits from people interested in fruit-growing.

COST OF PROPOSALS.

Non-recurring.

Land.—About 100 acres will be required. This is more than detailed in the foregoing notes, but some space will be required for roads and buildings, and a little should be left over for additional experiments. I understand that the Punjab Government has allotted 500 acres for fruit trials, etc., at Lyallpur. This estimate of 100 acres is, therefore, comparatively very modest.

The following are rough estimates for purchase of land in the Saharanpur district:—

Purchase Rs. 20,000 for 100 acres; rent Rs. 1,300 for 100 acres.

These figures are liable to considerable modification on account of accessibility of land irrigation facilities, etc. It would be better to purchase the land, as it would be uneconomical to invest money on improvements on a rented or leased piece.

Buildings.—(1) One building comprising a packing shed, store room and office room.—Lump sum estimate Rs. 2,000. This building will not be required during the first two or three years. A store room will, of course, be necessary but one of the *mali's* quarters can be used for this purpose until a proper one is built.

(2) One building for head <i>mali's</i> quarters	} Lump sum Rs. 2,000
(3) One building for <i>mali's</i> quarters	

Roads.—Some *pakka* roads will certainly be desirable to enable manure, etc., to be brought in and fruit to be taken out, and also to enable the visitors to get round the orchard comfortably.—Lump sum Rs. 3,000. Roads are not essential at the beginning and may be deferred till more funds are available.

Fencing.—This is essential. The length of fencing required will vary according to the shape of the land.—Lump sum Rs. 4,000.

Masonry water channels.—These are not absolutely essential to begin with but it is certainly desirable to have them to avoid loss of water which always occurs in *kachcha* water channels. At a rough estimate 7,000 running feet will be required which, at anna eight per running foot, will cost Rs. 3,500.

Tube-wells.—If canal irrigation is not available two or three tube-wells will be required.

Digging holes for trees.—Many of these can, of course, be dug by the staff but at the beginning there will be a rush and it is therefore advisable to provide for some holes to be dug by a contract. For this purpose Rs. 300 should be sufficient.

Manure.—To ensure good growth it is essential that manure should be mixed with the soil before planting. Rs. 2,500.

Cost of trees.—A number of trees can be supplied free by the Government gardens but some will be imported from foreign countries, and others, especially mangoes, from various parts of India. It is difficult to make an estimate, Rs. 3,000 would probably be sufficient.

Implements.—These will include a spraying machine, *phawaras*, etc., Rs. 500.

Cattle.—At least two pairs of bullocks will be required for ploughing work.—Lump sum Rs. 400.

DETAILS OF THE COSTS OF THE PROPOSED "FRUIT RESEARCH SCHEME" FOR PLAINS AT SAHARANPUR.

Non-recurring charges.

	Rs.
Land	20,000
Buildings, packing shed, store room and office room	2,000
<i>Mali's</i> quarters	2,000
Roads	3,000
Fencing	4,000
Masonry water channels	3,500
Two tube-wells	16,000
Digging holes for trees	300
Manure	2,500
Cost of trees	3,000
Implements	500
Cattle	400
Total, Non-recurring	57,200

Recurring charges.

Particulars.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Total.
<i>Staff and establishment.</i>	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One member of Subordinate Agricultural Service (trained in garden circle) on overseer's grade pay Rs. 140—10/2—240.	1,680	1,680	1,800	1,800	1,920	8,880
One head <i>mali</i> on Rs. 30—2—50 ..	360	384	408	432	456	2,040
One assistant to head <i>mali</i> on Rs. 20—1—30.	240	252	264	276	288	1,320
Four <i>malis</i> on Rs. 13 each ..	624	624	624	624	624	3,120
Twenty coolies at Rs. 10-8 each ..	2,520	2,520	2,520	2,520	2,520	12,600
Total, Pay of establishment ..	5,424	5,460	5,616	5,652	5,808	27,960
<i>Contingencies.</i>						
Miscellaneous (including purchase and repair of tools, purchase of manure and cost of water, etc.)	4,000	4,000	4,000	4,000	4,000	20,000
Total, Contingencies ..	4,000	4,000	4,000	4,000	4,000	20,000
Total, Recurring ..	9,424	9,460	9,616	9,652	9,808	47,960
Total, Recurring and Non-recurring	..	..	..	..	..	1,05,160

N. B.—The garden staff of the Government will be in charge of the work and hence no great demand has been made of the overhead charges. The existing buildings in the Saharanpur garden will be utilized and only a few necessary items required for the working of the new piece have been asked for.

ENCLOSURE VII

LETTER FROM B. K. GOKHALE, Esq., I.C.S., SECRETARY TO THE GOVERNMENT OF BIHAR AND ORISSA, EDUCATION AND DEVELOPMENT DEPARTMENT, TO THE SECRETARY OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, SIMLA, NO. 132-D. R., DATED RANCHI, THE 24TH MAY 1932.

I am directed by the Government of Bihar and Orissa in the Ministry of Education to submit for the consideration of the Imperial Council of Agricultural Research, a Fruit Research scheme, which has been drawn up by Mr. D. R. Sethi, officiating Director of Agriculture, Bihar and Orissa. The scheme has been considered and approved by the Bihar and Orissa Agricultural Research Committee.

2. I am to request that the Imperial Council may be pleased to consult the Advisory Board at its next meeting in June and approve the scheme and take necessary steps to allot funds to further this very desirable piece of research.

FRUIT RESEARCH SCHEME, BIHAR AND ORISSA.

1. The diversity of its soils and the suitability of its climatic conditions makes Bihar admirably suited for cultivation of a wide varieties of fruits. The Bihar mangoes and litchies have a reputation of their own throughout India while the Ranchi *papayas* find a ready market in Calcutta.

2. The problems connected with fruit cultivation including that of marketing are varied and numerous. Although a beginning was made some years ago to study some of these it has so far not been possible to take up the work seriously owing to lack of funds. It is now hoped that with the assistance of the Imperial Council of Agricultural Research it will be possible to take up the work in right earnest.

3. The first necessity is an intensive study of the mangoes, litchies and papayas. In addition to these there is a vast field for the introduction of citrus fruit, guavas, ber, custard apples, etc., in the plains while on the plateau of Chota Nagpur such fruits as peaches, strawberries, etc., can be grown with success.

4. At the Sabour Estate, the Government of Bihar and Orissa have a very fine fully mature orchard of mangoes where some of the well known local varieties exist. There is also another younger orchard of mangoes and litchies at this estate, part of which has just come into bearing and the remainder will do so within a short time. The total area of these two orchards is 16 acres. The whole of the Sabour Estate is tube well irrigated and orchards are thus fully protected. Additional suitable land for studies on fruit can be made available whenever required. There is also available at Sabour sufficient suitable accommodation for the Laboratory and staff and no new buildings are required.

I. Technical Aspect.

5. For the present it is proposed to concentrate work at Sabour on mangoes, litchies, and papayas. Details below show the items of work that it is proposed to take up.

A. Mangoes.

- (i) Identification and classification of all local varieties.
- (ii) *Studies on propagation.*—This will include studies on suitable stocks and their effects on scion and various methods of propagation including budding.
- (iii) *Studies on cultivation.*—This will include tillage, irrigation, manuring, etc.
- (iv) *Fruiting.*—This will include the very important problem of studying the causes and their control if any which lead to the periodic fruiting of mangoes causing a great deal of loss to the mango growers. This will include phenological observations.

B. Litchies.

- (i) Identification and classification of all local varieties.
- (ii) *Studies on propagation.*

- (iii) Studies on cultivation.
- (iv) Fruiting—its periodicity.

C. Papayas.

- (i) Survey of all the strains grown in the province.
- (ii) Collection of all important strains from other provinces with a view to selection of those superior to local strains.
- (iii) Cultural requirements of the crop.
- (iv) Methods of propagation including renovation of old trees by different methods including budding.
- (v) Study in the seedling stage with a view to distinguish male from female plants.

I. General.

Work common to the above three fruits will consist of studies on—

- (a) the keeping quality of these,
- (b) their marketing,
- (c) their preservation both in the fresh and dry state, and
- (d) control of their pests.

The above will form the major part of work. In addition it is proposed to plant out a representative collection of the more famous strains of Guavas, Bers and custard apples with a view to their extensive introduction in the province.

II. Financial.

6. The local Government's contribution to the Research Scheme will consist of:—
- (a) Fully mature and partially mature orchards amounting to 16 acres.
 - (b) Additional 14 acres whenever required making a total of 30 acres of land.
 - (c) All building requirements including laboratory and residential quarters for the staff. No new buildings are necessary as there is sufficient suitable accommodations available at Sabour.
 - (d) Free supply of irrigation water.
 - (e) One quarter of the recurring expenses amounting to about Rs. 500 per annum required for the cultivation, manuring, etc., of the experimental orchards. The annual receipts from the orchards being credited to local Government.
7. The Imperial Council of Agricultural Research is requested to sanction the following:—

A. Non-recurring.

(a) Laboratory equipment .. .. .	..	..	Rs.	5,000	0	0
(b) Office equipment (including furniture, typewriter, stationery, etc.) .. .. .	..	..	Rs.	1,000	0	0
Total				6,000	0	0

B. Recurring.

(a) Staff—

1. One Horticultural officer	@ Rs. 250—20—350.
2. One Botanical Assistant	@ Rs. 80—5—100.
3. One clerk	@ Rs. 40—2—48.
4. One head Mali	@ Rs. 20.
5. One Assistant Mali	@ Rs. 15.
6. One peon	@ Rs. 10.
(b) Travelling allowance	@ Rs. 500 per annum.
(c) Laboratory Requisites	@ Rs. 750 per annum.
(d) Contingencies (including purchase of plants, etc., the employment of an Artist for 3 months every year @ Rs. 100 a month, stationery articles and miscellaneous contingencies including part charges on account of cultivation, etc.	@ Rs. 1,500 per annum.

8. The attached table shows detailed recurring expenditure year by year. The Advisory Board of the Imperial Council has already recommended for sanction more expensive fruit schemes of a number of other provinces. In view of their financial position the Government of Bihar and Orissa are making a handsome contribution to research on this very important aspect of Agricultural Development and their request for help from the Imperial Council amounts to a very small non-recurring grant and a modest provision for the minimum of staff and contingencies required. It is, therefore hoped that the Council will sanction the scheme now submitted. It is proposed when sanctioned—that the Horticultural officer will be recruited through the Public Service Commission, India.

9. Abstract of grant to be provided by the Imperial Council of Agricultural Research.

<i>Non-Recurring</i>	Rs. 6,000 0 0
<i>Recurring—</i>	
1st year	Rs. 7,730 0 0
2nd year	Rs. 8,054 0 0
3rd year	Rs. 8,378 0 0
4th year	Rs. 8,702 0 0
5th year	Rs. 9,026 0 0
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Total	Rs. 41,890 0 0
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Grand Total for 5 years	Rs. 47,890 0 0
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Table showing details of annual recurring expenditure.

"Fruit Research Scheme".

Items.	1st year per month.	2nd year per month.	3rd year per month.	4th year per month.	5th year per month.
1. Horticultural Officer	250	270	290	310	330
2. Botanical Assistant	80	85	90	95	100
3. Clerk	40	42	44	46	48
4. Head Mali	20	20	20	20	20
5. Assistant Mali	15	15	15	15	15
6. Peon	10	10	10	10	10
	415	442	469	496	523
Total staff annually	4,980	5,304	5,628	5,952	6,276
7. Laboratory Requisites	750	750	750	750	750
8. Contingencies (including purchase of plants, etc., part time employment of an artist for 3 months annually @ Rs. 100 a month and stationery and stamps, part cultivation charges, etc.)	1,500	1,500	1,500	1,500	1,500
9. Travelling allowance	500	500	500	500	500
Total	7,730	8,054	8,378	8,702	9,026

ENCLOSURE VIII.

COPY OF LETTER FROM THE SECRETARY TO THE GOVERNMENT OF ASSAM IN THE TRANSFERRED DEPARTMENTS, AGRICULTURE BRANCH, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI, No. 3342-E., DATED SHILLONG, THE 10TH DECEMBER 1930.

I am directed by the Government of Assam to forward a note by the Officiating Director of Agriculture, Assam, outlining a scheme for investigating the possibilities of fruit culture in this province on an organised basis, and to request that it may be laid before the Advisory Board so that it may be presented to the next session of the Governing Body with this Government's request for financial aid. As the Council are aware, the resources of the province are lamentably insufficient even for work upon the staple crops, and it is impossible to allot more than trivial amounts for the purpose of experiment on promising new fields such as this of fruit culture. The Assam Government, therefore, trust that the Council may find it possible to contribute the whole recurring and non-recurring cost of the venture, especially in view of the natural suitability of the province for expansion of fruit-growing, and also of the fact that the demands made by them upon the Council's resources have been limited by strict scrutiny of the proposals made by their Agricultural Department. The nature and scope of the scheme are fully detailed in the accompanying note.

A SCHEME FOR EXPERIMENT ON FRUIT CULTURE IN ASSAM.

1. With the large area covered by hill districts and the varying climatic and soil conditions, the possibilities of fruit growing in Assam are very large. Out of a total provincial area of 35,299,970 acres the hills comprise 13,950,080 acres, of which 11,120,826 acres are reported to be arable and only 909,652 acres are under actual cultivation. A considerable portion of the arable area in the hills could be planted profitably with fruit

plants. The importance of Assam for fruits has been stressed in paragraph 515 of the report of the Royal Agricultural Commission. Most of the plains abound in "Tillas" or small hillocks, which, though not very suitable for ordinary crops, may be profitably planted with fruit trees. In the plains the cultivation of fruits, wherever possible, is likely to prove a much more paying proposition in Assam, with its labour difficulties, than many of the ordinary crops, particularly for educated farmers. The actual area under fruits, roots and vegetable is, however, reported to be only 545,293 acres, of which perhaps less than half is under fruit.

2. *Citrus fruits*.—The orange is *par excellence* the most important commercial fruit in Assam. Oranges from Assam not only supply the markets of Bengal, including Calcutta, but even find their way up to Akyab in the east Madras in the south and Benares in the west. The fruit is grown extensively on the slopes of the Khasi Hills and is extending throughout the plains of the whole province—the present acreage being estimated as about 11,000. With proper methods of cultivation, picking and marketing, the Assam orange should find a ready market throughout India, Burma and perhaps even in Europe. Recent figures of export are not available but the figures from 1904-05 to 1921-22 indicate an annual export varying from 29,837 maunds valued at Rs. 2,38,696 to 104,714 mds. valued at Rs. 5,44,514 through Chhatak in Sylhet, through which place most of the oranges of the Khasi and Jaintia Hills pass for export by boat. The export through other channels must be at least another 25 per cent. of this figure. Most of these oranges find their way to Bengal and other provinces, which shows the interest of other provinces in the problem of improvement of the crop. There are various problems in connection with its cultivation which require investigation.

The most serious factor limiting the cultivation of oranges in Assam is the yellowing or "die-back" of the trees, the cause of which requires further investigation. Enquiries show that this is acting as a serious deterrent to the expansion of cultivation. The most important line of investigation, however, will be the trial of suitable stocks for budding. Budding is a simple method for propagating a large number of trees in a short time, and, in the case of oranges, the budded trees may be expected to come to fruit in three years whereas a seedling would take about seven years or more. This presents an opportunity of getting a hardy root, while budded trees produce more uniform fruits and a better shaped tree than seedlings. Experiments are being made on this line at Haflong and Khanapara (Gauhati) fruit gardens but the work is restricted by limited resources. The areas both at Haflong and Khanapara require enlargement and a much larger number of plants have to be budded than the department has been able to deal with hitherto. Varieties from other provinces should also be tried. The types grown in the different parts of the province vary somewhat in quality. The most promising types should be tested and suitable selections made for different localities.

There is a large demand already for orange seedlings and grafts from within and beyond the province, which cannot be supplied. Properly developed, these two stations will be able to supply all the requirements. Grape fruits are rapidly coming into considerable importance and there are large possibilities of extension in Assam, the soils of which are suitable for most citrus fruits. "Pomellos" are already largely grown. During the last year some budded grape fruit plants were obtained from Florida and planted at Jorhat and Haflong. Some of these have come into fruit this year and a few more plants have been indented for. Budding has also been started. It is, however, necessary to carry out systematic experiments on a more extensive scale.

In paragraph 515 of their report the Royal Commission have mentioned the transport difficulties of fruit growers in Assam. This is indeed a serious difficulty but a preliminary enquiry is necessary so that remedies may be suggested to achieve substantial results. It has not been possible to ascertain the loss caused by present methods of picking, packing and marketing of oranges but this is known to be considerable. Not only is there loss in quantity during transit, but defective methods of picking and packing are undoubtedly responsible for a considerable deterioration in value. Oranges are transported from Assam by country boats, steamers and railways. To enable the growers to get the maximum value it is necessary to make careful enquiries as to the destination of the fruit and the cheapest and quickest methods of transport. A marketing officer has, therefore, been provided in the scheme. He will make enquiries as to how the oranges

are sold, their ultimate destination, methods of transport, and loss during transit, and will suggest remedies. It is very probable that action on co-operative lines will considerably reduce the losses, but for such a purpose a special trained officer is needed.

3. *Deciduous Fruits.*—The experiments on the deciduous fruits have been carried out mainly at the La Chaumiere Garden, Shillong, since 1912. It has been shown that certain varieties of apples, pears, peaches and plums can be grown successfully, and grafts have been supplied throughout the province. During the last ten years over 1,500 grafts are reported to have been supplied from the La Chaumiere Garden to various places including Barisal in Bengal and Ranchi.

4. There is now little doubt that with the selection of suitable varieties pears, peaches, plums and certain varieties of apples can be grown in all the Khasi and Jaintia Hills, and fruit-growing can be developed as a very profitable business. It is also clear that in many parts of the hill areas deciduous fruits can be successfully grown but it is now desirable to discover which varieties are most suitable for particular areas. Experiments on a limited scale have been carried out by various persons. These have, however, not been carried out systematically or under scientific control. It is necessary to extend the experiments and keep accurate records, so that the varieties best suited to each locality may be selected.

The principal experiments to be carried out may be summarised as follows:—

1. Trial of various indigenous stocks for grafting and budding.
2. Trial of different varieties under different conditions.
3. Selection and propagation of a few definite commercial varieties and their extensive distribution.
4. Trial of various manures and fertilisers.

Incidentally experiments will also be conducted on the following lines:—

- (1) Control of the "Woolly aphid" (*aphis lanigera*) as well as of other diseases of deciduous fruits.
- (2) Trial of various methods of pruning.
- (3) Commercial management of orchards.
- (4) Encouragement of private commercial orchards wherever possible especially by supplying suitable grafts.
- (5) Introduction of better methods of picking, packing and marketing.

5. A good deal of work along each of these lines for deciduous fruits has already been done by the late Mr. C. H. Holder as the lessee of the Government Garden at Shillong. A large number of grafts were obtained from abroad and many of them have been successfully grown. A number of imported and indigenous stocks have been tried, but the experiments have not yet been exhaustive or reduced to scientific form. Assam with its wealth of jungles affords a particularly fruitful field for experiments with indigenous stocks, which require further investigation.

6. It is, therefore, proposed that the experiments on deciduous fruits should be carried out at and from the La Chaumiere Garden and that on citrus fruits at the Khanabara Farm at Gauhati and the Baktiar Farm at Haflong, both of which require extension for the purpose.

7. Details about these stations are given below:—

La Chaumiere Garden.—This is believed to be one of the best gardens for deciduous fruits on this side of India. It contains an arable area of 30 acres of which 22·66 acres are under fruit trees. There are now about 6,000 fruit trees in the garden, consisting of 3,171 apples, 775 pears, 362 plums, 321 peaches and the balance of miscellaneous trees mostly in bearing condition. A large number of the trees, however, require replacement and attention. There are also a large number of grafts. The garden was started in 1912, and was under the management of Government until 1921, when it was leased out to the late Mr. Holder, previously the manager on behalf of Government, who died in August 1930.

If the present scheme is accepted all experiments on deciduous fruits will be carried out at this station, which will also form the nursery for supplying grafts of these trees for the whole province and perhaps beyond. With proper development, it is confidently expected that at least 1,000 grafts can be supplied annually from this station. The station will be under the immediate supervision of a Fruit Inspector.

Khanapara, Gauhati.—This station will be used for experiments on citrus fruits and pineapples as outlined above, particularly for the Assam Valley. The present orchard consists of about three acres only and there is no room for expansion except by acquisition of some more land. There is an area of about 5 acres of suitable land contiguous to the present orchard which can be acquired. Budded orange plants will be supplied for the Assam Valley from this station. Five acres should be planted with oranges.

There are at present about 450 orange trees which are expected to come into bearing in 2 or 3 years.

Baktiar, Haflong.—This will be the main station for work on oranges and pineapples for the Surma Valley. There are now about 250 orange trees, most of which are in a bearing condition, and over one thousand seedlings. The work on budding oranges has been carried on since 1925, and some of the budded plants have come into bearing this year. This orchard requires expansion, and plenty of contiguous Government land is available. At present an Overseer is in charge but more expert supervision is required and a Fruit Inspector will be stationed here. Five acres should be planted with oranges.

8. *Staff.*—The experimental work will be at any rate for the present, under the supervision of Economic Botanist, who had special training in fruit culture in California. The whole of his salary and travelling allowance will be borne by the Local Government. Any laboratory work necessary will be conducted at the departmental laboratory at Jorhat by the existing staff. The headquarters of the present Fruit Inspector should be removed to Shillong. He will be in charge of the work in the Khasi and Jaintia Hills and the Assam Valley. No provision for a residential building is necessary as he can easily live in the town. A Second Fruit Inspector should be appointed for the Surma Valley with headquarters at Baktiar. Quarters will have to be provided, as the orchard is about three miles away from the town of Haflong and no private houses are available even in the town. It is impossible for one Fruit Inspector to manage the work of the whole province.

The Fruit Inspectors will not only look after the Government orchards in their respective circles but will also visit private gardens and give advice, for which there is great demand, as an increasingly large number of educated people are taking to fruit growing. They will also arrange for the supply of fruit trees and grafts. Each will require a peon.

Khanapara, Gauhati.—This will be in charge of an Horticultural Assistant working under the Fruit Inspector, Shillong. As the headquarters of the Fruit Inspector will be in Shillong, it will be necessary to have a superior type of man in charge than an ordinary overseer.

Baktiar, Haflong.—The Fruit Inspector, Surma Valley, will have his headquarters at Haflong and will supervise the work of this station, which will be in immediate charge of an overseer as at present.

A grafter will be required at each of the three stations at Shillong, Gauhati and Haflong. At present there are one Fruit Inspector and one grafter at Khanapara and one overseer at Haflong. They will continue to be paid by the Department as shown in the detailed estimates.

9. If the scheme is accepted there will be a great incentive to fruit-growing, and as the whole of the produce will not be required for consumption within the province, there will be a large surplus for export and canning, in both of which the Empire Marketing Board is interested. The successful working of the scheme will benefit not only this province but consumers of fruits throughout India.

Cost of Scheme.—The total cost for a period of five years will be Ra. 78,656 after deduction of the present provincial expenditure, as shown in the abstract.

Receipts.—It is rather difficult to form an estimate of probable receipts with any degree of accuracy as there are few data to go upon. It is believed that the present receipts from the sale of fruits from La Chaumiere Garden will not be less than between Rs. 2,500 to Rs. 3,500 per annum. The probable receipt from sale of grafts may be estimated at Rs. 500 per annum.

Both at Haflong and Khanapara it is proposed to have about five acres under orange trees. When these come into bearing, the receipts may be estimated at Rs. 2,500 to Rs. 3,500 from each.

If the Council of Agricultural Research provides the extra funds needed the excess receipts over those for the present year will be allowed for on such terms as may be agreed upon between the Council and Government.

The 25th November 1930.

J. N. CHAKRAVARTY.

Abstract of estimates for fruit culture in Assam.

Particulars.	Non-recurring.	Net recurring for 5 years (after deducting contribution by local Government).					
		1st year.	1st year.	2nd year.	2nd year.	4th year.	5th year.	Total recurring.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1. Fruit Experiment Station at Haflong.	9,200	1,550	1,562	1,574	1,586	1,598	7,870
2. Fruit Experiment Station at Khanapara (Gaubati)	5,000	1,420	1,492	1,564	1,636	1,708	7,820
3. Fruit Experiment Station at Shillong.	5,000	3,910	3,922	3,982	3,994	4,054	19,869
4. Appointment of one Fruit Inspector in the Surma Valley with headquarters at Haflong.	5,300	2,280	2,580	2,700	2,712	2,832	13,104
5. Appointment of one Marketing Enquiry Officer for one year.	..	5,500	..	..	..	..	5,500
Total ..	24,500	14,660	9,556	9,820	9,928	10,192	54,156

Estimate for the Fruits Experimental Station at Haflong.

Details.	1st year.		2nd year.	3rd year.	4th year.	5th year.	Ultimate annual.
	Non-recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.
1	2	3	4	5	6	7	8
ESTABLISHMENT.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
One overseer (Rs. 30—4/2—50).	..	360	360	408	408	456	492
One grafter mali (Rs. 25—140).	..	300	312	324	336	348	384
Allowance, etc.—							
Travelling allowance ..	..	50	50	50	50	50	50
Water supply ..	2,000	..	..	..	..	..	..
Reclamation ..	500	..	..	..	..	..	..
Godown ..	2,500	..	..	..	..	..	..
Overseers quarters ..	1,200	..	..	..	..	..	..
Labourers' shed ..	500	..	..	..	..	..	..
Quarters for grafter mali	1,200	..	..	..	..	..	..
Fencing ..	1,000	..	..	..	..	..	..
Furniture ..	100	..	..	..	..	..	..
Implements ..	200	..	..	..	..	..	..
Seeds, plants and manures	..	400	400	400	400	400	400
Wages of labourers ..	..	1,000	1,000	1,000	1,000	1,000	1,000
Miscellaneous contingencies—							
Stamps, office expenses, etc., including one garden mali.	..	500	500	500	500	500	500
Petty repairs ..	..	300	300	300	300	300	300
Total ..	9,200	2,910	2,922	2,982	2,994	3,054	3,126
Deduct—Expenditure to be met from Provincial grant—							
One overseer ..	..	360	360	408	408	456	492
Contingencies including menial.	..	1,000	1,000	1,000	1,000	1,000	1,000
Total Deduction ..	..	1,360	1,360	1,408	1,408	1,456	1,492
Total estimate ..	9,200	1,550	1,562	1,574	1,586	1,598	1,634
						Rs.	
Net non-recurring ..	..	..	..	..	..	9,200	
Recurring for 5 years ..	..	..	..	..	..	7,870	
							Grand Total .. 17,070

Estimate for Fruit Experimental Station at Khanapara, Gauhati.

Details.	1st year.		2nd year.	3rd year.	4th year.	5th year.	Ultimate annual.
	Non-recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
ESTABLISHMENT.							
1 Horticultural Assistant (Rs. 60—6—120).	..	720	792	864	936	1,008	1,128
1 Grafter mali (Rs. 25—1—40).	..	300	312	324	336	348	384
Quarters for Horticultural Assistant.	2,500	..	..	..	..	..	..
Quarters for grafter mali ..	1,200	..	..	..	..	..	..
Acquisition of land (5 acres)	500	..	..	..	..	..	..
Reclamation and fencing ..	500	..	..	..	..	..	..
Implement	200	..	..	..	..	..	..
Furniture	100	..	..	..	..	..	..
Seeds, plants and manures	..	200	200	200	200	200	200
Wages of labourers ..	..	600	600	600	600	600	600
Miscellaneous contingencies	..	100	100	100	100	100	100
Petty repairs .. ..	..	100	100	100	100	100	100
Total ..	5,000	2,020	2,104	2,188	2,272	2,356	2,512
<i>Deduct—Expenditure to be met from Provincial grant—1 Grafter mali.</i>	..	300	312	324	336	348	384
Contingencies .. ..	..	300	300	300	300	300	300
Total Deduction ..	..	600	612	624	636	648	684
Net estimate ..	5,000	1,420	1,492	1,564	1,636	1,708	1,828

	Rs.	
Total non-recurring	5,000	
Total recurring for 5 years	7,820	
Grand Total	12,820	

Estimate for Fruit Inspector in the Surma Valley with Headquarters at Haflong.

Details.	1st year.		2nd year.	3rd year.	4th year.	5th year.	Ultimate annual.
	Non-recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
ESTABLISHMENT.							
1 Fruit Inspector (Rs. 125—300).	..	1,500	1,800	1,920	1,920	2,040	2,472
1 Peon (Rs. 15—1/3—18—1/5—20).	..	180	180	180	192	192	204
Allowances, etc.—							
Travelling Allowance of establishment.	..	500	500	500	500	500	500
Quarters for 1 Fruit Inspector.	5,000	..	..	..	..	..	..
Quarters for 1 peon ..	300	..	..	..	..	..	..
Contingencies—							
Miscellaneous, stamps, etc.	..	100	100	100	100	100	100
Total ..	5,300	2,280	2,580	2,700	2,712	2,832	3,276

Rs.

Total non-recurring 5,300

Total recurring for 5 years 13,104

Grand Total .. 18,404

Estimate for the Fruit Experimental Station at Shillong.

Details.	1st year.		2nd year.	3rd year.	4th year.	5th year.	Ultimate annual.
	Non-recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.	Recurring.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
ESTABLISHMENT.							
1 Overseer (Rs. 30—4/2—50).	..	360	360	408	408	456	492
1 Grafter mali (Rs. 25—1—40).	..	300	312	324	336	348	384
Allowance, etc.—							
Travelling allowance of establishment.	..	50	50	50	50	50	50
Quarters for 1 Overseer ..	1,200	..	..	..	..	..	..
Quarter for 1 grafter mali ..	1,200	..	..	..	..	..	..
Godown	1,000	..	..	..	..	..	..
Labourers shed	500	..	..	..	..	..	..
Reclamation and fencing	800	..	..	..	..	..	..
Implements	200	..	..	..	..	..	..
Furniture	100	..	..	..	..	..	..
Seeds, plants and manures	..	1,000	1,000	1,000	1,000	1,000	1,000
Wages of labourers ..	..	1,500	1,500	1,500	1,500	1,500	1,500
Miscellaneous Contingencies—							
Stamps, office expenses, etc.	..	500	500	500	500	500	500
Petty Repairs .. ..	..	200	200	200	200	200	200
Total ..	5,000	3,910	3,922	3,982	3,994	4,054	4,126

	Rs.
Total non-recurring	5,000
Total recurring expenditure for 5 years	19,862
Grand Total ..	24,862

Estimate for the appointment of one Marketing Enquiry Officer for one year.

Details.	Amount.
	Ra.
Pay at Rs. 250 per mensem	3,000
Travelling allowance	2,000
One peon at Rs. 11 per mensem	132
Contingencies	368
Total	5,500

ENCLOSURE IX.

EXTRACT FROM THE REPORT OF THE FRUIT SUB-COMMITTEE, JANUARY 1932.

United Provinces Schemes.—Two schemes were for consideration. One for the Kumaun Hills and the other for the plains of the United Provinces.

Mr. Mehta stressed the great extent and the importance of fruit growing in the United Provinces; the facilities for developing the industry and the keenly felt want of scientific advice and assistance among the large number of fruit growers. He laid a good deal of stress on the importance of the Hills scheme, but after discussion it was decided for the present to recommend only the plains scheme with the following alterations:—

From the *non-recurring* expenditure.

Omit

	Ra.
Lands	20,000
Buildings, packing shed, store room and office room ..	2,000
Malis quarters	2,000
Roads	3,000
Fencing	4,000
Masonry water channels	3,500
One tube well	8,000

The scheme as recommended for consideration by the Advisory Board will therefore cost as follows:—

Non-recurring—

	Ra.
One Tube well	8,000
Cost of digging holes for trees	300
Manure	2,500
Cost of trees	3,000
Implements	500
Cattle	400
Total non-recurring	14,700

Recurring.

This was left unaltered.

Mr. Mehta stressed the importance of the Hill Scheme and he urged that if he could be given a sum of Rs. 4,640 he would be satisfied ; but it was decided that the Hill Scheme should be sent back to be revised, and put up again.

ENCLOSURE X.

COPY OF LETTER FROM S. V. RAMAMURTY, ESQ., I.C.S., DIRECTOR OF AGRICULTURE, MADRAS, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NO. D. CAMP. 32, DATED 19TH JULY 1932.

With reference to the Bombay Fruit Storage Scheme (Enclosure III) the papers relating to which were circulated to me yesterday, I wish to point out that Madras has many more varieties of good mangoes than Bombay and that considerable quantities of good mangoes are sent from Madras for the Bombay Market. I understand too that the mango season in the two Provinces somewhat differs which permits a longer season for Indian export of mangoes than Bombay alone can provide. While welcoming the Bombay Scheme for research on the storage of mangoes, I consider that the scheme as a scheme to help the export of Indian mangoes to England would be quite incomplete unless it provided for a study on the same lines of good varieties of Madras Mangoes as is proposed for Bombay varieties. The Jahangir, Imam Phasand and several other varieties of Mangoes in Madras (like Humayuddin and Ali Beg) have even a better flavour than the Alphonso. I am having the vitamin contents of some of these determined at Coimbatore as there is a large demand in Madras for help in export of mangoes to England—a demand stimulated by the reports of the Bombay experiments in export of Alphonso to England. The keeping qualities of some of the Madras Mangoes are promising. A fruit of the Ali Beg variety cut near Anakapalle on the 16th June last was taken by me through Madras on to Ootacamund on the 24th and I found it retained excellent flavour on the 3rd of July. A fruit of the Humayuddin variety cut at Anakapalle was sent to Ootacamund and after a few days there, was sent back to Madras at 107° temperature for 2 days and then taken to Bombay where I gave it to Dr. Cheema who found it of good flavour. An Indian scheme for export of mangoes would lose sight of rich possibilities if it ignored Madras mangoes.

2. I propose, therefore, that the Bombay Scheme should be modified so as to provide:—

- (1) for experiments on Madras varieties to an equal extent with Bombay varieties.
- (2) for the provision of a Junior Research Officer on Rs. 150 per mensem for 3 years to work at Poona and be in charge of the Madras varieties, and
- (3) for consequent charges under contingencies (purchase of fruit, etc.).

I have already placed an Upper Subordinate (on Rs. 85-120) who has been trained at Poona on special duty to study the cultivation and marketing of Mangoes and other fruit. He will be in charge of the work in regard to the supply of Mangoes for the scheme from Madras during the season—to the exclusion, if necessary, of other work.

ENCLOSURE XI.

COPY OF LETTER FROM THE DIRECTOR OF AGRICULTURE, BOMBAY PRESIDENCY, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, NO. 493 OF 1932, DATED 20TH JULY 1932.

Cold Storage Scheme.

With reference to the discussion in the Fruit Sub-Committee held on 19th instant regarding the Cold Storage Scheme, I have the honour to forward herewith a note containing revised estimates for the Cold Storage Scheme in order to make provision for the mangoes of the three Provinces, Madras, U. P., and Bihar and Orissa. The total additional expenditure is Rs. 18,000.

Cold Storage Research Scheme for Fresh-Fruit Export.

Note showing modification of estimates required to provide for the testing of six varieties of mangoes from other Provinces.

It is assumed that—

Madras will send 3 varieties.
 United Provinces 2 varieties.
 Bihar and Orissa 1 variety.
 Total 6 varieties.

To provide for this additional work it will be necessary to enlarge the cool-chambers, from—

7' x 9' x 8' to 10' x 9' x 8'

and in addition there will be certain alterations to the Ammonia Compressor plant.

It is anticipated that the season for the work will be extended as the Madras Mangoes will become available earlier than the Bombay mangoes and the U. P. and Bihar mango season will extend to the middle of August. For this reason it will be necessary to make the Junior Research Assistant and one of the Junior Mechanics and one of the Coolies permanent throughout the year instead of temporary for six months per annum only.

Provision will also have to be made for the purchase and transport of fruit from the three Provinces. The number of fruits required of each variety is 2,800 for Experiment No. I in the first year, 2,400 in each of Experiments Nos. II and III in the second year and 2,400 in each of Experiments Nos. IV and V in the third year. On this basis the following tabular statement has been prepared which shows the total quantity of fruit required to be supplied by each Province.

Statement showing the number of fruits required for experiments from each province.

Name of province.	1st year I experiment.	2nd year II and III Experiments.	3rd year IV and V Experiments.	Total No. of fruits.
Madras ..	8,400 (for 3 varieties). (@ 2,800 for each) (for one experiment).	4,800 (for one variety and two experiments).	4,800 (for one variety and two experiments).	18,000
United Provinces.	5,600 for two varieties (for one experiment).	4,800 (for one variety and two experiments).	4,800 (for one variety) (for two experiments).	15,200
Bihar and Orissa.	2,800 (for one variety) (for one experiment).	4,800 (for one variety) (for two experiments)	4,800 (for one variety) (for two experiments).	12,400

ESTIMATES.

Non-recurring additional expenditure.

Serial No.	Item.	Amount in rupees.
I	Enlargement of cool chambers and additional shelvage therein ..	5,000
II	Alterations and additions to the Ammonia Compressor plant ..	3,000
	Total	8,000

Recurring additional Expenditure.

		First year.	Second year.	Third year.
III	Pay of Establishment per annum .. .. .	..	..	1,530
IV	Purchase and transport of fruit.			
	{ Madras ..	1,200	700	700
	{ U. P. ..	800	550	550
	{ Bihar and Orissa.	300	450	450

Hence the total additional expenditure will amount to Rs. 18,090 made up as follows:—

Item.	Amount in rupees.
Non-recurrent Expenditure	8,000
Recurrent expenditure on establishment at Rs. 1,530 per annum for three years	4,590
Recurrent expenditure on purchase and transport of fruit for three years	5,500
(Total recurrent expenditure)	10,090
Grand Total	18,090

When the additional expenditure is added to the estimates given in the printed scheme the revised estimates become:—

Initial Expenditure	38,875
Recurrent Expenditure	53,779
Total	92,654

From this figure a sum of Rs. 2,500, shown against item 12 on page 10 of the printed scheme (Enclosure III), should be subtracted as this expenditure will be met by the Bombay Government. This leaves a net total expenditure of Rs. 90,154 to be provided by the Imperial Council of Agricultural Research.

(Sd.) T. F. MAIN,
Director of Agriculture,
Bombay Presidency.

CAMP SIMLA,

The 20th July 1932.

APPENDIX XL.

SUBJECT No. 34.

MARKETING OF AGRICULTURAL PRODUCE.

At its meeting held on the 28th January 1932 the Advisory Board considered the question of marketing of agricultural produce with special reference to the recommendations made by the Royal Commission on Agriculture in India in their chapter on communications and Marketing and the action taken thereon by the various provincial governments. The point for consideration was, whether, and in what manner, the Imperial Council of Agricultural Research could take the initiative in assisting in the more rapid development of better primary markets for agricultural produce in India.

2. The subject was, however, postponed till the summer (1932) meeting of the Board as it was hoped that by that time fuller information would be available. It will be remembered that the Board wanted to have an idea of the report of the Fact Finding Enquiry Committee appointed jointly by the Railway and the Education, Health and Lands Department of the Government of India to examine and report regarding the transport and other intermediate charges which have to be paid on Indian Agricultural produce. It is now understood that the reports submitted by the members of the Committee referred to above are still under consideration. In the circumstances, therefore, the Chairman of the Advisory Board is of opinion that no useful purpose will be served by discussing the subject at this stage. It may therefore be considered at the next cold weather meeting of the Board.

3. The Government of India, Finance Department, have also referred certain recommendations made by the Indian Central Banking Enquiry Committee relating to—

- (i) the provision of additional storage accommodation in various parts of India ;
- (ii) the advancing of long-term loans at concessional rates of interest to co-operative societies to build godowns in suitable centres and
- (iii) the providing of warehouses by private agencies and licensing them and of provision of capital for their construction.

These may also be considered along with the main subject mentioned in paragraphs 1 and 2 above at the next meeting of the Board.

CHARAN DAS,

Secretary.

The 6th July 1932.

APPENDIX XLI.

PROCEEDINGS OF THE COMMITTEE APPOINTED BY THE ADVISORY BOARD ON THE 21ST JULY 1932 TO DEVISE MEANS OF CO-ORDINATION AND CO-OPERATION BETWEEN THE AGRICULTURE, VETERINARY, MEDICAL AND FOREST DEPARTMENTS IN THE WORKING OF THE SCHEME DRAWN UP BY LT.-COL. R. N. CHOPRA FOR RESEARCH IN SYSTEMATIC CULTIVATION OF MEDICINAL PLANTS, STUDY OF FOOD POISONS IN INDIA. (SUBJECT NO. 35 OF AGENDA.) (APPENDIX XXXIII).

The following were present :—

1. Diwan Bahadur Sir T. VIJAYABHAYACHARYA, *Chairman*.
 2. Mr. A. D. BLASCHECK.
 3. Lt.-Col. R. N. CHOPRA.
 4. Dr. W. McRAE.
 5. Col. A. OLVER.
 6. Mr. P. T. SAUNDERS.
- Rai Sahib Malik CHARAN DAS, *Secretary*.

SUBJECT No. 35.

Application from Lieutenant-Colonel R. N. Chopra of the School of Tropical Medicine, Calcutta, for a grant for research in systematic cultivation of medicinal plants and study of food poisons in India.

Mr. Blascheck, Inspector-General of Forests, said that he was very willing to help in any way but he would have to know what particular drug were to be dealt with as the plants which produce them may grow in certain districts and not in others. It would be impossible for him to grow any large number of such plants at Dehra Dun but he could arrange to get them from districts in which they grew naturally. He would like to consider with Col. Chopra which forest products the Forest Research Institute would deal with and which Col. Chopra would be able to deal with himself. He considered that it was necessary to have a first class systematic botanist and a first class chemist.

Col. Chopra explained that he had only asked for a young man to train up himself because he did not think it likely to be able to obtain a more highly trained man. His idea was to train this young man himself and supervise his work and where he was unable to identify any particular plant he would have to consult some other institution where more highly qualified botanists were available. He said that he had already worked through about 50 drugs but some of them required years of study to work out thoroughly.

It was agreed between Colonel Chopra and Mr. Blascheck that it would be necessary to have a definite programme of collaboration and it was arranged that they should exchange schedules of the work proposed.

Col. Chopra said he would be able to go to Dehra Dun, when necessary, to discuss matters with Mr. Blascheck. Some arrangement might be necessary to enable him to obtain the information he might require from Conservators of Forests regarding particular plants, but he would write to Mr. Blascheck if he were to take up any particular plant.

In regard to veterinary diseases *Col. Olver* explained that it would be of great assistance if work could be done in collaboration between Col. Chopra and the Muktesar staff on such diseases as Kunri, the study of which was now being taken up at Muktesar, lathyrism and cyano genetic poisons met with in certain classes of forage, such as Jowar. It would also be of great value if Col. Chopra could supply Mr. Saunders with information as to any work which may have already been done on the drugs which he proposed to study in relation to domesticated animals.

Col. Chopra said that he was already doing a good deal of clinical work on Beri-beri and allied diseases as well as on lathyrism and allergic conditions. He said he would be able to make such chemical analyses as might be necessary and the Inspector General of Forests would get plants identified if numbered specimens were sent to him. Col. Chopra would be particularly glad to help with any investigation in cattle poisons.

Mr. Saunders in regard to his scheme said that he had from the start been in communication with Col. Chopra and had arranged to work with the Madras Medical Department. What he particularly wanted to do was to obtain precise information as to the value or otherwise of a great many plants and drugs used in the villages and credited with curative properties which might or might not be valid, and he would be very glad of such information Col. Chopra could supply regarding such drugs. It was arranged that he should let Col. Chopra know what drugs he was working on so as to avoid overlapping.

During further discussion *Col. Chopra* said he would be very glad to take up the study of Kumri with Mr. Ware and would be able to do any special chemical or pathological work which might be required in that connection.

Dr. McRae said that Pusa could help on the Mycological side and in growing certain plants but the crops produced at Pusa were mostly arable crops. They were not horticulturists at Pusa. Bengal had offered and other Provinces would also help in providing rice and pulses required and all the material at Pusa was available.

Col. Over suggested that Mr. Saunders working with Col. Chopra might be able to carry out some investigations into the cyano genetic poisons of such fodder crops as Jowar.

Mr. Saunders thought that it might be advisable to get in touch with commercial drug houses but Col. Chopra said that he could probably supply all the information necessary regarding drugs ordinarily used in India. Col. Russell who was obliged to attend another meeting considers the above arrangements very satisfactory but would like to stress the importance of continual contact between Col. Chopra and the three Departments dealt with by the Imperial Council of Agricultural Research.

CHARAN DAS,

Secretary.

The 22nd July 1932.

APPENDIX XLII.

SUBJECT No. 38.

ASSISTANCE TO BE GIVEN BY THE INDIAN RAILWAY CENTRAL PUBLICITY BUREAU TO PROMOTING AGRICULTURAL AND VETERINARY DEVELOPMENT.

At its meeting held in January 1931 the Advisory Board considered a memorandum (Encl. I) by Mr. W. T. Aldous, Commercial Officer, Indian State Railways, in regard to the subject mentioned above. An extract from the Proceedings of the Board relating to the subject in question (Encl. II) together with a copy of the memorandum (Encl. I) was sent to the Railway Department (Railway Board). The remarks of the Railway Department on the various recommendations made by the Advisory Board will be found in Encl. III.

2. It may be stated as regards item (i) of Encl. III (*freight rates on agricultural produce*), that a Fact Finding Enquiry Committee consisting of a representative each of the Railway and Education, Health and Lands Departments of the Government of India was appointed in 1931 to examine and report regarding the transport and other intermediate charges which have to be paid on Indian agricultural produce. The members of the Committee have submitted their reports to their respective Departments which are still under consideration. The question will therefore be pursued further when the reports become available.

With regard to the type of cattle wagons (item VI, Encl. III), it has been ascertained that the question was considered by the Commercial Committee of the Indian Railways in March 1931 and that the following resolution (which has since been approved by the Indian Railway Conference Association) has been passed :—

“The Commercial Committee are not in favour of a rule making it compulsory to unload and rest cattle after travelling 200 miles. Such a rule would be difficult to work and would be unpopular with owners.

“As regards the question of improving the type of wagon used for the carriage of cattle, investigation shows that the standard types of wagons are satisfactory.”

3. The attached report* on the possibility of railways in India developing and increasing goods traffic by Mr. W. T. Aldous may also be of interest in this connection.

4. A copy of the pamphlet entitled ‘Demonstration Trains’ issued by the Publicity Bureau of the Indian State Railways has already been circulated to all members of the Advisory Board with this Department memorandum No. 536-Agri., dated the 6th March 1931. The question of further action, if any, to be taken is now for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**The 6th July 1932.*

ENCLOSURE I.

MEMORANDUM FOR DISCUSSION AT THE NEXT MEETING OF THE ADVISORY BOARD OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

SUBJECT :—*Assistance to be given by the Indian Railways Central Publicity Bureau and by Railways in promoting improved agricultural and veterinary methods.*

1. *Demonstration Trains.*—(a) *Provincial.*—The Punjab and Bengal Governments have co-operated with the North Western and Eastern Bengal Railways respectively in the running of Demonstration Trains in the past but some of the other Local Governments, although approached, have not seen their way to allotting the necessary funds. This

year it is probable that the Punjab and Bengal Governments will not join in running any trains due to financial stringency. It is understood that Governments that have taken part in these trains believe fully in their efficacy as a medium of propaganda, and it is to be decided how funds are to be provided for them in future. The railway charges represent the cost of running only, and it is understood that these are but a small proportion of the cost of the train, so that even if railways were to reduce these charges, it would not solve the financial difficulty.

(b) *All-India*.—A proposal has been made to organise such trains on an All-India basis, with a tour of anything from three to eight months, covering the greater part of India either in one or more tours. There is some difference of opinion as to whether this proposal is feasible, owing to the different languages that would have to be used, and the changes necessary in staff for the same reason. A saving in cost would, however, be effected as only one set of exhibits would be required for all the provinces covered, but here again the question arises as to whether one set of agricultural exhibits would be suitable for the whole area. It has to be decided whether this proposal is practicable, and, if so, how it is to be financed. The normal railway charges amount to about Rs. 600 per unit of half a bogie carriage per mensem, or Rs. 7,200 a month for a train of six bogies.

2. *Films*.—Most of the larger railways now run regular cinema cars, and it is generally felt that this is a valuable medium of propaganda among audiences which are largely illiterate, especially if a lecturer is present to explain the films. The Imperial Council of Agricultural Research have had under consideration the appointment of two film production officers and it is a matter for consideration whether the appointment of these men should not be expedited. These men could also undertake the preparation of lantern slides for lectures. Suggestions are invited as to suitable subjects for films and slides for the encouragement of the better production of crops, and generally for raising the standard of living.

3. *Visits by Cultivators to Model Farms*.—There appears to be some difference of opinion as to whether cultivators should be encouraged to visit model farms, or whether demonstration plots only should be used for this purpose. A suggestion has been made that parties of about fifty cultivators should pay regular visits to model farms throughout the year, or at suitable times of the year, and that railways might then agree to the quotation of concession rates for such parties at one and a half fares for the return journey. It has to be decided whether such visits are to be encouraged and the idea proceeded with.

4. *Other methods by which Railways can assist Agriculture*.—Railways have an extensive machinery in existence throughout India which might be usefully employed in distributing propaganda for better agricultural methods, or possibly even in the exhibition and sale of improved implements at stations. The views of the Council are invited on this subject.

5. *Liaison between Railway and Agricultural interests*.—The question arises whether the present system provides adequate touch between railways and agriculture or whether some better means of liaison would be desirable. It might be advisable to have a definite officer working with the present Central Publicity Bureau, which would interest itself and railways in agricultural requirements and act generally as a clearing house between the two departments. In that case Publicity Officers on railways, working under their Agents, would develop a similar interest in agricultural requirements, and would keep the railway officials interested in such matters. This is purely a tentative proposal, but the views of the Council on it would be welcomed.

N.B.—The above note has been submitted by the Railway Member on the Advisory Board as a basis for discussion, and any decisions arrived at would require the approval of the Railway Board and the Railways concerned.

ENCLOSURE II.

EXTRACT FROM THE PROCEEDINGS OF THE ADVISORY BOARD, JANUARY 1931.

Assistance to be given by the Indian Railway Central Publicity Bureau to promoting agricultural and veterinary development.—Major Budden introducing the subject said

that he would like the views of members of the Advisory Board on the memorandum which he had submitted on the subject and which had been circulated to the Board. Mr. Burt said that by far the greatest help which railways could give to agriculturist in India was to reduce the freight on agricultural produce. This point had already been dealt with in the resolution passed on subject No. 26 of the agenda; but he would like to emphasise that Indian agriculture was passing through a very critical time and as a country which had a large export trade in agricultural produce, it was important that at a time when there was over production in the world the agriculturist in India should be assisted as much as possible in the matter of freight to maintain the position of his produce in the markets of the world. Mr. Plymen, as well as the other members of the Advisory Board, said that this question of freight was really the most important direction in which the railways could assist the agriculturist.

Opinion in the Board was divided in regard to the utility of provincial demonstration trains. Though their use had been discontinued in the Punjab and Bengal this year that was not due to their being considered of little value, but because of financial stringency. Opinion was, however, definitely against the feasibility of running an all-India demonstration train owing to difficulties in regard to language and also because of the difference in varieties of crops grown. Major Budden informed the Board that he had prepared a pamphlet on demonstration trains which would be circulated to all members of the Board. Finally it was agreed to hold over the question of the utility of demonstration trains for consideration at the next meeting of the Advisory Board, so that in the interval members might have the opportunity of reading Major Budden's pamphlet as well as of considering the question further.

Opinion was in favour of the railways encouraging visits of cultivators to model farms, agricultural shows and exhibitions by means of concession tickets. The members of the Board were also in favour of the Directors of Agriculture being members of Provincial Railway Advisory Committees, which at present had no representative of the Agricultural Department on them. The following suggestions also found favour with the Board :—

- (1) Allowing cows and buffaloes to be transported back from towns to the country at cheap rates when no longer in milk. This would avoid the present slaughter of good milking animals after their period of lactation.
- (2) The establishment of agricultural stalls at railway stations.
- (3) The exhibition and sale of agricultural implements *approved* by the provincial Department of Agriculture at railway stations.
- (4) Provision of improved types of cattle wagons for the transport of cattle. The railway representative, Major Budden, said that there were already special types of ventilated wagons on the railways, but the co-operation of cattle-owners was also necessary. As the amount charged was often for the whole wagon, there was a tendency on the part of cattle consignors to overcrowd the wagons.
- (5) Pictures on agricultural subjects in railway carriages. The railway representative said that they had tried having pictures and advertisements in third class compartments, but they found that these were generally torn up.

In the result of the Board took note of Major Budden's suggestions and passed on to the consideration of the next item of the agenda.

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ENCLOSURE III.

OFFICE MEMORANDUM FROM THE GOVERNMENT OF INDIA, RAILWAY DEPARTMENT (RAILWAY BOARD), TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, No. 3947-T., DATED SIMLA, THE 12TH SEPTEMBER 1931.

With reference to paragraph 8 of the proceedings of the Advisory Board of the Imperial Council of Agricultural Research held in January 1931 (Appendix I), received

under the Imperial Council, Agricultural Research No. 1371/Agri., dated 23rd June 1931 (not printed), the Railway Department have the following remarks to offer—

- (i) *Freight rates on agricultural produce.*—Attention is invited to the Railway Department (Railway Board) U. O. I. note No. 344-T./31, dated 28th April, 1931 (not printed), in which the views of this Department on subject No. 26 of the agenda (not printed) for the meeting of the Advisory Board were communicated to the Imperial Council of Agricultural Research through the Department of Education, Health and Lands.
- (ii) *Issue of concession tickets to cultivators.*—This is a matter which, in the opinion of the Railway Board, might suitably be taken up by provincial Directors, of Agriculture with Railway Administrations concerned. The Board understand that most Railways allow the concession of free carriage on the return journey for exhibits sent to recognised shows and exhibitions, but the grant of a concession to cultivators visiting such shows and exhibitions is on an entirely different footing and may give rise to difficulties. In any case, this point as also that in regard to the grant of a concession to cultivators visiting model farms, is a matter which can only be considered with reference to local conditions and might, therefore, suitably be referred by provincial Directors of Agriculture to the Railway Administration concerned in each case. The Railway Board do not consider that their intervention in this matter is necessary.
- (iii) *Representation on Railway Advisory Committees.*—Railways already find considerable difficulty in endeavouring to give adequate representation on their Advisory Committees to all interests desiring such representation. On practically all Committees, the Local Governments concerned have their representatives but if in any case it is felt that the Agricultural Department's interests are likely to be overlooked, Local Governments could take up the matter with the Railway Administrations concerned.
- (iv) *Reduced rates for the carriage of dry milch cattle.*—The Railway Board are unable to support the suggestion that cows and buffaloes, when no longer in milk, should be carried from towns to the country at lower rates than those now in force. In this connection, attention is invited to the debate in the Council of State on the 10th July 1930 on a resolution moved dealing with this point (not printed).
- (v) *Agricultural stalls and sale of agricultural implements at railway stations.*—In the absence of any detailed proposals in regard to the establishment of agricultural stalls at railway stations and the exhibition and sale of agricultural implements, the Railway Board are unable to offer any remarks. It seems to the Board that these are matters in which the initiative should be taken by provincial Directors of Agriculture in direct communication with Railway Administration.
- (vi) *Type of cattle wagons.*—The question of improving the type of wagon used for the carriage of cattle was taken up by the Railway Board on the recommendation contained in paragraph 315, page 379, of the report of the Royal Commission on Agriculture in India, and was referred by them to the Indian Railway Conference Association for consideration. The Association are now investigating this point.

D. A.—N7.

To

The Indian Council of Agricultural Research.

APPENDIX XLIII.

SUBJECT No. 39.

SCHEME FOR CARRYING ON RESEARCH WORK IN THE ANAND CREAMERY
IN THE MANUFACTURE OF PRODUCTS AND BY PRODUCTS OF MILK.

Attention is invited to the letter from the Government of India, Education, Health and Lands Department No. 1838-A./32, dated the 12th July 1932 (Enclosure I) forwarding a scheme submitted by the Imperial Dairy Expert on the subject mentioned above. The scheme involves an initial capital expenditure of Rs. 13,650 and a recurring expenditure of Rs. 54,000 spread over three years or a total expenditure Rs. 67,650. The anticipated receipts by sale of dairy products and other miscellaneous sales have been estimated to be Rs. 9,000 for three years. The net estimated charge, therefore, comes to Rs. 58,650.

2. The Animal Husbandry Expert to the council in consultation with the Imperial Dairy Expert has modified the nature of work to be done in connection with the research and the first three annexures, showing the estimates, establishment and specification of plant, etc., (Enclosure II). According to the revised estimates the scheme involves, a capital expenditure of Rs. 19,600 and a recurring expenditure of Rs. 91,098 spread over three years, or a total of Rs. 1,10,698. The receipts for three years have been worked to be Rs. 11,400 and the net cost will thus be 99,298. The scheme as revised by the Animal Husbandry Expert to the Council is now submitted for the consideration of the Advisory Board.

CHARAN DAS,

*Secretary.**The 16th July 1932.*

ENCLOSURE I.

COPY OF A LETTER NO. 1838-A/32, DATED THE 12TH JULY 1932, FROM THE OFFG. DEPUTY SECRETARY TO THE GOVERNMENT OF INDIA, DEPARTMENT OF EDUCATION, HEALTH AND LANDS, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Scheme for research work in the manufacture of products and by-products of milk produce in the villages.

I am directed to forward a scheme (Annexure) submitted by the Imperial Dairy Expert for research in the manufacture of products and by-products of milk produced in rural areas and for the transportation of milk to large cities from a distance. The scheme involves an initial capital expenditure of Rs. 13,650 and an annual recurring expenditure of about Rs. 18,000, and covers a period of three years in the first instance. It will be seen that the utilisation of the buildings, machinery, etc., of the Anand Creamery, which has been closed since the 1st March 1932, is an essential part of the scheme. The Government of India have no objection to the utilisation, free of charge, of the Anand Creamery for the purpose, provided its ownership continues to vest in them and they are not asked to meet any direct or indirect expenditure on this account. It is understood that the plants and buildings will be kept in proper repair by the Imperial Council of Agricultural Research.

2. The Imperial Dairy Expert refers to the establishment of a small Experimental Creamery after the preliminary investigations are over. The Government of India consider that this proposal need not be considered at the present stage.

ANNEXURE I.

SCHEME FOR RESEARCH WORK IN THE MANUFACTURE OF PRODUCTS AND
BY-PRODUCTS OF MILK PRODUCED IN INDIA.*Object and importance of scheme.*

The advancement of the dairy industry in this country depends mainly on the commercial development of rural dairying, in other words, on the more intensive use of the milk

produced in villages by small producers, who are mainly agriculturists, by turning it into products and by-products such as butter, ghee, condensed milk, milk powder, casein, etc., and by organising the transport of milk from rural to urban areas. All these problems require proper investigation and it is necessary therefore, to carry on research into the processes of manufacturing these products most profitably and then trying out the most suitable methods on a factory scale at a Central Experimental Creamery provided for the purpose. Industrial dairying, or the factory side of the dairy industry, is not to be confused with farm dairying, as the former forms a subject by itself and the greatest importance is attached to its development by such leading dairy countries of the world like Denmark, Holland, etc. Any efforts at improving the cattle of the country must be preceded by the organisation of the dairy industry, as the problem of breeding improved type of cattle can never be placed on a sound economic basis unless a suitable outlet is provided for the increase out put of milk from the improved type of cow. The dairy problem is also linked up with the health and welfare of the people in urban areas. The conditions of milk supply in Indian cities are too well known to be described and Bombay provides a glaring example of the most expensive milk in the world and yet of the poorest quality produced and distributed under the most unhygienic conditions. The effect of all this is reflected in the death rate of children which amounts to 400 on an average for every 1,000 children born in the city. The faulty system of milk production also takes a heavy toll of the best type of milch cattle that the country produces. Bombay on an average imports about 150 head of cattle every day for milk production and all these animals find their way to the slaughter houses after about a year when they have finished their milking. This loss to the country through its cattle wealth runs into several lakhs every year. What is true of Bombay is true of most of the other big cities in India. The real solution of the problem lies in organising the transport and supply of milk to big cities by handling the milk produced in rural areas on a factory scale, thus utilizing it to better advantage than at present. Similarly several other products and by-products of milk manufactured in rural areas at present, suffer from serious handicap in competition in the open market with imported products from foreign countries, owing to the imperfect methods of manufacture in this country and the general lack of technical knowledge. At one time almost the entire demand for butter in the East from Rangoon right round to Vladivostok was met from India, and to-day, within a period of about fifteen years, this trade is not only captured by Australia, New Zealand and other foreign countries, but the very existence of the butter industry in India is being threatened by the increasing importation into this country of butter prepared by more perfected processes in foreign countries. The quality of imported butter rose from 542 cwt., value Rs. 1,38,839, in 1922-23 to 3,570 cwt., value Rs. 5,42,397, in 1931-32. Similarly the casein industry in India with its large export trade which was established during the war has been ruined as the product manufactured in this country does not come up to the requirements of foreign markets. Ghee in the manufacture of which India at one time practically held a monopoly, is being imported in this country in increasing quantities and the value of its import last year amounted to Rs. 1,31,557. It is also estimated that through the manufacture of ghee by out-of-date wasteful processes this country suffers an annual loss of about Rs. 8,00,00,000. The manufacture of condensed milk and milk powder is altogether unknown to India, although there is an ever increasing demand for these commodities in this country as is indicated by the import figures which rose from 61,054 cwt., value Rs. 44,12,316 in 1922-23 to 2,42,611 cwt., value Rs. 88,34,943, in 1929-30. Given the necessary facilities, there is no reason why this industry cannot be started in India, thereby converting the surplus milk and separated milk obtainable in dairy tracts, which at present is wasted, into a commercial commodity and making dairying more remunerative for small producers. All these problems call for thorough investigation into the technical processes of manufacture of these products and by-products under conditions peculiar to India both as regards its climate and the kind of milk that is produced in its rural areas. It is, therefore proposed in this scheme that precise research into the manufacturing processes of various products and by-products of milk should be carried out for at least three years and from the experience obtained during this period, the most satisfactory methods should subsequently be tested on a factory scale at an up-to-date small Experimental Creamery established for the purpose in a suitable dairy tract of the country. Such a creamery will also have its value for instructional purposes. Technical education must go hand in hand with research work, otherwise, without trained hands there can be no advancement in the Dairy industry.

Nature of work to be done.—The investigation and reasearch work to be carried out will pertain to the following principal problems :—

- (a) The supply of milk from rural areas to big cities. It is necessary to discover what form of treatment in the direction of heating, retarding, cooling, or a combination of one or more of these treatments and what class of transport vessel and tranport conditions will give the best results in railing milk over long distances requiring 5 to 20 hours journey by rail.
- (b) Manufacture of condensed milk from whole and separated milk.
- (c) Manufacture of milk powder from whole and separated milk.
- (d) Manufacture of butter from ripened and unripened cream, its packing and transport under tropical conditions.
- (e) Manufacture of commercial casein.
- (f) Improved and economical methods of ghee manufacture.
- (g) Improved and economical methods of manufacturing some of the indigenous products of milk such as Khava, curds, etc.

Importance of place and Site.—The importance of selecting a proper place for carrying out preliminary investigation and for the eventual establishment of an up-to-date Central Experiental Creamery cannot be over emphasised. This work should be carried out in a dairy tract representative of the general conditions in rural areas and where the dairy industry is already in existence. I consider Gujrat as the most suitable area and Anand the most suitable place for the purposes of investigations and for the eventual establishment of an Experimental Creamery in preference to Karnal or Bangalore or any other place. The following are my reasons :—

- (1) North Gujrat is a typical dairy tract and Anand and the country surrounding it is the biggest milk producing area in this country. The conditions of milk production obtainable there are typical of the rural areas of this country. Moreover, the climatic conditions of the place and its location in relation to big towns like Bombay are points which go in its favour. The climate provides that degree of severity of conditions which will make the results of experiments performed under such conditions applicable to all possible conditions obtainable in India and yet it is healthy throughout the year. The three distinct seasons of the place, e.g., winter, summer and monsoon which affect the feeding of village cattle and which in turn affects the quality and the nature of the constituents of milk produced will enable the questions arising out of different feeding conditions to be investigated. Experience gained under such conditions will be more or less of universal application. The situation of Gujrat within easy reach of Bombay will enable the problem of the transport of milk from rural to urban areas to be properly investigated.
- (2) Gujrat forms the principal centre of butter supply for the whole country and this industry in Gujrat was first started and helped all along by the Government Dairy Department. Several problems relating to the manufacture of butter on factory scale still remain to be solved and if the industry is not helped by Government at this stage in solving these problems, its future development will be seriously retarded. Again, the manufacture of by-products of milk, such as condensed milk, milk powder, casein, etc., is closely associated with the butter industry, as the products like separated milk, butter milk etc., which are obtained through the manufacture of butter can be economically utilised. As such no better place than Gujrat can be selected for the establishment of a Research Creamery as the butter industry has so well established itself there.
- (3) In times like the present when it will be hard to obtain funds, Anand offers the very great advantage of a ready established creamery to be taken over for research work. The starting of a new creamery, even on a modest scale, will involve important questions regarding site, water supply, disposal of

sewage water from the creamery, etc., conditions which are not easily obtainable at all places. For the requirements of an Experimental Creamery the site of the existing creamery is almost ideal. The water supply is quite satisfactory and the system of sewage disposal well established. There is ample scope for future expansion if necessary, and the existing floor space can be remodelled at a moderate cost, etc., provide a building to suit the requirements of a most up-to-date creamery to be run economically. Again, the present creamery as an established institution affords many other advantages which cannot be overlooked.

My reasons for not locating it at Karnal are as follows :—

- (1) The energy and resources of the Karnal Farm are concentrated on cattle improvement and that should continue. Any new institution started there more especially of the type of a research creamery will result in divided attention and consequent diversion from the main task of cattle improvement. Again the association of a quasi commercial concern like the Karnal farm with a research creamery would lead to complications which will affect the working of both.
- (2) Karnal is by no means a typical dairy or milk producing tract. The milk available at the farm for experiments will only be of cows, whereas the experience necessary to be gained in the manufacture of commercial products and by-products of milk will mostly have to be from buffaloes milk produced in rural areas. Moreover, milk produced under farm conditions will not be the same as that produced in villages, as such, the experience gained will always be imperfect and will have to be repeated in the case of village-produced milk if the development of dairy industry in rural areas is desired.
- (3) The climatic factor in the case of Karnal cannot be lost sight of. Continuity of work all throughout the year in such experiments is of utmost importance and the unhealthy season in Karnal will make this very difficult if not impossible.

Line of working and estimate of expenditure.—Assuming, therefore, that Anand is to be selected and the existing plant, machinery, building, etc., of the present Government Research Creamery which has been closed as a measure of retrenchment can be utilised estimate of plant and establishment for the preliminary investigation period of three years and the subsequent remodelling of the existing creamery into a small up-to-date Experimental Creamery have been drawn up accordingly. Some of the machinery which was despatched to other farms on the closing of the Anand Creamery will have to be transferred to Anand. The following are appended :—

Annexure II.—Estimates of expenditure for the first three years of preliminary investigation.

Annexure III.—List of establishment required for the first three years of preliminary investigation.

Annexure IV.—Details of equipment required for the first three years of preliminary investigation.

Annexure V.—Estimates of expenditure and receipts for the Experimental Creamery.

Annexure VI.—List of establishment required for the Experimental Creamery.

Details of the plant and machinery required for the Experimental Creamery and plan for remodelling the existing creamery when it is converted into an Experimental Creamery by embodying the latest system of gravity and pumping system of handling milk are under preparation. In the meantime a lump sum provision has been made in the estimates.

During the period of preliminary investigations, as all the milk will be utilised for experimental purposes and no marketable commodity can be expected to be produced, very little receipts are taken into account for this period.

In the estimates for the Experimental Creamery, value of receipts has been included as a large quantity of milk will be handled.

In the list of establishment provision has been made for a Manager and a Supervisor. These men will have to be thoroughly conversant with dairy-factory practices and of handling milk in bulk. The chemist should have a thorough knowledge of dairy chemistry and bacteriology.

(Sd.) ZAL R. KOTHAWALA,
Imperial Dairy Expert.

ANNEXURE II.

Estimate for the first three years of preliminary investigation.

	Rs.
(i) Estimated Capital Expenditure.—	
Alteration to building for laboratory	300
Laboratory equipment	5,000
Plant and machinery as per list	8,000
Cost of transfer of machinery to Anand	350
Total ..	13,650
(ii) Estimated annual recurring expenditure.—	
Cost of establishment (as per Annexure II average)	5,232
T. A. of staff	300
Leave salary	300
Coal and other fuel	3,000
Dairy chemicals, lubricating oil, etc.	200
Repairs and upkeep of dairy plant and utensils	200
Purchase of dairy utensils and appliances	300
Purchase of milk	4,500
Chemicals, gas, etc., for laboratory	1,000
Purchase of laboratory apparatus	700
Freight on dairy produce (transport of milk samples, etc.)	800
Upkeep of buildings	300
Rates, taxes, etc.	300
Stamps, telegrams, stationery	200
Miscellaneous expenses (books, etc.)	300
Contingencies	350
Total ..	17,982
(iii) Estimated receipts per year for the three years of experimental period.—	
By sale of dairy produce	2,500
Miscellaneous sales	500
Total ..	3,000

N. B.—As the milk will be utilised for experimental purposes the above receipts cannot be guaranteed.

(iv) *Summary of estimated cost for the first three years for experimental period.*—

	Capital expenditure.	Recurring expenditure.	Expected receipts.	Net cost of working.
1st year	13,850	17,982	3,000	14,982
2nd year	<i>Nil</i>	17,982	3,000	14,982
3rd year	<i>Nil</i>	17,982	3,000	14,982

ANNEXURE III.

List of establishment required for the first three years of preliminary investigation.

	Rs.	
	Per mensem.	
1 Supervisor	100—10—120	
1 Accountant typist	60	
1 Mechanic (with boiler certificate)	60	
1 Boilerman	15	
2 Dairy workers	20 (each)	
1 Sweeper	12	
1 Chowkidar	15	
1 Peon	12	
1 Chemist	125—10—145	
1 Assistant Chemist	60—5—70	
1 Laboratory boy	12	
	Per month.	Per annum.
Total 1st year	411	4,932
2nd year	436	5,232
3rd year	461	5,532

ANNEXURE IV.

Specification of plant and machinery required for the first three years of preliminary investigation.

- 1 Electric refrigerator unit.
- 2 Galvanised iron round bottom washing tanks.
- 1 Milk separator, 20 gallons.
- 1 Butter churn 40 lbs. capacity.
- 1 Polar type cream and milk cooler 40 gallons capacity with milk pans.
- 1 Set Chloride batteries for 110 volts.
- Crystallizing and cooling vat, etc., for the existing milk condensing plant.
- 6 Insulated milk cans.
- 1 Milk clarifier small size.
- 1 4 cycle Kerosine oil engine of sufficient power.

ANNEXURE V.

Estimates for the experimental creamery.

	Rs.
i) <i>Estimated capital expenditure.—</i>	
Buildings—	
Remodelling the existing creamery	20,000
Quarters for staff	5,000
Plant, machinery and equipment	50,000
Electric power, lighting, etc.	5,000
Purchase of portion of Municipal land	1,500
Total ..	81,500
ii) <i>Estimated annual recurring expenditure.—</i>	
Cost of establishment as per Annexure V	12,600
T. A. of staff	1,000
Leave salary	500
Coal and other fuel	7,000
Chemicals and other manufacturing sundries	500
Repairs and upkeep of plant and machinery	1,000
Purchase of dairy utensils, appliances, etc.	1,000
Purchase of milk	20,000
Chemicals, gas, etc., for laboratory	1,500
Purchase of laboratory apparatus, etc.	1,500
Freight on dairy produce	3,000
Upkeep of buildings	500
Erection and addition to buildings	1,000
Rates, taxes, etc.	500
Miscellaneous expenses (workshop, etc.)	700
Contingencies	700
Stamps, telegram, stationery	300
Total ..	53,300
 <i>N. B.—The above estimates both for capital and recurring expenditure may have to be revised if market conditions change after three years.</i>	
ii) <i>Estimated annual receipts.—</i>	
By sale of dairy produce	40,000
Miscellaneous sales	2,500
Total ..	42,500

N. B.—The above estimated receipts are subject to the methods perfected during the experiment period of manufacturing products and to the market conditions prevailing at the time.

(iv) Summary of cost of establishing and working the experimental creamery.—

	Capital expenditure.	Recurring expenditure.	Estimated receipts.	Net cost of working.
	Rs.	Rs.	Rs.	Rs.
1st year	81,500	53,300	42,500	10,800
2nd year	Nil	54,200	42,500	11,700
3rd year	Nil	55,100	42,500	12,600

(Sd.) ZAL R. KOTHAWALA,
Imperial Dairy Expert.

ANNEXURE VI.

List of establishment required for the experimental creamery.

	Per mensem. Rs.
1 Manager	200—25—500
1 Supervisor	100—10—200
1 Accountant	75
1 Cashier	60
1 Typist	30
1 Engineer	75—10—150
1 Mechanic and greaser	30—5—75
1 Storekeeper	50—5—75
1 Fireman	25
3 Dairy workers	20 each
1 Dairy Jemadar	25
1 Chowkidar	20
1 Sweeper	15
1 Mali	15
1 Peon	15
1 Chemist	150—15—300
1 Assistant Chemist	75—5—150
2 Laboratory boys	15 each
Per month	1,050
Per annum	12,600

(Sd.) ZAL R. KOTHAWALA,
Imperial Dairy Expert.

ENCLOSURE II.

Nature of work to be done.

The investigation and research work to be carried out will pertain to the following principal problems which are arranged in the order of importance :

- (1) The supply of milk from rural areas to big cities:
- (2) Manufacture of condensed milk from whole and separated milk.
- (3) Manufacture of butter from ripened and unripened cream, its packing and transport under tropical conditions.
- (4) Manufacture of commercial casein.
- (5) Improved and economical method of ghee manufacture.

ANNEXURE 1.

Estimates for the first three years of preliminary investigations.

	Amount. Rs.
<i>(i) Estimated Capital expenditure.—</i>	
Alterations to buildings for laboratory	600
Laboratory Equipment	6,500
Plant and machinery as per list	12,000
Cost of transfer of machinery to Anand	500
Total ..	19,600
<i>(ii) Estimated recurring expenditure per year.—</i>	
Cost of establishment as per Annexure II (average)	11,016
Travelling allowance of staff	500
Leave salary	500
Coal and other fuel	4,000
Dairy chemicals, oil, etc.	400
Repairs and upkeep of dairy plant and utensils	400
Purchase of dairy utensils and appliances	550
Purchase of milk	7,000
Chemicals, gas, etc., for laboratory	1,500
Purchase and replacement of laboratory apparatus	950
Freight on dairy produce (transport of samples of milk, butter, etc.)	1,200
Upkeep of buildings	500
Rates, taxes, etc.	300
Stamps, telegrams and stationery	250
Miscellaneous expenses (books, etc.)	500
Contingencies	800
Total ..	30,366

iii) *Estimated receipts per year for the three years of experimental period.—*

	Ra.
By sale of Dairy produce	3,000
Miscellaneous sales	800
Total ..	3,800

N. B.—As the milk will be utilized for experimental purposes the above receipts cannot be guaranteed.

(iv) *Summary of estimated cost for the first three years of experimental period.—*

	Capital expenditure.	Recurring expenditure.	Anticipated receipts.	Net cost of working.
	Ra.	Ra.	Ra.	Ra.
1st year	19,600	30,366	3,800	26,566
2nd year	Nil	30,366	3,800	
3rd year	Nil	30,366	3,800	
		91,098	11,400	

ANNEXURE II.

List of establishment required for the first three years of preliminary investigations.

	Ra.
1 Manager	200—25—250
1 Supervisor	100—10—130
1 Accountant typist	60
1 Mistry with boiler certificate	75
1 Boiler man	25
1 Dairy Jemadar	35
2 Dairy workers	20 (each)
1 Sweeper	12
1 Chowkidar	15
1 Peon	12
1 Chemist	175—25—225
1 Assistant chemist	75—10—95
2 Laboratory boys	12 each
	Per month. Per annum.
	Ra. Ra.
Total 1st year	848 10,176
2nd year	918 11,016
3rd year	998 11,976
Average for three years	11,016

ANNEXURE III.

Specification of plant and machinery required for the first three years of preliminary investigations.

- 1 Electric refrigerator unit.
- 2 Galvanized iron round bottom washing tank.
- 1 Milk separator 40 lbs. capacity motor driven.
- 1 Butter churn 40 lbs. capacity.
- 1 Polar type cream and milk cooler 40 gallons capacity with milk pan.
- 2 Small power electric motors.
- 1 Set chloride storage battery 110 volts.
- Crystalizing vat, etc., for the existing milk condensing plant.
- 6 Insulated milk cans.
- 1 Hand tinning machine.
- 1 Starter making unit.
- 1 Brine evaporation coil tank.
- 1 Milk clarifier small size.
- 1 4 cycle Kerosine oil engine of sufficient power.
- Necessary shafting, pulley, belts, etc.
- Necessary electric wirings, etc., for switch boards.

APPENDIX XLIV.

SUBJECT No. 40.

IMPROVEMENT OF THE STANDARD OF EDUCATION IN THE EXISTING VETERINARY COLLEGES IN INDIA.

Attention is invited to the enclosed note (Enclosure I) circulated to the Veterinary members of the Advisory Board on the subject mentioned above. The Veterinary members at their informal meeting held on the 19th July 1932, adopted a resolution (Enclosure IV) recommending the appointment of an expert committee consisting of the members named therein to consider the question. The proposal is now submitted for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

SIMLA ;

Dated the 21st July 1932.

ENCLOSURE I.

IMPROVEMENT OF THE STANDARD OF EDUCATION AT THE EXISTING VETERINARY COLLEGES IN INDIA.

Attention is invited to the attached letter (and enclosures) No. F. 101-A./32, dated the 6th July 1932 (Enclosure II) from the Education, Health and Lands Department on the above mentioned subject. The Education, Health and Lands Department in their circular letter No. 1857-Agri., dated the 5th December 1931, to all the Local Governments and Administrations referred the following two proposals for their views :

- (i) To enable students to start with purely veterinary subjects immediately on their joining a veterinary college and to take up such subjects as pathology, bacteriology and parasitology, the entrance qualification at all veterinary colleges in India should in future be the F. Sc. (Medical Group), Punjab, or equivalent standard.
- (ii) The courses of veterinary instruction at all the colleges at which this standard is insisted on should be of three years duration, and should be confined to veterinary subjects proper, English being the medium of instruction.

The replies received from the Local Governments and Administrations have been tabulated Enclosure III. The Government of India have now asked for the advice of the Council on the above proposals, which are submitted for the consideration of the Committee.

CHARAN DAS,

Secretary.

SIMLA ;

The 13th July 1932.

ENCLOSURE II.

COPY OF A LETTER NO. F. 101-A./32, DATED THE 6/11TH JULY 1932, FROM THE DEPUTY SECRETARY TO THE GOVERNMENT OF INDIA, DEPARTMENT OF EDUCATION, HEALTH AND LANDS, TO THE SECRETARY, IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Improvement of the standard of education at the existing veterinary colleges in India.

In continuation of this Department endorsement No. 1872-Agri., dated the 5th December 1931, I am directed to forward a copy of the replies (Annexure I) of Local Governments other than the Government of Burma, to circular No. 1857-Agri. (Annexure II) of the same date in which their views were invited on certain proposals in regard to the improvement of the standard of education at the existing veterinary colleges in India. I am to request that the Imperial Council of Agricultural Research

may consider the replies of local Governments and favour the Government of India with its advice thereon.

ANNEXURE I.

LETTER FROM THE CHIEF COMMISSIONER, DELHI, No. 10790-R. & A., DATED THE 17TH DECEMBER 1931.

SUBJECT.—*Training of the candidates for the Provincial Veterinary Services.*

In reply to your letter No. 1857-Agri., dated the 5th December 1931, I have the honour to say that the principles enunciated in paragraph 3 thereof appear *prima facie* to be sound, but there is no Veterinary College in Delhi and I am prepared to accept the conclusions arrived at by the Punjab Government.

LETTER FROM THE CHIEF COMMISSIONER, AJMER-MERWARA, No. 7186-C./520-CC/29, DATED THE 22ND DECEMBER 1931.

Recommendation made by the Royal Commission on the Agriculture in India for the institution in one of the existing Veterinary Colleges of a course of training for candidates for the Provincial Veterinary Services.

With reference to letter No. 1857-Agri., dated the 5th December 1931, from the Government of India in the Department of Education, Health and Lands, on the subject mentioned above I have the honour to state that the principles stated in paragraph 3 thereof meet with my approval.

LETTER FROM THE CHIEF COMMISSIONER, NORTH-WEST FRONTIER PROVINCE, No. 37, VII-J.-99-REV., DATED THE 22ND JANUARY 1932.

I have the honour to acknowledge the receipt of your letter No. 1857-Agri., dated the 5th December 1931 and in reply to say that as no Veterinary Training College is maintained in this Province, this Administration is not so intimately concerned as others. The principles laid down in paragraph 3 of the Government of India letter are, as far as I can judge, unexceptionable.

LETTER FROM THE SECRETARY TO THE CHIEF COMMISSIONER, COORG, No. 2/120-29, DATED THE 1ST JANUARY 1932.

I am directed to refer to your letter No. 1857-Agri., dated the 5th December 1931, and to say that the principles stated in paragraph 3 of your letter appear to the Chief Commissioner to be suitable. I am, however, to add that as already pointed out in paragraph 5 of Major Loch's letter No. 3020/120-29, dated the 1st November 1929, the training of Veterinary personnel, so far as Coorg is concerned, must depend on the arrangements made in Madras.

LETTER FROM THE GOVERNMENT OF THE CENTRAL PROVINCES, No. 60/992 XIV, DATED THE 12TH JANUARY 1932.

I am directed by the Government of the Central Provinces (Ministry of Agriculture) to refer to Sir Frank Noyce's letter No. 1857-Agri., dated the 5th December 1931, in regard to the improvement of the standard of education at the existing veterinary colleges in India.

2. In reply I am to say that this Government has no veterinary college of its own and its recruits for posts of veterinary assistant surgeons are generally trained at Bombay. This Government, while it approves of the principles stated in paragraph 3 of the letter referred to, apprehends that their immediate application would impose a handicap on those communities which are less advanced in education, and it would therefore prefer to postpone giving effect to the changes recommended for a period of about five years.

M123ICAR

LETTER FROM THE HON'BLE THE AGENT TO THE GOVERNOR GENERAL IN BALUCHISTAN
No. 473/R., DATED THE 29TH JANUARY 1932.

With reference to your letter No. 1857-Agri., dated the 5th December 1931, I am directed to state that the principles stated in paragraph 3 of your letter under acknowledgment meet with the approval of the Hon'ble the Agent to the Governor General in Baluchistan.

LETTER No. 2354-A./28, DATED THE 12TH FEBRUARY 1932, FROM THE GOVERNMENT OF BOMBAY.

VETERINARY EDUCATION.—*Revision of Course of instruction at Veterinary Colleges.*

With reference to your letter No. 1857-Agri., dated the 5th December 1931, I am directed by the Government of Bombay (Transferred Departments) to state that they approve of the principle of raising the standard of preliminary education at the veterinary colleges by raising the entrance qualifications and confining the study to purely veterinary subjects. The scheme would, however, necessitate replacement of the most of the existing staff of veterinary colleges by first class teachers of really good education and scientific attainments, and would also necessitate improvement in existing equipment and buildings. It would not, therefore, be possible during the prevailing financial stringency to give effect to the scheme. The course suggested in paragraph 3 of the Government of India's letter will however, be kept as an ideal to be worked up to in the future as funds are available.

LETTER No. 520-D., DATED THE 19TH FEBRUARY 1932, FROM THE GOVERNMENT OF THE PUNJAB.

I am directed to indicate that the Punjab Government (Ministry of Agriculture) approves of the principles detailed in paragraph 3 of your letter No. 1857-Agri., dated the 5th December 1931, for the improvement of the standard of education at the existing Veterinary Colleges in India.

LETTER No. 105-I., DATED THE 29TH FEBRUARY 1932, FROM THE GOVERNMENT OF THE UNITED PROVINCES.

Improvement of the standard of education in the existing veterinary colleges in India.

With reference to your letter No. 1857-Agri., dated December 5, 1931, on the above subject, I am directed to state, for the information of the Government of India, that the Government approve of the principles stated in paragraph 3 of the letter.

LETTER No. 1270, DATED THE 10TH MARCH 1932, FROM THE GOVERNMENT OF BENGAL.
Training of Assistant Veterinary Surgeons curriculum—for appointment of a committee of experts to draft—.

I am directed to refer to the correspondence resting with your letter No. 1857-Agri., dated the 5th December 1931, on the subject mentioned above.

2. In reply, I am to say that for sometime past the question of revision of the curriculum of the Bengal Veterinary College has been engaging the attention of the Government of Bengal (Ministry of Agriculture). The matter was referred to the Board of Examiners of the College who recommended that pending examination of the whole question by the Veterinary Committee of the Imperial Council of Agricultural Research the sanctioned curriculum of the college should be continued and this was accepted by the Government. The Government of Bengal (Ministry of Agriculture), therefore, welcome the proposal of the Government of India to take immediate steps for the improvement of the standard of education at the existing Veterinary Colleges.

3. As regards the formulas mentioned in paragraph 3 of your letter to which the approval of local Governments is asked for, I am to say that Government in the Ministry of Agriculture have given their careful consideration to the question of raising the standard of qualification for entrance to Veterinary Colleges to the F. Sc. (Medical Group), Punjab, or its equivalent. At present the entrance qualification at the Bengal Veterinary College is matriculation or its equivalent but the rules do not debar admission of non-matriculates, who are otherwise suitable, whilst there is always a small number of graduates and I. A. or I. Sc. students on the rolls. The scale of pay of veterinary assistant surgeons in Bengal is Rs. 50—10/5—100 and difficulty has been experienced in the past to obtain the requisite number of students in view of a career with a maximum pay of Rs. 100 being unattractive. It is apprehended that it will be still more difficult to attract a sufficient number of candidates with an equivalent of F. Sc. qualification, i.e., I. Sc. in Bengal, with the result that the scope and activities of the College will be seriously crippled. The Government of Bengal (Ministry of Agriculture) are, therefore, of opinion that no fixed qualification is desirable but that the standards of entrance qualification and curricula should be so adjusted as to suit the need for veterinary aid in the different provinces and the pay and prospects that can be offered. This Government have no objection to the proposal that the courses of veterinary instruction should be of 3 years' duration and should be confined to veterinary subjects proper, English being the medium of instruction. This procedure is actually followed in the Bengal Veterinary College.

—

COPY OF LETTER No. 725-D., DATED THE 19TH MARCH 1932, FROM THE GOVERNMENT OF
BIHAR AND ORISSA.

I am directed to refer to your letter No. 1857-Agri., dated the 5th December 1931 in which the Government of India desire to know whether the local Government approve of the following principles, formulated at an informal meeting of Veterinary officers, held at Simla :—

- (1) that to enable students to start with purely veterinary subjects immediately on their joining a Veterinary College and to take up such subjects as Pathology, Bacteriology and Parasitology, the entrance qualification at all Veterinary Colleges in India should in future be the F. Sc. (medical group), Punjab, or equivalent standard ; and
- (2) that the courses of veterinary instruction at all the colleges at which this standard is insisted on should be of three years' duration, and should be confined to veterinary subjects proper, English being the medium of instruction.

2. In reply, I am to say that the entrance qualification for the Bihar and Orissa Veterinary College, Patna, is the matriculation examination or its equivalent standard, which is also the qualification for admission to the engineering and medical schools in the Province.

The course is a three years' course with English as the medium of instruction. The subjects include, besides purely veterinary subjects, elementary chemistry and general biology which it is necessary to teach in the first year in view of the entrance qualification.

3. The scale of pay of veterinary assistant surgeons in Bihar and Orissa, is Rs. 50—10/5—80 with two senior grades of Rs. 100 and Rs. 125, and the number of posts is strictly limited. In the circumstances, the local Government are inclined to think that it would be difficult to expect students to read up to the F. Sc. (medical group), Punjab, or equivalent standard and then take up a specialised course of 3 years to qualify for an appointment on a starting pay of Rs. 50. While, therefore, the local Government are generally in agreement with the principles stated in paragraph 1 above, they consider that it would be inadvisable at present to prescribe a more elaborate course with a higher entrance qualification, at any rate, so far as the veterinary college in this province is concerned.

COPY OF LETTER No. 830, DATED THE 8TH APRIL 1932, FROM THE GOVERNMENT OF ASSAM, EDUCATION DEPARTMENT.

SUBJECT.—*Improvement of the standard of education at the existing veterinary colleges.*

I am directed to refer to your letter No. 1857-Agri., dated the 5th December 1931, and to say the Government of Assam agree that it is desirable to improve the training of veterinary assistant Surgeons. Financial considerations appear, however, to be involved, and are important at the present juncture. They consider that the entrance qualification for the Veterinary colleges should be at least the I. Sc. (Calcutta) and consider that they would be able to obtain candidates of this standing for posts on the present pay.

2. The Assam Government understand that the F. Sc. (Medical Group), Punjab, is not only possibly of a higher standard than the I. Sc. (Calcutta) but include compulsory subjects which the Colleges in Assam are not at present in a position to teach. The proposal therefore to raise the standard of admission to the Veterinary colleges to the F. Sc. (Medical Group), Punjab, or equivalent standard would, even if the revised courses in the Veterinary colleges involved no serious increase in cost of training, cause inconvenience to this Province in view of the present financial obstacles to the provision of new affiliations.

3. The Government of Assam would have no objection to the application of the proposed standard and veterinary courses to the district veterinary Surgeons advocated by the Agricultural Commission to whom, indeed, they appear more adopted than to Veterinary Assistant Surgeons of the present class. The scale in Assam runs from Rs. 55 to Rs. 135 with a selection grade on Rs. 150 and is applicable to all the staff of the department except four inspectors who have a similar training.

LETTER FROM THE GOVERNMENT OF MADRAS, No. 276 MS., DATED THE 25TH FEBRUARY 1932.

VETERINARY COLLEGES.—*Training of candidates for Provincial Veterinary Service.*

With reference to your letter No. 1857-Agri., dated the 5th December 1931, on the above subject, I am directed to state that this Government are generally in agreement with the conclusions arrived at the informal meeting of veterinary officers at Simla and mentioned in paragraph 3 of your letter and agree to the suggestion that the question of drafting a suitable curriculum may be referred to a committee of experts as recommended by the Royal Commission on Agriculture.

2. In this connection, I am to state for the information of the Government of India that the revised curriculum to which reference was made in Mr. Ramamurti's letter No. 2128, dated the 29th November 1929, has been in force at the Madras Veterinary College since July 1930. A copy of the proceedings of this Government No. 782-Development, dated the 7th April 1930 on the above subject is enclosed for the information of the Government of India.

GOVERNMENT OF MADRAS, DEVELOPMENT DEPARTMENT.

G. O. No. 782, 7TH APRIL 1930.

Veterinary College—Revision of curriculum—Orders passed.

READ—the following papers :—

I

LETTER FROM F. WARE, Esq., F.R.C.V.S., I.V.S., DIRECTOR OF VETERINARY SERVICES TO THE SECRETARY TO GOVERNMENT, DEVELOPMENT DEPARTMENT, DATED MADRAS THE 14TH MARCH 1929, R.O.C. No. 1159-A/28.

I have the honour to address Government in regard to the revision of the curriculum of the Madras Veterinary College.

2. In the first place I would refer Government to Mr. Aitchison's letter R.O.C. No. 530 A/27, dated 12th September 1927, which details the events which led up to proposals for improving the courses at the different Indian Veterinary Colleges, and makes proposals

for raising the course at the Madras Veterinary College from three years to four years. Since the issue of that letter this question has been examined and reported on by the Linlithgow Commission and their conclusions, which are embodied in paragraphs 255 and 256 of their report, are that while the course for training Veterinary Assistant Surgeons needs revision the length of it should not extend beyond three years. In view of the above it is necessary to modify one's previous views on this subject, and the proposals below are an attempt to carry the recommendations of the Linlithgow Commission into effect. In his letter quoted above Mr. Aitchison stated that for the four years course proposed by him it would be necessary to obtain students who had already passed their Intermediate in Science, offer them stipends of Rs. 20 per mensem instead of Rs. 15, and start them on an initial pay of Rs. 100 per mensem. Now that the course is to be left at three years, these proposals need not be adopted for the majority of the students. I would suggest that the preliminary educational standard be kept at a S. S. L. C. with 45 per cent. of English, the stipends remain at 40 a class of Rs. 15 each, and the initial pay for these men remain at Rs. 60 per mensem, but there is no doubt of the great advantage which a better preliminary education confers, and to encourage some of such men to join this profession I would recommend that those who have passed the Intermediate Science examination at a recognized University be given three years seniority for pay and promotion, and Science graduates five years similar seniority, on appointment to this department.

3. In attempting to crowd into three years what should really be taught in five, I wish to emphasize the very great responsibility this throws on the lecturing staff. However well the syllabus for each subject may be devised, it will fall on the Lecturer concerned to deliver his lectures and carry out his practical classes in such a way that the students are not crammed and yet are made thoroughly conversant with the fundamentals of each subject. The Linlithgow Commission recognized this, and in paragraph 259 of their report refer to the necessity of drawing no distinction between the standard required for teachers for the provincial colleges and those teaching the students in the five years degree course. They go on to say that the teachers selected should be expected to engage also in research and be placed in the new Superior Provincial Service.

4. In designing this revised curriculum my aim has been to include all the essential subjects, and to do this I have had to sacrifice in part some of the older ones. This is particularly the case with Anatomy, which I propose to attempt to teach in one year instead of two. It is no doubt easy to criticise this decision, but on the other hand a veterinary course which does not include Organic Chemistry, Zoology, Pathology and Parasitology is such only in name. In view of the short time which can be spread for each subject I have made special provision for practical classes, for it is a well-known fact that a student remembers of what he sees and does far more than of what he is told. When drawing up a syllabus for each subject special attention will be given to the question of cattle, as desired by the Commission. The curriculum which I propose is based on the assumption that there will be 30 full weeks available during the year for teaching purposes, each week consisting of twenty hours made up of four hours a day for five days. This excludes the time, 7—30 A.M.—9 A.M., spent each morning by all the students doing clinical practice, and in addition to this, each student before appearing for his examination in classes B and C should produce a certificate to the effect that he has spent at least six weeks of the long vacation seeing practice either at the Madras Veterinary College hospital or some other recognized veterinary hospital.

5. The proposed curriculum is as follows:—

Class.	Subject.	Weekly.	Lectures.	Practical.	Total.
A 1	Anatomy	10	60	240	300
2	Chemistry—Inorganic and Organic ..	4	60	60	120
3	Biology—Botany and Zoology ..	3	60	30	90
4	Handling of animals	3	..	90	90
					600

B 1	Histology and Embryology	2	30	30	60
2	Physiology including Bio-Chemistry ..	4	90	30	120
3	Pathology, Bacteriology and Immunology	5	90	60	150
4	Parasitology including Protozoology ..	2	30	30	60
5	Pharmacology including Materia Medica	5	60	90	150
6	Surgical Anatomy and Shosing ..	2	..	60	60
					600
<i>Note.</i> —Nos. 1 and 2 and Nos. 3 and 4 will be examined together.					
C 1	Surgery, including Obstetrics, Soundness and Jurisprudence.	8	90	150	240
2	Therapeutics and Toxicology	5	90	60	150
3	Preventive Medicine, including meat and milk inspection and Sanitary law.	4	90	30	120
4	Hygiene, including Genetics and Nutrition	3	90	..	90
					600

Note.—(a) 150 hours practical in Surgery includes times for two hours clinical and one hour for major operations a week.

(b) 60 hours practical in Therapeutics provides for two hours clinical a week.

(c) No special time is allotted for post mortem examinations, but the Lecturer in Pathology will hold classes in these whenever possible.

To teach this curriculum I consider seven lecturers, excluding the Principal of the College, will be required, as follows:—

	Hours weekly.
Lecturer in Anatomy—Anatomy and Histology	12
Lecturer in Physiology—Chemistry and Physiology	8
Lecturer in Parasitology—Biology and Parasitology	5
Lecturer in Pathology—Pathology, etc.	5
Lecturer in Surgery—Surgery, Shosing and Handling	13
Lecturer in Pharmacology—Pharmacology and Therapeutics	10
Lecturer in Hygiene—Hygiene and Preventive Medicine	7
	60

In order to help him prepare material for and demonstrate during the practical classes each of the above will require an assistant Lecturer. Those required for the Lecturers in Pathology and Parasitology will be taken from the existing staff of the Laboratory and the 3 Lecturers and 2 assistant Lecturers at present employed at the College will supply the assistants for the other 5 Lecturers. The Lecturer in Anatomy will require a whole-time assistant as he has a great deal of preparation work to do, not only in connexion with subjects for dissection but in cutting sections for the Histology class. The Assistant Lecturers in Surgery, Pharmacology, Physiology and Hygiene will be required to hold charge of the three hospital wards at the Madras Veterinary College and run the branch dispensary at Rayapuram, as at present, in addition to their other duties. It will be observed that the Lecturers with the least teaching work to do will be those in Pathology, Parasitology, Physiology and Hygiene. The first three will also have work to do in connexion with the post-graduate course, which runs for 6 months each year, and it is from the first two from

whom we hope to obtain most results in research. The Lecturer in Hygiene will usually hold the post of Resident Veterinary Officer, in addition to his other duties, and also be in charge of the Library.

6. It only remains for me to refer to the question of the Principal, whom I propose to relieve of all teaching work, and in this connexion I would refer Government to my letter R. O. C. No. 32-B/29, dated 5th February 1929. As I have explained there, it would, in my opinion, be a great mistake to ask the Principal to do any teaching work in addition to the multifarious and responsible duties in connexion with administration and direction which will fall to his lot under such a reorganized institution as is contemplated in this letter. It is quite certain that he would not be able to do justice to his subject, and at the same time perform his administrative duties in an efficient manner.

7. It has already been stated that the Lintithgow Commission have recommended that specially trained men capable of carrying out independent research in addition to teaching should be obtained for these Lecturers' posts and that they should be placed in the Superior Provincial Service. Until the new five years degree course men are available, it may be taken that only those men who have a very good past record and have taken an approved post-graduate course of study outside Madras could be considered suitable for such posts, but I wish to introduce this new curriculum on 1st July 1930, and to do this it will be necessary to make temporary arrangements, in some cases, until properly trained men are available. The posts of Lecturer in Surgery and Pathology are already held by officers of the Imperial Service and I anticipate that on that date I shall be able to find a suitable officer for the Superior Provincial Service to fill the post of Lecturer in Hygiene. For the other four lecturerships I propose that posts in the ordinary Provincial Service be created for the time being, and that these be filled by the most promising senior men from amongst the subordinate ranks. A much higher standard of teaching than hitherto, will be required and they should therefore be given this promotion.

The net result of these proposals will be that on 1st July 1930 the staff at the Madras Veterinary College will be increased by one officer or the proposed Superior Provincial Service and three officers of the ordinary Provincial Service and I append a statement showing the extra cost involved during 1930-31 and another showing the ultimate average cost, when all the seven Lecturers' posts are borne on the cadre of the Superior Provincial Service. The pay of the Principal has been omitted as it has been proposed in this office letter R. O. C. No. 32-B/29, dated 5th February 1929 that he should be placed on a special rate.

8. I request Government to favour me with their orders on the subject at an early date, as in the event of my proposals being accepted a detailed syllabus for each subject, a very laborious proceeding, will have to be prepared in consultation with the Principal of the College.

ENCLOSURES.

(1)

Statement showing the extra cost that will be involved during the year 1930-31 owing to proposed revision of the curriculum at the Madras Veterinary College from 1st July 1930.

Present staff.	Existing scale.	Average cost per month.
	Rs.	Rs.
Professor of Surgery ..	350—1,250, Indian Veterinary Service <i>plus overseas pay</i>	L190
Professor of Pathology ..	350—1,250, Indian Veterinary Service ..	917
Assistant Professor and Personal Assistant to the Principal, Madras Veterinary College.	250—25—750, Madras Veterinary Service ..	537
		2.644

Proposed staff.	Scale of pay.	Average cost per mensem.
	Ra.	Ra.
Lecturer in Surgery ..	350—1,250, Indian Veterinary Service scale plus overseas pay	1,190
Lecturer in Pathology ..	350—1,250	917
Lecturer in Hygiene ..	Superior Provincial Service, 350—1,500 ..	953
Lecturer in Anatomy ..	} Ordinary Provincial Service, 250—25—750 (537×4) or	2,148
Lecturer in Physiology ..		
Lecturer in Parasitology ..		
Lecturer in Pharmacology ..		
		<u>5,208</u>

Rs. 5,208 minus 2,644 or 2,564 per mensem.

Extra cost in 1930-31 from 1st July 1930 .. Rs. 2,564×8=20,512 or 20,500.

(2)

Statement showing the ultimate average cost when all the seven Lecturers' posts in the above statement are borne on the cadre of the Superior Provincial Service.

Present cost	Rs. 2,644 per mensem.
Proposed cost—	
Seven Lecturers of Anatomy, Physiology, Parasitology, Pathology, Surgery, Pharmacology and Hygiene at Rs. 953 per mensem	6,671 ..

II

OFFICIAL MEMORANDUM NO. 1216-III/29-1, DEVELOPMENT, DATED 24TH SEPTEMBER 1929.

The Government generally agree with the suggestions of the Director as regards preliminary educational standard required for admission into the College and the desirability of encouraging Intermediates and Graduates in Science to join the College with the assured prospect of a higher starting pay. The Director is requested to report how many students of the latter class he proposes to admit every year. The Government also accept the curriculum proposed but consider that the Principal in addition to general supervision should take up teaching work in his own subject and that, excepting the two Professors in Surgery and Pathology belonging to the Indian Veterinary Service, the other four Lecturers required may be on the scale of the ordinary Provincial Service. They do not consider that for the present there is any need to have a Lecturer in Hygiene on the superior scale. The Director is now requested to report the subject which the Principal can teach and to consider whether the extra cost of the scheme as now modified may not be met by abolishing or reducing the stipends now given to the students. It is requested that a reply to this reference may be submitted to Government within a week.

S. V. RAMAMURTI,
Secretary to Government.

To the Director of Veterinary Services.

III

LETTER FROM T. J. HURLEY, Esq., M.R.C.V.S., D.V.S.M., I.V.S., ACTING DIRECTOR OF VETERINARY SERVICES, TO THE SECRETARY TO GOVERNMENT DEVELOPMENT DEPARTMENT, DATED MADRAS, THE 29TH SEPTEMBER 1929, D. DIS. NO. 1590-A/29.

[Reference.—Government Memorandum No. 1216-III/29-1, dated 24th September 1929.]

I have the honour to state that according to the proposals submitted to Government for the revision of the curriculum, Intermediates and Science Graduates will get three years

and five years seniority respectively. This concession with stipends should naturally give sufficient impetus for these candidates to seek admission into the Veterinary College. With stipends alone this year, 5 Graduates and 64 Intermediates applied for admission. As it is desirable to have candidates with higher preliminary qualifications, 50 per cent. of the total number, *i.e.*, twenty seats can safely be allotted for Intermediates and Science Graduates. Out of these twenty seats, six can be reserved for Science Graduates and the remaining fourteen for Intermediates.

2. I agree to the proposal that the Principal should, in addition to general supervision, take up teaching work as this will bring him into closer contact with the students.

3. The distribution of work among the various lecturers was done on the understanding that the Principal will have no teaching work. As it is proposed to allot teaching work to the Principal, there is no necessity to have a lecturer in Hygiene in the superior provincial scale.

4. According to the original proposals, the Lecturer in Hygiene is to take up two subjects, *viz.*, Preventive Medicine and Hygiene. As this officer will have the least amount of teaching work, it was also proposed that he should take up the duties of the Resident Veterinary Officer and be in charge of the Library. The subject, preventive medicine, can be allotted to the Principal. The remaining duties of this lecturer cannot possibly be allotted to any of the other lecturers without detriment to their legitimate teaching or research work. I therefore recommend that another lecturer in the ordinary provincial scale may be sanctioned and he will, in addition to teaching Hygiene, be Resident Veterinary Officer, Personal Assistant to the Principal and the officer in charge of the Library.

5. As regards the question of abolishing stipends, I would invite the attention of Government to this office letter No. 1193-A./29, dated 25th September 1929, in which it was pointed out that it was inadvisable to discontinue the grant of stipends. The evil effects of reducing the number of stipends were also brought to the notice of Government in this office letter No. 532-A./27, dated 12th July 1927. I may, however, point out that the proposal to start Intermediates and Science Graduates on a higher scale of pay will be encouragement enough to attract students of the above classes and therefore stipends will be necessary only in the case of the remaining twenty candidates with Secondary School-Leaving Certificates. But I would strongly recommend the continuance of the stipends for another year after the introduction of the revised curriculum and that the number of candidates seeking admission during this period remains as large as it was this year, the question of reducing or abolishing the stipends altogether can be taken up for consideration.

IV

LETTER FROM P. T. SAUNDERS, Esq., O.B.E., M.R.C.V.S., I.V.S., ACTING DIRECTOR OF VETERINARY SERVICES, TO THE SECRETARY TO GOVERNMENT, DEVELOPMENT DEPARTMENT, DATED MADRAS, THE 14TH FEBRUARY 1930, R. O. C. No. 2212-A./29.

I have the honour to state that in accordance with the proposals submitted to Government in regard to the revision of the curriculum of the Madras Veterinary College, it is intended that the new curriculum will be introduced with effect from the commencement of the next session in July 1930.

2. It is obviously impossible to introduce the new curriculum "en bloc" and three separate academic years will be required to bring it entirely into being. Only the subjects taught in the first year will need to be changed, in accordance with the new curriculum, in the ensuing session, *viz.*, 1930-31. In the next year, 1931-32, the subjects of the first and second years will be taught according to the new syllabus and only in the third year, 1932-33, will the final year subjects of the new curriculum be introduced. Thus under this arrangement the College course will be as follows for the first three years:—

		New curriculum.		Old curriculum.
1930-31	.. ..	Class A	.. ..	Classes B and C.
1931-32	.. ..	Classes A and B	--	Class C.
1932-33	.. ..	„ A, B and C	.. ..	New curriculum in complete force in all classes.

Difficulties may, of course, arise in giving effect to the new curriculum in this manner. Two different courses will be in progress during the transitional period and some subjects, e.g., Anatomy, will be difficult to teach in these circumstances. Further, the teaching and subsequent examination of failed students, may create difficulties. These difficulties are not insuperable and can be dealt with as they occur.

3. The subjects to be taught in accordance with the new curriculum, for the first year class in the ensuing session are—

- (1) Anatomy.
- (2) Chemistry (Organic and Inorganic).
- (3) Biology, Botany and Zoology.
- (4) Handling of animals.

New syllabuses for all the subjects have already been drawn up by the Principal and are now being examined by me. Recommendations for the appointment of the requisite staff will be submitted after the receipt of the orders of Government on the proposals, but other arrangements in regard to the equipment, materials, etc., required for giving effect to the new curriculum in July next, should be made sufficiently in advance. I therefore request Government kindly to inform me whether I can instruct the Principal to proceed with the necessary arrangements in anticipation of the sanction of Government to the introduction of the revised curriculum.

V

OFFICIAL MEMORANDUM No. 1216-III/29-5, DEVELOPMENT, DATED 7TH MARCH 1930.

[Reference.—Director of Veterinary Services' letter R. O. C. No. 2212-A./29, dated 14th February 1929—Madras Veterinary College—Curriculum—Revision.]

The Director of Veterinary Services is informed that the scheme of the revision of the curriculum at the Madras Veterinary College has generally been approved by Government and that the necessary arrangements may be proceeded with, provided no expenditure is incurred nor any commitment of such expenditure made until the budget is passed by the Council.

S. V. RAMAMURTI,
Secretary to Government.

To the Director of Veterinary Services.

ORDER—No. 782, DEVELOPMENT, DATED 7TH APRIL 1930.

The question of the revision of the curriculum at the Madras Veterinary College was considered at some length in the light of the recommendations of the Royal Commission on Agriculture. The subject was examined under the three main heads—

- (a) Preliminary educational standard,
- (b) Curriculum of studies,
- (c) Staff,

and the conclusions derived at by Government are as follows.

The preliminary educational standard will be S. S. L. C. with 45 per cent. in English and in order to induce young men with higher educational qualifications to join the College, 14 of the 40 seats in the College will be reserved for Intermediates and six for Science Graduates. On appointment to the department, three years seniority for pay will be given in the case of Intermediates and five years similar seniority in the case of Science Graduates. These men will not however be given stipends as they will be started on a higher initial pay than the ordinary S. S. L. C. holder.

2. The course will extend for a period of three years as it is now but the subjects will be distributed according to the new curriculum as under—

First year—

- (1) Anatomy.
- (2) Chemistry—Inorganic and Organic.
- (3) Biology—Botany and Zoology.
- (4) Handling of animals.

Second year—

- (1) Histology and Embryology.
- (2) Physiology including Bio-Chemistry.
- (3) Pathology, Bacteriology and Immunology.
- (4) Parasitology including Protozoology.
- (5) Pharmacology including Materia Medica.
- (6) Surgical Anatomy and Shoeing.

Third year—

- (1) Surgery including Obstetrics, Soundness and Jurisprudence.
- (2) Therapeutics and Toxicology.
- (3) Preventive Medicine including meat and milk inspection and Sanitary law.
- (4) Hygiene including Genetics and Nutrition.

3. There will be eight lecturers under the new curriculum including the Principal who, in addition to his work of general supervision, will take up teaching work in his own subject. They will be designated as—

- (1) Principal and Lecturer in Preventive Medicine.
- (2) Lecturer in Pathology.
- (3) „ Surgery.
- (4) „ Hygiene, Resident Veterinary Officer and Personal Assistant to Principal.
- (5) „ Anatomy.
- (6) „ Physiology.
- (7) „ Parasitology.
- (8) „ Pharmacology.

If the Principal cannot teach Preventive Medicine, he may take any other subject and the subjects correspondingly redistributed among the other lecturers. The Lecturer in Hygiene will also be in charge of the Library.

4. Four additional posts of lecturers in the Madras Veterinary Service (250—25—750) are sanctioned with effect from 1st July 1930 in connexion with the above scheme. These posts will be filled by officers with qualifications which have been laid down for recruitment to the Madras Veterinary Service. If such persons are not available, four temporary appointments on the scale of the selection grade of Veterinary Assistant Surgeons will be created in their stead for providing the lecturers needed. The assistants required for each of these lecturers will be found from the existing staff of lecturers, assistant lecturers and laboratory assistants. A post of an attender on Rs. 23—35 and two posts of attendants on Rs. 15—20 are also sanctioned with effect from 1st July 1930. This sanction is registered as No. 130 of 1930-31.

5. Necessary provision of funds has been made in the Budget Estimate for 1930-31, under '34. b. Agriculture—Veterinary—v.-Veterinary College—Pay of officers—Voted', as shown below:—

	Rs.
Four additional lecturers in the Madras Veterinary Service	8,000
One attender (on Rs. 23—35)	184
Two attendants (on Rs. 15—20)	240
Local allowance at Rs. 100 per mensem to the lecturers	3,200
Purchase of animals for dissection	600
Furniture and appliances	400
Apparatus and chemicals required	5,000
Microscopes 20 at £20, and 10 at £30 and other appliances	10,000

The Director of Veterinary Services is requested to employ only so much of the additional staff as is absolutely required in the first year and surrender any savings in the provision made in the budget.

(By order of the Government, Ministry of Development).

S. V. RAMAMURTI,

Secretary to Government.

To the Director of Veterinary Services.

„ Accountant-General, through Finance Department.

„ Finance Department.

(ANNEXURE II).

COPY OF LETTER NO. 1857-AGRI., DATED THE 5TH DECEMBER 1931, FROM THE SECRETARY TO THE GOVERNMENT OF INDIA, DEPARTMENT OF EDUCATION, HEALTH AND LANDS, TO ALL LOCAL GOVERNMENTS AND ADMINISTRATIONS.

I am directed to refer to the correspondence ending with the local Government's
your
 letter No. *2128-Ms. dated the 29th November 1929, on the subject of the recommenda-
 etc., etc.,
 tion made by the Royal Commission on Agriculture in India for the institution at one of the existing Veterinary Colleges of a course of training for candidates for the Provincial Veterinary Services.

2. The recommendation was, generally speaking, accepted by all local Governments, but the majority of them made it clear that they are unable to proceed with the expansion of their Provincial Veterinary Services while present financial conditions continue. The Government of India now find themselves for the same reason unable to proceed with the recommendation at present. The cost of proceeding with it has been roughly worked out, and it is estimated that it would amount immediately to a non-recurring expenditure of Rs. 1,325 and a recurring expenditure of Rs. 70,760, and ultimately to a non-recurring expenditure of Rs. 86,825 (if an additional hostel for students had to be built at Lahore, which would probably be selected as the site), and to a recurring expenditure of Rs. 1,02,470, exclusive of the cost of a dairy which would probably be required as an adjunct to the College. The Government of India could not find such sums at present, even if they accepted them as a legitimate charge on central revenues and, as local Governments are evidently not in a position to do so, the scheme cannot be proceeded with. It has been decided, therefore, to defer further consideration of proposals for the provision of higher veterinary education in this country indefinitely for the present.

3. Notwithstanding this decision, the Government of India see no reason why immediate steps should not be taken to improve the standard of education at the existing Veterinary colleges. In this connection, I am to invite attention to paragraph 256 of the Re-

* Not printed.

port of the Royal Commission on Agriculture, in which it was recommended that the framing of a suitable curriculum for the training of Assistant Veterinary Surgeons should be referred to a body of experts. The question was recently discussed at an informal meeting of Veterinary officers held at Simla, who arrived at the following conclusions :—

- (1) that, to enable students to start with purely veterinary subjects immediately on their joining a veterinary college and to take up such subjects as pathology, bacteriology and parasitology, the entrance qualification at all veterinary colleges in India should in future be the F. Sc. (Medical Group) Punjab, or equivalent standard ; and
- (2) that the courses of veterinary instruction at all the colleges at which this standard is insisted on should be of three years duration, and should be confined to veterinary subjects proper, English being the medium of instruction.

4. The Government of India will be glad to know whether the principles stated in paragraph 3 above meet with the approval of the local Government. If these principles are ^{your approval} generally approved, the Government of India propose to proceed further with the case requesting the Imperial Council of Agricultural Research to appoint a committee of experts, as suggested in the recommendation referred to above, to draft a suitable curriculum for all veterinary Colleges. I am to request that the views of the local Government ^{your views} in the matter may kindly be communicated as soon as convenient.

ENCLOSURE III.

Summary of replies received from the local Governments and Administrations to the proposals referred to them by the Government of India in the Education, Health and Lands Department, regarding improvement of the standard of education, at the existing veterinary colleges in India.

Proposals referred to the local Governments and Administrations.	Local Governments and Administrations replying.	Summary of replies.
(1) To enable students to start with purely veterinary subjects immediately on their joining a veterinary college and to take up such subject as pathology bacteriology and parasitology, the entrance qualification at all veterinary colleges in India should in future be the F. Sc. (Medical Group) Punjab, or equivalent standard. (2) The courses of veterinary instruction at all the colleges at which this standard is insisted on should be of three years duration, and should be confined to veterinary subjects proper, English being the medium of instruction.	Madras Government	Approves the principles. A revised curriculum has already been in force at the Madras Veterinary College since July 1930.
	Bombay Government	Approves the proposal, but remarks that the scheme which would necessitate replacement of most of the existing staff of veterinary colleges by teachers of really good education and scientific attainments and also improvement in existing equipment and buildings, cannot be given effect to immediately on account of the prevailing financial stringency.
	Bengal Government	Remarks that no entrance qualification should be fixed but that the standard of entrance qualification and the curriculum should be so adjusted as to suit the need for veterinary aid in the different provinces and the pay and prospects that can be offered. Agrees that the course of veterinary instruction should be of 3 years' duration and should be confined to veterinary subjects proper, English being the medium of instruction.

Proposals referred to the local Governments and Administrations.	Local Governments and Administrations replying.	Summary of replies.
	Government of the United Provinces. Punjab Government Bihar and Orissa Government.	Approves the principles. Do. do. Agrees with the principles but owing to the poor scale of pay of veterinary assistant surgeons in Bihar and Orissa (viz., 50—10/5—80 with two senior grades of Rs. 100 and Rs. 125), the Bihar and Orissa Government, in so far as they are concerned, do not consider it advisable at present to prescribe a more elaborate course with a higher entrance qualification than what is in force at present in that province.
	Central Provinces Government.	Has no veterinary college. Recruits for posts of veterinary assistant surgeons are generally trained at Bombay. While approving the principles, apprehends that their immediate application would impose a handicap on those communities which are less advanced in education and therefore prefers to postpone giving effect to the changes for a period of about 5 years.
	Assam Government	Agree that it is desirable to improve the training of veterinary assistant surgeons but considers that entrance qualification for the veterinary colleges should be at least the I. Sc. (Calcutta). That Government understands that the F.Sc. (Medical Group), Punjab, is not only possibly of a higher standard than the I. Sc. (Calcutta) but includes compulsory subjects which the colleges in Assam are not at present in a position to teach and would therefore cause inconvenience in view of the present financial obstacles to the provision of new affiliations. The Government of Assam would not also object to the application of the proposed standard and veterinary courses to the district veterinary surgeons advocated by the Agricultural Commission to whom they appear more adopted than to veterinary assistant surgeons of the present class.
	N. W. F. P. Government.	Although not much concerned, as there is no veterinary college in the province, the N. W. F. P. Government considers the principles unexceptionable.
	Ajmer-Merwara ..	Approves the principles.
	Baluchistan ..	Approves the principles.
	Coorg ..	Considers the principles suitable and adds that so far as Coorg is concerned the training of veterinary personnel must depend on the arrangements made in Madras.
	Delhi ..	<i>Prima facie</i> the proposals appear to be sound. There is no veterinary college in Delhi. Prepared to accept the conclusions arrived at by the Punjab Government (which approves the principles).

ENCLOSURE IV.

INFORMAL MEETING OF VETERINARY OFFICERS AT THE ANIMAL HUSBANDRY EXPERT'S ROOM, ROCK HOUSE, SIMLA, DATED 19TH JULY 1932.

After discussing the replies of the Local Governments and Administrations which had been approached for their views in Education, Health and Lands Department letter No. 1857-Agri., dated the 5th December 1931 copies of which were placed before the meeting, it was agreed that the following resolution should be submitted to the Advisory Board for acceptance, viz. :—

This Board recommends that the Expert Committee recommended by the Royal Commission on Agriculture in India be now formed to draw up a curriculum for a three year course of veterinary instruction, at all veterinary colleges in India, excluding Burma, in accordance with the two proposals made in letter No. 1857-Agri., dated 5th December 1931, the principles of which have been generally agreed to by the Local Governments and Administrations addressed. The Board suggest that the composition of the Committee be as follows :—

- Colonel A. Olver, Animal Husbandry Expert.
- Mr. F. Ware, Director, Imperial Institute of Veterinary Research.
- Mr. W. Taylor, Principal, Punjab Veterinary College.
- Mr. A. D. McGregor, Principal, Bengal Veterinary College.
- Mr. R. T. Davis, Principal, Bihar and Orissa Veterinary College.
- Mr. T. G. Hurley, Principal, Madras Veterinary College.
- Mr. V. R. Phadke, Principal, Bombay Veterinary College.

The Board also recommends that the Chairman of the Expert Committee should have powers to co-opt other members in the event of any of the above being unable to attend.

APPENDIX XLV.

SUBJECT No. 30.

Progress Reports on Research Schemes :—

- (a) Scheme for research into properties of colloid soil constituents by Dr. J. N. Mukherjee, Khaira Professor of Chemistry, University of Calcutta.
- (b) Scheme for statistical investigations on experimental errors in field trials, by Mr. P. C. Mahalanobis, Professor, Presidency College, Calcutta.
- (c) Report for the year 1931-32 on the 'Effect of Ions on the Growth of Plants' by Dr. S. S. Bhatnagar.
- (e) Report on the work done in the Agricultural Research Section of the Department of Chemistry, Dacca University, Dacca, during 1930-31 and 1931-32, in connection with the scheme for agricultural research sanctioned by the Imperial Council of Agricultural Research.
- (f) Report of the investigations carried out by Dr. A. N. Puri, on the standardization of Physico-Chemical Single Value measurements most suitable for Indian soils.

Report of the Committee appointed by the Imperial Council of Agricultural Research to examine progress reports of —

- (a) the scheme for research into the properties of colloid soil constituents by Dr. J. N. Mukherjee, University of Calcutta.
- (b) Professor Mahalanobis' scheme for statistical investigation of experimental errors in field trials.
- (c) Dr. Bhatnagar's scheme, on the effect of ions on the growth of plants.
- (e) the Dacca University scheme.
- (f) Dr. Puri's investigations.

The following were present :—

1. Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, *Chairman*.
2. Mr. A. G. BURT.
3. Mr. P. H. CARPENTER.
4. Professor J. C. GHOSH.
5. Dr. G. P. HECTOR.
6. Mr. T. F. MAIN.
7. Dr. W. McRÆ.
8. Mr. D. MILNE.
9. Mr. D. R. SETHI.
10. Dr. F. J. SHAW.

Rai Sahib Malik CHARAN DAS, *Secretary*.

The Committee sat from 3 P.M. to 4-30 P.M.

30. (a) Progress report on scheme for research into properties of colloid soil constituents by Dr. J. N. Mukherjee, University of Calcutta (Enclosure I) was recorded.

30. (b) Scheme for statistical investigations on experimental errors in field trials, by Professor Mahalanobis.—(Enclosure II).

Mr. Carpenter advised that Professor Mahalanobis might be consulted in laying out the plots in the fruit schemes as he had found with tea that it was extremely difficult to lay out experimental plots in a permanent crop, both with regard to the number of trees and arrangement of plots, so that they would be statistically significant. Loca

Governments had been informed of the facilities offered by Professor Mahalanobis and cases were stated where advantage was being taken of the offer. Mr Main thought it important to work out the minimum size of plot suitable for the most important crops.

30. (c) *Report for the year 1931-32 on the 'effect of ions on the growth of plants' by Dr. S. S. Bhatnagar.*—(Enclosure III).

Professor Ghosh drew attention to the fact that plants under experiments died after 6 weeks and suggested that this period be looked into with a view to eliminate the adverse factors. Dr Shaw suggested that dry weight of plants would be a more suitable measure than length of the plant and Mr. Milne said that Dr. Bhatnagar was now doing this. Mr. Milne suggested that it would give better results if the plots be filled with soil to a depth of 6 feet as roots of crops easily reached this depth. Dr. Shaw suggested that it was necessary to work with pure lines of gram, etc., and that mention of the exact name of the pure line used would enhance the value of the record. Both Dr. Shaw and Mr. Carpenter suggested that more replications in the plot experiment would lead to better results and that Professor Mahalanobi's experience might be invoked in this connection, in order that the work might be statistically significant, Dr. Shaw pointed out that if the weight of seeds were taken at the beginning of the experiment and the weight of the plant at the end, it would be possible to calculate the constant of increase and correlate this with the chemical composition of the nutrient solution.

30. (e) *Report on the work done in the Agricultural Research section of the Department of Chemistry, Dacca University, Dacca, during 1930-31 and 1931-32, in connection with the scheme for agricultural research sanctioned by the Imperial Council of Agricultural Research.*—(Enclosure IV).

Mr. Carpenter drew attention to the figures regarding the effect of drying and thought that they were not statistically significant, hence the deduction that ammonia was the principal substance from which the rice plants derive their supply of nitrogen was only a suggestion. In tea it may happen even on the disappearance of ammonia and nitrogen from considerable quantities to three parts per million the plant lives, develops and give a heavy crop. With regard to the clay and clay plus silt in the dried soil the results of the Puri method are much the same as those of the direct soda method so that it would seem that the presence of sodium chloride had no direct value. With regard to the organic matter, Mr. Carpenter did not like a method that was applicable only provided the organic matter was present within limitations. He would prefer a general method that would apply to all types of soil else misleading results might follow. As hydrogen peroxide cannot be used in this country because of the temperature, he would like to see the work continued using sodium hypochloride or hypo-bromide. Dr. Shaw discussed these points and said he would bear them in mind. With regard to the work done in pots Professor Ghosh said that he had consulted Professor Mahalanobis who had suggested a scheme of field experiment which the Director of Agriculture, Bengal, had allowed to be laid out on the Dacca farm. Mr. Carpenter explained the need for standardisation of methods and considered this an important part of Professor Ghosh's work. He pointed out that it was his opinion that in the range within which a plant will grow, acid reaction tends to produce vegetative growth and alkaline reaction seed production. After discussion of particular points in the work by Dr. Shaw, Mr. Milne and Mr. Carpenter the Committee came to the conclusion that satisfactory progress had been made.

30. (f) *Report of the investigations carried out by Dr. A. N. Puri on the standardization of physico-chemical single value measurements most suitable for Indian soils.*—(Enclosure V).

Mr. Carpenter said he still preferred to use the sedimentation method especially when dealing with a large number of samples as it was a simple method and could be carried out by unqualified assistants after a little training, whereas this could not be done with the technique required for Puri's method. As Professor Ghosh had found it was not applicable to all classes of soil he had put it into a more practical form. Mr. Milne suggested that the method be brought to the notice of chemists in the provincial departments so

that it might be tried out; we could then say if it was applicable to all soils in India; that would be the test of the value of the Puri method.

CHARAN DAS,
Secretary.

The 22nd July 1932.

ENCLOSURE I

SUBJECT No. 30 (a).

SCHEME FOR RESEARCH INTO PROPERTIES OF COLLOID SOIL CONSTITUENTS BY DR. J. N. MUKHERJEE, KHAIRA, PROFESSOR OF CHEMISTRY, UNIVERSITY OF CALCUTTA.

At its meeting held in June 1930 the Advisory Board recommended a scheme for research into properties of colloid soil constituents to be carried out by Professor J. N. Mukherjee of the Calcutta University. The scheme was sanctioned by the Governing Body at its meeting held in July 1930 and was started with effect from the 1st October 1930.

2. Professor Mukherjee has so far submitted three reports (Annexures I—III) on the progress made by him during the period from 1st October 1930 to 31st March 1932.

The reports are now for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

The 23rd May 1932.

ANNEXURE I.

OCTOBER 1930—MARCH 1931.

In a recent paper Mukherjee and Sen (communicated for publication to the Indian Journal of Agricultural Science) have dealt with the titration curves of sparingly soluble acids in relation to the behaviour of clay acids. Their work has been continued under the auspices of a grant from the Imperial Council of Agricultural Research.

Investigation is being carried on the following colloidal systems:—

- (1) Aluminium hydroxide.
- (2) Silicic acid.
- (3) Humic acid.

Some difficulties have been met with in connection with accurate electrometric and conductometric titrations of the above sols. These are being pursued further.

Measurement of charge of silicic acid sol and humic acid sol at different dilutions are being carried out simultaneously by the microscopic method with a proper black background and sideways illumination. Systematic colloid chemical analysis of aluminium hydroxide sol and silicic sol including the determination of the concentration of the different ions, composition of the colloid micelle and intermicellar fluid are in progress.

Most of these are preliminary observations. Further corroborative experiments are in progress and the results will be, later on, communicated for publication.

J. N. MUKHERJEE.

March 1931.

ANNEXURE II.

Mukherjee and Sen (Ind. Journ. Agri. Sci, 1931, 1, 189) have given titration curves of saturated solutions of cinnamic, iso-phthalic and p-toluic acids both in the presence and absence of an excess of the solid phase and for different times of interaction with the alkali. The titration curves resemble those of acids in true solution but show some peculiarities. The values of the dissociation constant depend on the condition of interaction and on the time of interaction. It has also been pointed out that intermicellary electrolytes in aluminium oxide sols play an important part in determining its behaviour with regard to electrolytes.

This work has been continued in the last year with aluminium hydroxide sol, silicic acid sol and humic acid sol. The following gives a summary of the present position :—

Contamination of the sol and the titrating acid or alkali from the carbon dioxide of the atmosphere during the process of titration. To avoid this difficulty the measurements are to be conducted in atmospheres of pure gases (N_2 or H_2). Arrangements to ensure this are nearing completion.

A confirmation of the results obtained by hydrogen electrode with quin-hydrone electrode and also by colorimetric methods is desirable. The accuracy of the methods, the reliability and the reproducibility of the results obtained should be beyond reproach. This has necessitated a certain amount of preliminary work and the knowledge thus gained enables us to say that sufficient attention does not seem to have been paid by earlier workers, to this aspect. The charge of colloidal particles of silicic acid and aluminium hydroxide are being measured using dark background for the illumination of the boundary.

Accurate measurements of the concentration of ions in the intermicellary liquid such as H^+ ion, Cl^- ion, total chloride concentration, etc., are being carried out. Much of our time has been used in obtaining a satisfactory technique for these types of measurements as a confirmation of the results obtained by alternative methods is necessary.

The results so far obtained are as follows :—

Potentiometric and conductometric titration curves of silicic acid sol show definitely that the acid has the character of a much stronger acid than silicic acid in solution where its dissociation constants are supposed to be of the order of 10^{-10} and 10^{-13} . The titration curves of humic acid similarly show that we are dealing with a fairly strong acid. This observation is of considerable interest in relation to our main work.

It is also found (in agreement with work simultaneously published) that the addition of neutral electrolytes changes the pH of the intermicellary liquid of sols like ferric hydroxide and arsenious sulphide. The pH of the ferric hydroxide sol on coagulation with the following electrolytes shows an increasing value in the order $K_2SO_4 > KNO_3 > KBr > KCl$. With arsenious sulphide sol KCl and KBr are found to have almost equal effect.

With aluminium hydroxide sols with dilution the cataphoretic speeds of the particles of the sol increase at the first dilution (1 : 1) and decrease on further dilution (1 : 5). Concentrations of Cl^- ions, H^+ ions, and total chloride of this sol decrease with dilution.

Colloid chemical analysis of silicic acid sol exhibits the fact that concentrations of Cl^- ions, total chloride, H^+ ion, and specific conductivity diminish continually with dilution and also that the observed specific conductivity cannot be accounted for by the partial ionic conductances of the ions in the solution. Silicic acid sol exhibited a marked tendency for floc-formation and for setting to a polydisperse system.

Many agricultural chemists have emphasised the desirability of working with active clay matter of the soil, namely the fraction of colloidal clay obtained from soil by the help of a (Sharples) Super Centrifuge. This machine has far greater centrifugal power than other types of centrifuges.

The advocates of chemical theory of soil acidity lay stress on the similarity of what they call colloidal clay acid with ordinary acids in true solution. Even such systems should however show certain peculiarities on account of the role of surface forces. It is therefore necessary to work with the uniform 'colloidal' clay which has been emphasised to be the active matter and whose reactions are supposed to be responsible for the peculiarities of chemical reactions involved in the results.

Present work.

The works on humic acid, silicic acid, aluminium hydroxide and ferric hydroxide sols are being continued. We are also studying the nature of colloidal solutions of palmitic, stearic, p-toluic, and of similar sparingly soluble acids. The effect of time of reaction, temperature, ultrafiltration, ageing and reaction with acid, alkali and neutral salt solutions on these colloidal systems form part of our investigation. It is expected to communicate a paper shortly for publication.

J. N. MUKHERJEE.

October 1931.

ANNEXURE III.

The work which appeared in the Indian Journal of Agricultural Science (Mukherjee and Sen, 1931, 1, 189) has been continued with aluminium hydroxide, silicic acid and humic acid sols. It was found by preliminary experiments that contamination of the sol and the titrating acid or alkali with the carbon dioxide of the atmosphere produces anomalous results. It appears from the literature that sufficient attention has not been paid to this matter. Besides, the reliability of the pH values obtained by procedures usually adopted in soil investigations requires close investigations. The previous history of the sol, the time of contact of an acid or alkali with the sol the carbon dioxide of the air all these factors have considerable influence on the measurements and in order to examine all these factors it is essentially necessary that simultaneous measurements of the concentrations of H^+ , Cl^- and other constituent ions as also the specific conductivity of the sol should be carried out. Moreover confirmation of the results obtained by alternative methods was found to be desirable.

So far we have been able to obtain an almost successful solution of all these problems. We have devised three apparatus for electrometric titration of sols. One of these is for the potentiometric titrations of the sol in presence of quinhydrone, one for simultaneous measurement of Sp. conductivity and chlorine ion concentration with gradual additions of acid or alkali and a third one for the simultaneous measurement of H^+ ion, Cl^- ion and Sp. conductivity. We have also made arrangements for stocking the sol out of contact with the oxygen or the carbon dioxide of the air. A satisfactory method has been devised for determining the carbonate content of sols. A portion of the results we have obtained by working with aluminium hydroxide sol, silicic acid sol and humic acid sol will shortly be communicated for publication in the Indian Journal of Agricultural Science.

The use of the Sharples Super Centrifuge, which we have just received and fitted up will enable us to take up similar problems connected with the active matter of different samples of actual soil. Mr. R. S. Finlow, C.I.E., B.Sc., F.I.C., Director of Agriculture, Government of Bengal, has very kindly agreed to supply us with the samples we require.

We also propose to carry out the work which we have already in hand, namely, the study of the nature of colloidal solutions of palmitic, stearic and of similar sparingly soluble acids with special attention to the effect of the time of reaction, temperature, ultrafiltration and ageing.

Dr. Wiegner who is working on somewhat allied problems has sent us a set of reprints of papers by himself and his collaborators.

J. N. MUKHERJEE.

March 1932.

ENCLOSURE II

SUBJECT No. 30 (b).

SCHEME FOR STATISTICAL INVESTIGATIONS ON EXPERIMENTAL ERRORS IN FIELD TRIALS BY P. C. MAHALANOBIS, PROFESSOR, PRESIDENCY COLLEGE, CALCUTTA.

At its meeting held in June 1930, the Advisory Board recommended a scheme for statistical investigations on experimental errors in field trials to be carried out by Professor

P. C. Mahalanobis of the Presidency College, Calcutta. This scheme was sanctioned by the Governing Body at its meeting held in July 1930 and was started in July, 1931. Professor Mahalanobis has now submitted his report (Annexure) on the work done during the period from July 1931 to 31st March 1932.

The report (Annexure) is for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 23rd May 1932.

ANNEXURE.

A SHORT REPORT OF THE WORK DONE BY MR. P. C. MAHALANOBIS (IN CONNEXION WITH THE GRANT FROM THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH) DURING 1931-32.

1. Work was started in July, 1931. The first few months were taken up in training the assistants and in organizing the work of the agricultural section.

2. The following two papers were completed and are being published in the Indian Journal of Agricultural Science :—

(i) On the Comparison of Mean Values based on Small Samples.

(ii) A Statistical Note on Rice-Experiments in the C. P.

3. The following notes were drawn up in reply to queries from persons mentioned within brackets.

(i) Percentage Infection of Wilt disease in the Cotton Plant (Mr. G. S. Kulkarn Special Cotton Mycologist, Government Farm, Dharwar).

(ii) Rate of Shedding of Buds, Flowers, and Bolls in the Cotton Plant (Mr. K. V. Joshi, Cotton Physiologist, Surat).

(iii) Manuring Effects on Boll-formation (Mr. K. V. Joshi, Cotton Physiologist, Surat).

Mr. B. C. Burt has suggested (during his visit in April) that some of these notes might be of sufficient interest to other workers. They are, therefore, being re-written with greater emphasis on the statistical methods used in each case, and will be forwarded shortly to the Secretary, Imperial Council of Agricultural Research.

4. Two detailed lay-outs were designed for certain field trials at the request of the authorities of Sriniketan, the Visva-bharati Institute of Rural Reconstruction. (I visited the Surul Farm in this connexion on two occasions). The material will also be analysed very shortly.

5. The following work is in hand :—

(i) A note on the Design of Lay-outs in Field Trials. (Nearly ready).

(ii) An Experimental Study of the Distribution of Treatment—Error Co-efficient (T. E. C.) in Random and Regular Arrangements in Field Trials.

A preliminary note by P. C. Mahalanobis and Subhendu Sekhar Bose was communicated to the Indian Science Congress, January, 1932. Further work is proceeding.

(iii) On certain Statistical Problems in connexion with Studies in Soil Physics (Questions forwarded by N. V. Nanitkar, Soil Physicist to the Government of Bombay, Manjri Farm).

6. I would like to add a few words with regard to the programme for 1932-33.

(a) Work of a more or less theoretical character (e.g., Study of Treatment-Error Co-efficients).

I have several topics in my mind, and will gradually take them up as opportunity permits.

(b) Statistical Problems arising in connexion with experimental work.

Bombay alone appears to be forwarding problems to us. I shall be glad to get similar problems from other provinces, and I hope the Secretary, Imperial Council of Agricultural Research, will kindly draw the attention of the different provincial authorities to this point. I shall also be prepared to offer specific advice regarding the design of field and other experiments.

(c) Analysis of Experimental or other Statistical Material.

I believe I shall be able to offer useful help in this connexion, and I shall be glad to receive material for statistical analysis and interpretation.

(d) Training of Statistical Workers.

I shall be glad to give short courses of specialized training in the analysis of agricultural data (including the handling of calculating machines, etc.), to such officers as may be deputed for this purpose by different provincial Governments or Institutions.

All the services mentioned above will be rendered, of course, free of all costs to the provincial authorities or to the Imperial Council of Agricultural Research.

P. C. MAHALANOBIS.

The 18th April 1932.

ENCLOSURE III.

SUBJECT No. 30(c).

REPORT FOR THE YEAR 1931-32 ON "THE EFFECT OF IONS ON THE GROWTH OF PLANTS" BY DR. S. S. BHATNAGAR.

In October 1930 the Advisory Board recommended, by circulation, an *interim* grant of Rs. 1,600 to Dr. S. S. Bhatnagar for research work on the effect of ions on Plant growth and at its meeting held on the 15th January 1931 the Board supported the main scheme for Rs. 3,000 per year for a period of two years (including the amount of Rs. 1,600 already recommended). These recommendations were accepted by the Governing Body and the scheme was accordingly started with effect from the 15th January 1931. Dr. Bhatnagar has now submitted a report (Annexure) of the work done in connection with the scheme during the period January 1931 to March 1932.

The report is submitted for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 26th May 1932.

ANNEXURE.

REPORT OF THE WORK ON "THE EFFECT OF IONS ON THE GROWTH OF PLANTS" BEING CARRIED OUT AT THE UNIVERSITY CHEMICAL LABORATORIES, LAHORE, UNDER A GRANT FROM THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH FOR THE YEAR FEBRUARY 1931 TO FEBRUARY 1932.

The work was started about the middle of February 1931 in continuation of the experiments on the effect of various inorganic substances on the growth of plants previously carried out by Dr. S. S. Bhatnagar and Mr. R. S. Gupta in these laboratories. The experiments of these workers consisted in transplanting small plants in bottles containing a culture solution and measuring their rate of growth. The results indicated definitely, that a large number of metallic ions when added in the form of nitrates affected the growth of the plants appreciably. Salts of uranium, thorium, cerium, calcium, iron, etc., showed

an increased growth while those of lead and silver were found to have an adverse effect on their growth.

During the year February 1931 to February 1932, similar experiments have been performed on gram, moth, jawar, cotton-seed, peas and barley. In all these cases the effect of more than 20 metallic ions has been investigated. The experiments were simultaneously performed in water culture and in pure silica sand. The presence of the radioactive substances especially of uranium, thorium and cerium showed a very accelerated growth in a number of cases and the effect of these ions is now being investigated in small fields where the conditions for the growth of plants are more natural than in the pots or the bottles containing the culture solution. Investigations on peas, wheat, linseed in the fields are now in progress.

The growth of the plants was found to be very much restricted when grown in pots or in culture solutions, and therefore the rate of growth under these conditions could only be measured during the first two or three weeks of their growth. The experiments in water culture and in sand for these reasons could not be continued for more than two months in any case. These experiments have, however, been successfully completed during the present year and it is hoped that further information on the effect of these ions on the full growth of these plants will be available after the field experiments now in progress have been completed.

The methods of preparing the sand and the culture solutions are described below :—

White sand of a high degree of purity was used and was supplied by the Ceramic Department of the Forman Christian College, Lahore. The purification of the sand was carried on for a number of days. It was first ignited in a muffle furnace to burn off any organic matter. After ignition the sand was analysed and gave the following composition :—

SiO ₂	..	..	..	..	..	..	99.4 per cent.
Al ₂ O ₃	Fe ₂ O ₃	..	..	..	..	..	0.4 per cent.
MgO	..	..	..	..	..	..	0.03 per cent.
Alkalies	..	..	..	..	..	..	0.14 per cent.

About two maunds of this sand were then treated with dilute nitric acid and thoroughly washed with distilled water. It took about 15 days to wash the above quantity of sand. The sand was then dried in porcelain dishes and then filled in the pots which were especially made of pure sand.

Experiments were simultaneously performed in the pots filled with the above quality of sand as well as in bottles containing the culture solution. The culture solution of following composition was used :—

Potassium nitrate	..	..	..	..	..	10.0 gms.
Calcium nitrate	..	..	..	..	..	2.5 gms.
Magnesium nitrate	..	..	..	..	..	2.5 gms.
Iron phosphate	..	..	..	..	..	5.0 gms.
Distilled water	..	..	..	..	..	10.0 litres.

Wide mouth bottles of equal capacities were selected for these experiments and each was fitted with a cork with three holes and cut in two halves to accommodate the plant. A small pad of cotton was placed between the two halves and the plants were carefully placed between them. The other two holes in the cork were used for bubbling in air after every third day. This was conveniently done by passing a stream of water into a big aspirator bottle and bubbling the displaced air into the bottles for five minutes. The plants showed a very regular growth in these bottles, but uncertain growth was measured after the fourth or the fifth week. The bottles were covered with black paper and were kept in a verandah where they were fully exposed to the diffused sunlight.

The seeds were carefully chosen of as nearly the same weight and size as possible and were placed in the purified sand for germination. After two or three weeks the plants of exactly the same size (both the stem and the root) were selected and replanted in the pots and the bottles containing the culture solution.

The experiments on gram were started in the first week of March as soon as the preparation of the sand was completed. 2 maunds of the sand were purified in the first

instance, and equal quantities of these were placed in the pots. One crop was sown on the 27th February 1931 in porcelain dishes. The plants of exactly similar lengths (both the stem and the roots) were selected and replanted on the 10th March. 100 c.c. of the culture solution were added to these pots every fourth day by way of manure. The measurements of the lengths of the plants, with dates when they were recorded are summarised in Table I.

TABLE I.
SEASON—MARCH AND APRIL.
Experiment in pot, 100 c.c. culture solution every fourth day.

Ions.	10th March.	12th March.	14th March.	20th March.	25th March.	1st April.
Uranium ..	3.4	3.8	4.4	7.65	8.85	Developed yellow stains on 29th March.
Thorium ..	3.4	3.95	4.3	7.81	9.04		10.35
Zinc ..	3.3	3.3	4.0	7.57	8.32	10.84
Cerium ..	3.5	3.7	4.1	7.8	8.64	9.75
Copper ..	3.4	3.5	4.2	5.94	7.92	9.14
Lead ..	3.4	3.4	4.1	5.10	7.41	Two plants out of five showed signs of drying up.
Silver ..	3.4	3.5	4.0	4.83	7.30	8.85
Nickel ..	3.6	3.7	4.0	5.23	7.05	8.90
Cobalt ..	3.45	3.5	4.1	5.47	7.45	9.25
Manganese ..	3.3	3.5	4.0	5.89	7.8	9.35
Calcium ..	3.41	3.5	4.2	5.74	7.75	9.55
Blank ..	3.4	3.6	4.1	5.81	7.63	9.33
Blank ..	3.4	3.6	4.1	5.83	7.58	9.00

Another set of experiment was simultaneously started in culture solution and the plants were transferred in the bottles on the 10th March. The plants were aerated on alternate days. Three plants were transferred in every bottle and the measurements in the following table is a mean of three. These experiments on gram were continued till the 1st week of April. The measurements after this time were irregular and are therefore not included in these tables.

TABLE II.
SEASON—MARCH-APRIL.
Plant—Gram in water culture.

Ions.	10th March.	12th March.	16th March.	20th March.	28th March.
Blank ..	3.46	4.3	5.9	6.10	7.54
Uranium ..	3.45	4.6	5.2	7.72	9.01
Thorium ..	3.40	4.7	5.9	8.12	9.23
Cerium ..	3.47	4.62	5.41	7.0	8.94
Copper ..	3.48	3.8	4.3	5.54	8.00
Lead ..	3.5	3.91	4.2	4.4	5.9
Silver ..	3.47	3.62	4.0	4.65	Yellow tips of the leaves after 16th March.
Nickel ..	3.50	4.11	4.75	5.11	7.45
Cobalt ..	3.48	3.62	5.0	5.55	7.25
Manganese ..	3.44	3.72	4.1	damaged.	
Calcium ..	3.42	4.14	4.6	5.83	8.12
Blank ..	3.49	4.21	4.7	6.02	7.84

Experiments on moth were started in the beginning of April. The season for sowing these cereals is in October, but the growth of these plants even in these months was found to be fairly satisfactory for the measurements required for these experiments. The seeds were sown on the 26th March. Plants of exactly similar lengths were sorted on the 10th March and were planted in the pots as well as in the culture solutions. The measurements for the set of experiments in culture solution are included in Table III.

TABLE III.

SEASON—APRIL-MAY.

Plant—Moth in water culture.

Ions.	Maximum height of the plants in cms. on				Remarks.
	10th April.	18th April.	22nd April.	26th April.	
Blank	2.0	2.7	4.1	..	Died. The plants which showed initial rapid growth were found to be the first to decay.
Thorium	2.0	3.5	4.1	4.8	
Nickel	2.0	3.5	4.1	4.8	
Cobalt	2.0	2.9	3.5	4.3	
Uranium	2.0	3.7	5.3	5.7	
Cerium	2.0	2.7	5.2	5.8	
Sodium	2.0	3.1	4.2	5.2	
Zinc	2.0	3.0	3.6	4.4	
Copper	2.0	2.6	3.3	4.1	
Manganese	2.0	2.5	4.4	5.3	
Aluminium	2.0	2.5	4.9	6.0	
Strontium	2.0	3.7	4.7	5.6	
Calcium	2.0	2.6	4.4	5.5	

Two other duplicate sets of experiments (both in water culture as well as in sand) were started on the 15th April and the 17th April, respectively. The quantities of the ions, and of the culture solution were kept the same as in the first set of experiments. The results of these two experiments are shown in Tables IV and V.

TABLE IV.

SEASON—APRIL-MAY.

Plant—Moth in sand.

Ions.	15th April.	19th April.	24th April.	28th April.	3rd May.	11th May.	20th May.
Blank	2.2	2.57	3.5	3.9	4.9	7.3	9.4
Thorium	2.3	2.9	3.5	4.1	5.8	9.1	11.1
Cobalt	2.2	2.5	3.5	3.8	5.0	6.5	8.4
Uranium	2.1	2.75	3.6	3.77	5.32	7.31	9.14
Cerium	2.1	2.65	4.11	5.05	6.02	8.00	10.2
Sodium	2.2	2.51	3.22	3.65	4.1	5.11	7.15
Zinc	2.15	2.45	3.1	3.60	4.51	5.9	8.05
Copper	2.25	2.5	3.01	3.75	4.71	damaged.	
Manganese	2.10	2.4	3.3	3.65	4.91	6.52	8.45
Aluminium	2.15	2.42	3.41	3.85	5.0	6.6	8.6
Strontium	2.2	2.5	3.41	3.72	4.71	6.01	8.6
Blank	2.18	2.65	3.3	3.8	5.0	6.5	8.5

TABLE V.

SEASON—APRIL-MAY.

Plant—Moth in water culture.

Ions.	17th	20th	25th	2nd	12th	20th
	April.	April.	April.	May.	May.	May.
Blank	2.40	2.60	3.55	5.1	7.65	9.6
Thorium	2.35	3.1	3.65	6.12	9.4	11.9
Cobalt	2.41	2.5	3.41	5.2	6.92	8.9
Uranium	2.37	2.8	3.75	5.5	7.75	10.7
Cerium	2.34	2.77	4.2	5.8	8.45	11.3
Sodium	2.40	2.65	3.2	4.3	5.45	7.78
Zinc	2.41	2.60	3.3	4.9	5.8	8.35
Copper	2.42	2.68	2.9	5.0	6.6	8.65
Manganese	2.41	2.55	3.41	5.15	6.85	8.85
Aluminium	2.37	2.67	3.42	5.17	6.75	9.2
Strontium	2.37	2.5	3.43	4.82	6.5	8.45
Blank	2.32	2.57	3.48	5.15	7.15	8.95

Jwar was sown on the 25th and 26th April in five big porcelain dishes containing purified sand. These dishes were each of five litre capacity and were filled with equal quantities of the sand. The plants were sorted on the 10th May and the measurements were taken after about 3 or 4 days. The growth in water culture was fairly regular, but in pots they showed an irregular growth after two weeks. The measurements of two experiments performed simultaneously in water culture and in sand are given in Tables VI and VII.

TABLE VI.

SEASON—MAY-JUNE.

Plant—Jwar in sand.

Ions.	Maximum length in cms. of the plant on								Total growth.
	12th May.	16th May.	20th May.	24th May.	28th May.	1st June.	5th June.	9th June.	
Blank	2.0	2.8	3.7	4.3	5.2	6.5	7.8	9.0	7.0
Thorium	2.0	2.8	4.0	5.0	6.2	7.5	8.8	10.0	8.0
Uranium	2.0	3.0	4.1	5.3	6.8	8.0	9.1	10.3	8.3
Cerium	2.0	2.7	3.6	4.4	5.25	6.7	8.8	9.3	7.3
Nickel	2.0	2.6	3.1	3.8	4.7	5.6	6.5	7.4	5.4
Cobalt	2.0	2.6	3.2	3.9	4.8	6.0	7.1	8.0	6.0
Sodium	2.0	2.6	3.15	3.9	4.65	5.6	6.55	7.5	5.5
Zinc	2.0	2.55	3.7	4.8	5.9	7.2	8.1	9.0	7.0
Copper	2.0	2.5	3.2	4.0	4.9	5.7	6.45	7.0	5.0
Manganese	2.0	2.7	3.5	4.1	4.75	5.3	6.2	7.3	5.3
Aluminium	2.0	2.4	3.0	3.75	4.7	5.7	6.6	7.45	5.45
Strontium	2.0	2.5	3.5	4.3	5.2	6.6	7.3	8.1	6.1
Calcium	2.0	2.6	3.4	4.1	5.1	6.3	7.0	7.6	5.6

TABLE VII.

SEASON—MAY-JUNE.

Plant—Jwar in water culture.

Ions.	Total length in cms. of the plant on					Total growth.
	12th May.	16th May.	20th May.	24th May.	28th May.	
Blank	2.0	3.0	3.8	7.1	8.2	6.2
Thorium	2.0	3.6	4.9	7.8	8.4	6.4
Nickel	2.0	3.2	4.6	7.4	7.8	5.8
Cobalt	2.0	3.4	4.7	7.4	8.0	6.0
Uranium	2.0	3.6	4.9	7.8	8.6	6.6
Cerium	2.0	3.3	4.6	7.4	8.3	6.3
Sodium	2.0	3.3	4.1	6.9	7.8	5.8
Zinc	2.0	3.2	4.1	7.1	8.0	6.0
Copper	2.0	3.3	3.9	6.3	7.6	5.6
Manganese	2.0	3.0	3.8	6.0	7.7	5.7
Aluminium	2.0	2.7	3.8	4.8	7.8	5.8
Strontium	2.0	2.7	4.1	7.2	7.9	5.9
Calcium	2.0	3.1	4.0	7.0	7.8	5.8

Two crops of jwar were again sown on the 20th May with a view to repeat the above experiments, but on account of the untimely season for the cereals and the intense heat of Lahore in these months, the measurements taken in June for this crop were very irregular. Cotton-seed was also tried but both these crops had to be abandoned on account of the very unfavourable season. In Table VIII are shown some of the measurements in the case of jwar. A dust storm on the 20th June destroyed the crop of jwar completely and no measurements could, therefore, be taken after that date.

TABLE VIII.

SEASON—JUNE.

Plant—Jwar in sand.

Ions.	3rd June.	8th June.	14th June.	19th June.	
Blank	3.66	3.97	4.56	4.60	
Thorium	3.72	4.21	4.32	4.5	
Uranium	3.68	4.68	4.75	5.6	Mean of two plants only ; 3rd was damaged.
Cerium	3.70	4.71	Yellow	ness de- veloped on certain leaves hence rejected.	
Nickel	3.77	4.21	4.64	4.75	Measurement of one plant only which showed satis- factory growth.
Cobalt	3.68	4.0	4.36	5.0	
Zinc	3.64	4.11	4.61	5.22	Yellowness on some plants after 19th.
Copper	3.67	damaged.			
Manganese	3.66	4.24	4.72	5.0	
Aluminium	3.7	damaged.			
Blank	3.60	3.82	4.4	..	One plant was damaged.

The rains had set in the middle of July and another set of jwar was sown on the 30th July. The plants were sorted on the 8th August and planted both in the culture solution as well as in pure sand. The quantities of the ions added in these experiments were nearly 10 times more than used in the previous experiments of jwar and moth. In the cases of thorium and uranium the growth was found to be increased on increasing the concentrations of these ions. Both these substances indicated the maximum growth and the effect of other ions was obtained in the same direction as in the previous experiments completed in the month of May. The results of the two experiments simultaneously carried out in the pots and in the bottles are summarised in Tables IX and X.

TABLE IX.

SEASON—AUGUST-SEPTEMBER.

Plant—Jwar in water culture.

Ions.	10th Aug.	15th Aug.	21st Aug.	23rd Aug.	28th Aug.	1st Sept.	15th Sept.
Blank	2.32	3.10	3.71	4.75	5.25	7.55	11.94
Thorium	2.35	3.16	4.00	5.45	6.86	9.32	12.86
Uranium	2.75	3.00	4.35	5.95	6.45	9.55	13.35
Cerium	2.50	2.85	4.25	5.26	6.51	6.75	12.35
Zinc	2.65	2.9	3.75	4.62	5.26	7.65	12.12
Copper	2.55	2.75	3.75	4.81	5.4	7.41	11.66
Manganese	2.31	2.81	3.58	4.92	5.50	7.40	11.75
Nickel	2.30	2.75	3.55	4.40	5.81	7.46	11.85
Cobalt	2.25	2.9	3.65	3.95	5.85	7.82	11.93
Blank	2.30	2.92	3.75	4.05	5.35	7.42	11.90

TABLE X.

SEASON—AUGUST-SEPTEMBER.

Plant—Jwar in sand.

Ions.	10th Aug.	15th Aug.	21st Aug.	23rd Aug.	27th Aug.	31st Aug.	9th Sept.	14th Sept.
Blank	2.25	2.97	3.67	4.65	5.15	7.45	10.22	11.54
Thorium	2.25	3.16	4.12	5.35	6.82	9.12	11.44	12.6
Uranium	2.35	3.00	4.25	5.87	6.35	9.45	11.63	15.1
Cerium	2.43	2.92	4.11	5.00	6.5	8.34	10.85	12.1
Zinc	2.45	2.96	3.81	4.62	5.16	7.66	10.41	11.89
Copper	2.34	2.87	3.81	4.85	5.33	7.41	9.85	11.21
Manganese	2.25	2.95	3.6	4.92	5.44	7.40	10.10	11.56
Nickel	2.31	2.86	3.55	4.41	5.93	7.36	9.65	11.4
Cobalt	2.28	2.9	3.56	4.0	5.5	7.41	10.00	11.65
Blank	2.28	2.92	3.68	4.75	5.25	7.32	10.1	11.75

Peas were sown in the middle of September. Twelve pots of equal capacities were filled with 5 lbs. of purified sand each, and about 20 seeds of exactly the same weight and

similar in colour were sown in each pot. The seeds germinated on the third day and developed rapidly. The rate of growth of these plants was about 1 cm. per day, and as these plants grew in their lengths only without any off-shoots, they were found to be much more suitable for these investigations than any of the plants investigated before. The results of one crop in which the effect of 12 ions was investigated are shown in Table XI.

TABLE XI.
SEASON—SEPTEMBER-OCTOBER.

Plant—Peas in pots.

Ions.	24th Sept.	28th Sept.	2nd Oct.	7th Oct.	9th Oct.	15th Oct.
Blank	10.34	15.64	19.9	25.6	32.64	40.4
Thorium	10.26	18.85	22.8	25.7	35.56	44.6
Uranium	10.34	17.94	22.0	28.64	34.85	44.1
Cerium	10.30	17.64	21.9	27.58	34.64	44.7
Zinc	10.37	16.25	20.14	25.8	32.8	40.6
Nickel	10.30	15.84	20.22	25.64	32.4	40.8
Cobalt	10.31	16.44	19.64	25.67	32.1	41.1
Manganese	10.29	16.59	20.14	25.55	32.54	40.4
Calcium	10.26	16.9	20.64	24.93	32.3	40.3
Barium	10.31	16.8	20.75	25.1	33.22	40.45
Strontium	10.36	15.7	20.85	25.65	32.54	40.56
Blank	10.32	15.84	20.15	25.56	32.56	40.31

The above readings are the mean of five plants which were found to show exactly similar growth. The growth of all the plants in one pot (about 15 in number) was first separately measured, and only those were selected which showed exactly the same growth. The remaining plants were all removed. It will appear from the above table that thorium, uranium, and cerium effected the plants very appreciably, but no effect was noticed in the presence of any other ion. Two other sets of experiments were simultaneously started in water culture and in sand in the first week of November, but in these sets only the three effective ions were tried.

TABLE XII.
SEASON—NOVEMBER.

Plant—Peas in sand.

Ions.	Maximum length in cms. of the plants on					Total growth.
	30th Oct.	6th Novr.	13th Novr.	18th Novr.	20th Novr.	
Blank	14.0	25.8	30.8	38.9	41.8	27.8
Thorium	14.0	25.4	33.3	47.4	49.6	35.6
Uranium	14.0	23.9	28.0	42.0	47.8	33.8
Cerium	14.0	26.2	31.1	44.0	49.1	35.1

TABLE XIII.

SEASON—NOVEMBER.

Plant—Peas in water culture.

Ions.	Maximum length in cms. of the plants on					Total growth.
	30th Oct.	6th Novr.	13th Novr.	18th Novr.	20th Novr.	
Blank	21.0	34.8	44.2	51.6	51.6	30.6
Thorium	21.0	42.3	55.3	61.2	62.2	41.2
Uranium	21.0	40.1	49.9	59.5	60.5	38.5
Cerium	21.0	38.3	47.1	55.4	56.8	35.8

Barley.—Experiments in water culture were tried. Difficulty in the measurements in the case of barley was experienced since from an early stage they developed branches. Some of the plants developed three or even four branches and these had to be discarded. Plants which were of the same form and developed only two branches were selected for the experiments. The maximum lengths of the taller branch are indicated in the following tables.

The plants were sorted from a crop of 600 plants, which were sown in six big dish containing equal quantities of pure sand. The readings in the following tables are the mean of the three plants.

TABLE XIV.

SEASON—NOVEMBER-DECEMBER.

Plants—Barley in water culture.

Ions.	14th Novr.	19th Novr.	24th Novr.	28th Novr.	2nd Decr.	15th Decr.
Blank	15.0	26.2	32.2	34.4	42.6	45.6
Thorium	15.14	26.3	31.68	35.8	44.6	47.9
Uranium	15.08	25.9	32.35	34.9	42.86	44.92
Cerium	15.15	26.22	32.56	34.5	Rejected on account of dissimilar growth.	
Zinc	15.2	25.9	32.4	34.3	Uncertain readings after 28th.	
Manganese	15.14	26.21	32.00	Rejected on account of dissimilar growth.		
Nickel	15.00	25.9	32.18	34.32	42.36	45.12
Cobalt	15.06	26.2	32.16	33.92	42.16	45.45
Silver	15.23	25.8	32.6	Developed yellowness on the edges and hence rejected.		
Lead	15.12	25.12	32.14	33.4	41.5	41.6
Blank	15.17	26.1	damaged.			

The irregularities in the above table are obviously due to the fact that the barley plants from the early stages developed in branches and not in their lengths only.

A perusal of the above tables will show that thorium nitrate, uranium nitrate and cerium even when added in very small quantities have a distinct accelerating effect on the growth of the plants. The above effect has been observed in almost all the plants investigated and has even been confirmed in several cases. The differences in the growth in the

presence of other ions were not very marked, excepting that lead was found to have a depressing effect on the growth of barley; and copper showed a slightly depressing effect on the growths of moth and jwar. The plants in which silver was added showed a tendency to develop yellowness.

As pointed out before, the main difficulty in the water culture and pot experiments was that the growth could not be measured very accurately after about six weeks of the replantation of the plants. It was therefore considered desirable to investigate the effect of these ions on the full growth of the plants and also to study the influence of these substances on their ultimate fruits. A plot of land has now been prepared to conduct field experiments on all these plants. A plot of land 21 ft. \times 10 ft. was completed in January 1932. The analysis of the soil used in this plot gave the following composition:—

Moisture	..	..	..	..	..	17.5 per cent.
SiO ₂	..	..	..	..	..	46.3 per cent.
Fe ₂ O ₃ Al ₂ O ₃	..	..	..	..	..	6.6 per cent.
MgO	..	..	..	..	..	3.6 per cent.
Alkalies	..	..	..	..	..	14.0 per cent.

Qualitative tests for sodium, sulphate, chloride and the nitrates were obtained.

The plot was uniformly filled with the soil of this composition to a depth of 3 feet. The whole plot was divided into 12 smaller plots, each separated by walls of tarred tin sheets which were kept more than 2½ feet deep in the soil. The whole plot was completely covered with a net-work of iron, the walls of the netted enclosure being 6 ft. high with a roof 21 ft. \times 10 ft. The plot has been built at a height of 1 ft. from the ground and is bounded by a brick work to completely protect it from the animals and the flow of rain water from the surroundings.

Peas were sown in 6 smaller plots in the third week of January. The distribution of the plots in which the ions have now been added is indicated in the diagram below:—

Cerium.		Blank (Uranium.)		Uranium.		Uranium.
Blank (Cerium).		Blank Thorium.		Thorium.		Thorium.

Every care has been taken to ensure that no diffusion of the ions from one plot to the other takes place. Thus in spite of protecting every plot with a tin-sheet, the seeds are sown in the alternate plots only. Every plot is thus separated from the other by a double wall of tin sheets, and a plot 2½ feet wide. It is hoped that a single wall of the tin sheet will completely prevent the diffusion of the ions and the plots that have now been left out will be used later on in case no trace of ions is detected in them.

The construction of the above plot, in which the effect of three ions only is being investigated at present proved to be a very costly one. As a very large number of field experiments have to be conducted, a larger area is now being prepared in which small plots separated at sufficient distances are being filled with the Ravi sand. It is hoped that these field experiments on the plants which have shown accelerated growth in pots and culture solution during this year will be successfully completed during the next year and the complete information regarding the influence of these ions on the full growth of the plants will be available before the end of the next year.

A paper on the effect of ions on the growth of plants including some of the above results which have already been confirmed by us is shortly to be communicated to the Indian Journal of Agriculture.

S. S. BHATNAGAR.
KRISHNA GOPAL.
D. N. GOYLE.

ENCLOSURE IV.

SUBJECT No. 30(e).

REPORT ON THE WORK DONE IN THE AGRICULTURAL RESEARCH SECTION OF THE DEPARTMENT OF CHEMISTRY, DACCA UNIVERSITY, DACCA, DURING 1930-31, AND 1931-32, IN CONNECTION WITH THE SCHEME FOR AGRICULTURAL RESEARCH SANCTIONED BY THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

At its meeting held in December 1929, the Advisory Board considered an application from the University of Dacca for financial assistance towards agricultural research and recommended that a grant for 5 years be given to the University for research work on three problems, viz.—

- (1) Methods for the mechanical analysis of soils;
- (2) The assimilation of nitrogen by the rice plant;
- (3) As a subsidiary portion of (1) a study of the organic matter in the soil.

This recommendation was accepted by the Governing Body and the scheme was started in June 1930.

2. The progress reports for the years 1930-31 and 1931-32 (Annexures I and II) received from the University are now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

The 31st May 1932.

 ANNEXURE I.

REPORT FOR THE YEAR 1930-31.

A BRIEF REPORT ON THE WORK DONE AND RESULTS OBTAINED IN THE AGRICULTURAL CHEMISTRY SECTION OF THE DACCA UNIVERSITY DURING THE PERIOD 1ST JUNE 1930 AND 31ST MARCH 1931.

Mechanical Analysis of Lateritic Soils.

Three existing methods and one new method of mechanical analysis were tried on a number of samples of lateritic soils, two from Dacca and four from the districts of Hazaribagh and Santhal Parganas in Bihar in order to find which method gave the maximum dispersion. The methods tried were:—

- (1) International Method ($H_2 O_2$ —HCl— NH_3) but without the peroxide treatment since lateritic soils contain little organic matter.
- (2) Sodium chloride method (NaCl—NaOH) as developed by Dr. Puri.
- (3) Sodium carbonate method ($Na_2 CO_3$) as developed by Dr. Joseph but using the pipette technique in place of sedimentation.
- (4) Sodium Hydroxide method (NaOH) in which attempt was made to disperse the soil with a small dose of NaOH without the previous, NaCl treatment as in (2) or the acid treatment as in (1).

In addition to above four more Dacca soils were analysed by (1) and also by (2) and 14 other Bihar soils by (2). Complete analyses were made in all cases.

Both International and NaCl methods dispersed all the Dacca soils practically to the same extent but in the case of two out of four Bihar soils the amount of clay obtained by the latter method was distinctly greater. There was also a loss by solution of soil materials to the extent of about one per cent, as a result of the acid treatment in the International method. On adopting a much longer period of shaking in either method, no gain in the amount of clay or clay plus silt was obtained. This shows that in the case of lateritic soils the maximum dispersion was obtained by the prescribed treatment for each method. In all cases the $Na_2 CO_3$ and NaOH methods gave much smaller amount of clay than did the other two methods, the amount obtained by $Na_2 CO_3$ being minimum. The lower disper-

sion with NaOH is believed to be due to the fact that the amount of alkali added was insufficient to convert the whole of the clay into sodium clay. But this was not so in the case of Na_2CO_3 method. Obviously the maximum dispersion in the latter case does not take place in one operation. Analyses are in progress employing higher doses of alkali and the sedimentation technique in the NaOH and the Na_2CO_3 methods respectively.

Problem of Nitrogen Supply to Rice Plants.

Estimations of total nitrogen, ammonia, and nitrate were made with as little delay as possible in fresh soil samples taken periodically from two cropped and one uncropped paddy fields in the Government Farm at Dacca with a view to find out the cycle of changes that take place in these nitrogen compounds in such fields. Unfortunately the uncropped plot had to be rejected a few months after the work was begun owing to the discovery in the field of bad patches of soil having extremely variable composition. The results obtained so far for the cropped plots show that the total nitrogen in soil increases during the water-logged period in spite of the fact that a crop is standing on the field becomes maximum before the crop reaches maturity and then decreases. The maximum gain in soil nitrogen was found to be 7 to 8 times more than the amount consumed by the crop in either plot.

The nitrate in soil decreases as soon as water is admitted into the field and practically disappears when the latter remains submerged for a few days. It begins to form again as soon as excess water in the soil evaporates but so far its accumulation in the two fields has not been found to exceed 4 p. p. m. (as nitric nitrogen). On the other hand free and saline ammonia in soil increase when the plots remain submerged and gradually decrease as the soil dries out. During the water-logged period an average of 15 p. p. m. of ammoniacal nitrogen was present in the two plots. The amount has now (in March) come down to 5 p. p. m. During the early part of the period under review a number of methods for estimating total nitrogen in soil were tested. With the Dacca soil the Kjeldahl and Gunning method gave as good a result as did the (1) Salicylic acid method, (2) Davison and Parson's method or (3) combination of Ulohes and Kjeldahl method. Bal's modified method to prevent cementation of heavy particles during digestion was also tried but found to give no higher result. However the salicylic acid method with thiosulphate as the reducing agent was adopted since it was less troublesome than either (2) or (3) and since digestion was quicker in this than in the Kjeldahl and Gunning method.

Results of Water Culture Experiments with Paddy.

- (1) Transplanted Aman brought from a field was found to grow best in complete nutrient solution having pH 4.6.
- (2) Contrary to observations of Gerric in America 7 to 8 weeks old both Aman and Boro plants were found to die out quickly when placed in a nutrient solution containing no phosphate, calcium and magnesium.
- (3) Absence of Boron and Manganese in nutrient solution did not affect the growth of Boro plants.
- (4) Continual presence of sufficient amount of iron in nutrient solutions in an available form is essential for the growth of paddy.
- (5) Boro plant thrived equally well in complete nutrient solutions containing either nitrate or Ammonia. But where both were present more Ammonia than nitrate was absorbed by the plant.

REPORT OF THE AGRICULTURAL RESEARCH SECTION OF THE DEPARTMENT OF CHEMISTRY,
Dacca University, FOR THE YEAR ENDING THE 31ST MARCH 1931.

Detailed Report.

General.—I joined my appointment on 1st June 1930. The Senior Assistant Mr. P. K. De and the Junior Assistant Mr. J. N. Chakraburty joined their respective appointments on 11th August 1930.

On 25th May 1930, *i.e.*, before I actually joined my appointment, I submitted a list of apparatus to the Head of the Department of Chemistry for favour of transmission to the Imperial Council of Agricultural Research through the Provincial Research Committee for approval and sanction of necessary cost. The list was approved by the Provincial Committee and finally by the Imperial Council with some modifications. Unfortunately however the University did not receive the money for making necessary purchases until December 1930. The progress of work during the period under review was therefore greatly hampered for want of apparatus, etc., and also for want of a pot culture house. It may be mentioned here that during the first two months I had to go to Tejgaon to work in the Government Research Laboratory since no proper facilities for the type of work needed to be carried out were available here. After the Assistants were appointed in August, work was begun in this laboratory. Some fittings had to be made in the laboratory during the month of October which took over three weeks. This impeded the progress of work considerably. Again the want of a fume cupboard where Kjeldahl digestions could be carried out satisfactorily was felt from the very beginning and it was after the receipt of grant from the Imperial Council of Agricultural Research that I could find money for the construction of a proper cupboard which has just been completed. A pot culture house is also on its way to completion now. Orders for apparatus necessary for our works have been placed soon after the receipt of the grant from the Research Council. When these have arrived the progress of work is expected to be more rapid. I should like to mention here that we want another room very badly. At present there is not even enough space for our ordinary routine works and consequently it will be impossible to find room to work with the microscope, incubator and other apparatus which are expected shortly.

A note on the lines of work which this section proposed to following was drawn up and shown to the Director of Agriculture, Bengal, for criticism, who fully approved it. A summary of this note was forwarded to the Registrar of the University for favour of communication to the Imperial Council of Agricultural Research in August 1930.

In conclusion, I want to express my thanks to Messrs. Finlow and Carbery, the Director of Agriculture and the Agricultural Chemist, Bengal, for trying to help me in every possible way whenever I approached them for advice, for experimental plots to be placed at my disposal or for the purpose of borrowing apparatus, etc.

ASHUTOSH SEN,

*Research Fellow in Agricultural
Chemistry, Dacca University.*

The 4th April 1931.

DETAILS OF WORK DONE BY DR. A. T. SEN, RESEARCH FELLOW IN AGRICULTURAL CHEMISTRY, DACCA UNIVERSITY, IN COLLABORATION WITH MESSRS. P. K. DE AND J. N. CHAKRABURTY, SENIOR AND JUNIOR ASSISTANTS.

I.—Mechanical Analysis of Lateritic Soils.

It was proposed to try at first a few existing methods of mechanical analysis on a number of lateritic soils with a view to find which gave the maximum dispersion without being drastic and without consuming undue time and labour. On the existing methods the one revised by A. E. A. (England) in 1923 now known as the International pipette method has been very widely adopted. The dispersion of soil in this method is effected by a preliminary treatment with H_2O_2 to remove organic matter followed by an acid treatment to destroy carbonates and finally by shaking a suspension of the treated soil made alkaline by ammonia. Since tropical soils contained very little organic matter, it has been suggested by many that H_2O_2 treatment was unnecessary for such soils. The peroxide treatment has therefore been omitted while using this or other methods in this laboratory. A number of people, however, object even to the acid treatment and notably amongst them are Dr. Joseph and Dr. Puri who advocate the use of Na_2CO_3 and NaCl (with little NaOH) respectively as the dispersing agent. The clay in the soil is thus converted into Sodium clay which both these authors claim, and right so, to be far more easily dispersible than Ammonium clay. The two methods will be termed Na_2CO_3 and NaCl methods.

As regards the division of soil into fractions the Atterburg scale has now been universally adopted which is as follows:—

Coarse sand 2.0 mm. to 0.2 mm.

Fine sand 0.2 mm. to 0.02 mm., silt 0.02 mm. to 0.002 mm. and clay below 0.002 mm. This scale in grouping the fractions, was also adopted in this laboratory.

In the International and NaCl methods the pipette technique is employed to obtain the silt and the clay fractions. Dr. Joseph, however, finds the technique unsuitable for Sudan soils which refuse to disperse completely at one operation. He, therefore, advocates the extraction of clay and silt by sedimentation. The repeated treatments involved in the latter process further disperse soil particles not fully dispersed in the first operation. But the principal objection to analysis by sedimentation is that it takes considerable time to be completed, so that unless it is found absolutely necessary the rapid pipette technique should be adopted wherever possible. When this work was going to be begun in this section, mechanical analyses of a few typical Bengal soils including a lateritic soil from Dacca were being conducted at the Agricultural Chemist laboratory at Dacca, using the 1906 Sedimentation the Na_2CO_3 sedimentation and the International pipette methods. Consequently it was decided to postpone the trial of Na_2CO_3 method until results of these analyses were available. Meanwhile analyses of a number of samples of Dacca soils were begun by the International and NaCl methods. The results of complete analyses of six of them are given below.

It is evident from the table that in four out of six cases both methods gave equal amounts of clay while of the remaining two cases the International method gave once one per cent. more and once one per cent. less clay than that given by the NaCl method. Again, the average differences in the amounts of silt and fine sand obtained by the two methods are not very much larger than the standard errors. It is clear, therefore, that both methods dispersed the soil more or less to the same extent. There was of course some loss by solution as a result of acid treatment in the International method. This loss was found to average at 1.3 per cent. for the above samples. If the average of the total percentages of the various fractions (last column) obtained by the two methods is calculated, it will be found to be 96.1 per cent. for the International and 97.3 per cent. for the NaCl method respectively. The lower value for the International method is obviously due to the loss by solution. Apart from the defects the International method appears to be as suitable as the NaCl method for Dacca soils.

TABLE I.

Various fractions as percentages of air-dry soil by the International and NaCl Methods.

Sample from—	Clay.		Silt.		Fine sand.		Coarse sand.		Total.	
	Inter.	NaCl.	Inter.	NaCl.	Inter.	NaCl.	Inter.	NaCl.	Inter.	NaCl.
1. Khoskhana, Dacca	22.3	22.3	31.5	31.7	38.2	36.1	2.8	3.3	94.8	93.8
2. Do. ..	24.3	24.2	32.2	33.8	36.0	36.1	2.7	2.9	95.2	97.0
3. Do. ..	25.3	25.4	31.4	33.4	35.9	36.2	2.8	3.1	95.4	98.0
4. N. Hazi Dacca ..	18.4	17.4	27.6	31.3	38.2	36.8	10.4	11.3	94.6	96.8
5. Do. ..	18.4	18.8	32.7	34.1	38.1	36.5	9.6	9.8	98.8	99.2
6. Do. ..	16.9	18.2	32.8	32.5	37.7	37.7	10.5	11.0	97.9	99.4
Average difference between international and NaCl results ..	0.45		1.35		1.09		0.43			
Standard error ..	+0.62		+1.01		+0.71		+0.19			

To avoid fluctuations in temperature effecting the results a thickwalled airtight wooden box was used in which the suspensions were allowed to stand for the requisite number of hours before clay fractions were pipetted. When the room temperature changed by 5 degrees the temperature inside the box altered by less than one degree. The slight variation in temperature did not affect the result. This was because 70 per cent. of the clay in the Dacca soils have diameters below .001 mm. Further, a longer period of shaking in the International method and also 24 hours' shaking in the NaCl method were employed without consequent gain in the amounts of clay and the silt fractions. Obviously the maximum amount of dispersion possible by either method was obtained by the prescribed treatment for each.

Next complete analyses of 18 samples of lateritic soils and sub-soils from the districts of Sonthal Parganas and Hazaribagh in Bihar were made using the NaCl method. Most of these samples were taken from paddy fields but one sample was collected near the side of a hill where laterisation had taken place in *in situ* and the granulated structure of the soil so common to laterites was clearly evident. After examination of the results of analysis, four samples were selected which were considered typical of the different parts of the two lateritic districts. These four samples were then analysed again by the International and the Na_2CO_3 methods using the pipette technique in the latter case. Since Na_2CO_3 would come into the clay traction, the theoretical amount of Na_2CO_3 present in 20 c. c. of the pipetted volume was deducted from the weight of the evaporated amount to give the actual weight of clay. An error is introduced in this way since the H ions exchanged for Na ions will cause some loss of carbonic acid during evaporation. This loss, however, is small and therefore negligible in the case of lateritic soils. Besides the International and Na_2CO_3 methods, a new method which will be termed NaOH method was tried. In this method 10 c. c. of N/10 NaOH were added to a suspension of 20 gms. of soil in 100 c. c. water (about 7 to 8 c. c. were found to make the suspension alkaline to phenolphthalein). The mixture was stirred by means of a glass rod for about 5 minutes and then transferred into a stoppered bottle and shaken overnight with about 500 c. c. of water. The suspension was then made up to two litres after separating the coarse sand and the usual pipette technique was adopted. If in the Na_2CO_3 and NaCl methods the primary intention was to convert the clay into sodium clay, the NaOH method would very likely do the same. As a start treatment with stronger concentrations of NaOH was avoided for obvious reasons. The concentration used was the same as that in the NaCl method where NaOH is added after removing the excess salt by washing. In the NaOH method, therefore, two operations are saved, *viz.*, the treatment with NaCl and the subsequent washing of excess salt for which extra care has to be taken especially towards the end to avoid peptisation. In addition to the four Bihar soils, two Dacca soils were analysed by the Na_2CO_3 and NaOH methods. Complete analyses were made in all cases in order to check the figures for the clay and the silt fractions by finding the total. The clay and fractions are given on the next page.

It is evident from the figures that the NaOH method failed to disperse the soil to the same extent as did the International or the NaCl method. Probably the amount of alkali added (10 c. c. of N/10 NaOH) was too small to convert all the clay into sodium clay. Further trial with the dispersion is now in progress using slightly higher concentrations of the alkali that will not unduly react with soil constituents effecting loss of silica by solution. It may be of interest to mention here that in the technical communication No. 17 of the Imperial Bureau of Soil Science a copy of which has just reached this laboratory, one finds that Professor Robinson had proposed the use of NaOH in place of Ammonia in the International method. He observed that the method thus modified gave the best results. In this laboratory it was also thought at first to introduce this modification in the International method, but in view of the prevailing diverse opinion on the desirability of an acid treatment in the mechanical analysis of soils and also in view of the fact that cementing materials such as CaCO_3 are generally present in lateric soils in very small quantities, it was decided to omit the acid treatment in the NaOH method. Professor Robinson, however, used NaOH eight times more than the quantity used to disperse the soil in the NaOH method.

TABLE II.

Clay and Silt percentages of air-dry soil obtained by different methods.

Soil from—	Percentage of clay by—				Percentage of silt by—			
	Inter.	NaCl.	Na ₂ CO	NaOH.	Inter.	NaCl.	Na ₂ CO ₃	NaOH.
1. Khoskhana, Dacca ..	25.3	25.4	22.0	21.4	31.4	33.4	36.4	38.1
2. N. Hazi Dacca ..	18.4	18.8	15.8	16.7	32.7	34.1	37.7	37.5
3. Giridih 1, Hazaribagh	21.2	21.8	14.4	17.2	8.2	9.5	14.5	13.4
4. Giridih 5, Hazaribagh	30.3	35.0	26.9	29.4	12.5	11.6	16.1	14.5
5. Deoghar 11, S. P. ..	21.1	21.3	18.8	19.8	15.3	16.9	18.4	17.8
6. Deoghar 15, S. P. ..	29.2	31.1	27.1	29.1	12.6	13.2	15.9	22.0

What, however, appears to be very striking in the results given in the preceding table is the fact that the dispersion effected by the Na₂CO₃ treatment was the minimum. The amount of Na₂CO₃ used was sufficiently large to convert the whole of the clay into sodium clay. Dr. Joseph's apprehension, therefore, regarding the maximum dispersion at one treatment appears to be justified. Accordingly analyses of the above soil samples are being made again by the Na₂CO₃ method but this time using the sedimentation technique.

In two out of the four Bihar soils more clay was obtained by the NaCl than by the International method. It is probable, therefore, that with different kinds of lateric soils extent of dispersion by the two methods will be different. Attempt is being made to secure through the Director of Agriculture, Bengal, a number of samples of lateric soils from all over India. When these have been received and various methods with modifications have been tried on them, it may be possible to suggest a method that would be suitable for all kinds of lateritic soils in India.

2.—The problem of Nitrogen Supply to Rice Plants.

In an investigation of this kind it is essential to know first of all the cycle of changes that take place in the various nitrogen compounds in paddy fields. Accordingly estimations of total nitrogen, ammonia and nitrate in some of the rice fields in the Dacca Government Farm are being made at different periods from middle of June 1930 onwards.

Method of estimating total nitrogen in soil.

Kjeldahl method or one of its modifications is generally used when the soil contains no nitrogen. When nitrates are present in appreciable amounts precautions are taken to arrest the nitric acid which otherwise will volatilise away thus giving a lower value for nitrogen. The following three known methods which give total nitrogen including nitrate, have been tried and were found to be equally efficient:—

- (1) Combination of Uliches and Kjeldahl method as suggested by Bristol and Page.
- (2) Davisson and Parson's method.
- (3) Salicylic acid method, A. O. A. C.

In the salicylic acid method, thiosulphate has been found to be a more suitable reducing agent than zinc. Moreover, when zinc is used, an excess of alkali has to be added in subsequent operation to dissolve the precipitated Zn(OH)₂. Bal's modified method, viz., treating the soil with water to prevent the cementation of heavy particles during digestion was also tried but found to give no higher results, thus indicating that there is no possibility of soil particles being cemented during digestion in the case of Dacca soils.

But in the routine work with rice soils it has been found unnecessary to adopt any of the above methods. Kjeldahl and Gunning method giving equally good results. The reason for this is that rice soils contain no nitrate during the waterlogged period and even in dry seasons (up till the writing up of this report) samples containing more than 4 p. p. m. of nitric nitrogen have not been found. Even if it is assumed that the whole of the nitric nitrogen is lost during digestion, the value for total nitrogen will be lowered by a 4 p. p. m. thus giving an error which is very smaller than the error due to the inherent defects of the method. Of the three methods stated above, the first two are troublesome and laborious while salicylic acid method is the easiest, although the latter cannot arrest nitric acid quantitatively in presence of sufficient moisture. The salicylic acid method, however, was finally adopted as it arrests at least a part of nitric nitrogen and also because the digestion is quicker in this than in the Kjeldahl and Gunning method. Whether the rapidity in digestion is due to the catalytic action of sulphur formed or to the additional amount of SO_2 evolved by the action of H_2SO_4 on thiosulphate is not known at present. Work, however, is in progress to find an explanation for this. In case the nitric nitrogen increases afterwards, the method of determining total nitrogen will be modified accordingly.

Seasonal changes of total nitrogen in soil.

Three plots, North Hazi-low, Khoskhana Bye and South Ravina, were selected in the Government Farm at Dacca. All these plots are unmanured rice fields, the first two being cropped and the latter uncropped. Soil samples were brought periodically from the three plots for estimation of total nitrogen. Since the effect of air-drying on the nitrogen content of these soils was not known it was decided to determine total nitrogen both in the first samples and also when they were dried in air. In order to be able to get an idea of the possible error involved in the determination, the latter was always carried out in duplicate. From the differences between the duplicate results the standard error of experiment was calculated and found to be 12 p. p. m. for soils containing nitrogen from 900 p. p. m. to 1,500 p. p. m. of dry soil. By trial it was found that the sampling error was minimum when soils from three or more holes (0'-6") taken at random from the plot were mixed together. The difference between the nitrogen figures for two such composite samples taken on the same day from a plot was not greater than the difference between the duplicate figures of each sample. In spite of this two composite samples are being taken periodically from each of the above plots since that would enable the calculation of the error, if any, due to soil heterogeneity. In the following table the results of analysis of the fresh soil samples from the two cropped plots are given. In the third column of the table the gain of nitrogen in soil since the date of collection of the first samples is given as pounds per acre assuming that half acre foot of soil weighs two million pounds.

TABLE III.

Showing seasonal changes in the nitrogen content of rice fields.

N. Hazi-low—Unmanured.

Date.	Total nitrogen in soil p.p.m. as lbs. per acre.	Gain of N. in soil since 21-6-1930.	Remarks.
21-6-1930	925	..	
27-6-1930	910	-30	Aman (paddy transplanted on 12-7-1930.
11-9-1930	1,086	322	
12-11-1930	1,112	374	Ears of paddy appeared.
11-12-1930	1,008	166	Paddy harvested on 17-12-1930.
9-1-1931	1,016	182	
11-2-1931	1,014	178	
6-3-1931	1,020	190	

Khoskhana Byde—Unmanured.

Date.	Total nitrogen in soil p.p.m. as lbs. per acre.	Gain of N. in soil since 21-6-1930.	Remarks.
21-6-1931	1,400	..	
11-7-1930	1,433	66	Aman paddy transplanted, 9-7-1930.
12-11-1930	1,593	386	Ears of paddy appeared.
15-12-1930	1,567	334	Paddy harvested on 15-12-1930.
16-1-1931	1,543	286	
18-2-1931	1,491	182	
30-3-1931	1,507	214	

It is evident from the above table that the nitrogen content of soils increases considerably under crop, becomes maximum at about the time when the ears of the plants begin to appear and then decreases. Although at the time of writing up this report the total nitrogen in either plot is much higher than what it was in June last year, the content may yet come down during the next two and half months and ultimately become equal to the original amount.

This large gain of nitrogen in soil at a time when a decrease would be expected owing to the removal of some nitrogen by the crop is rather striking. From the yields of the plots (which were about 33 maunds of dressed grain per acre), it can be shown that the total amount of nitrogen present in one acre's entire crop (grain and straw) was about 50 lbs. Even if all of this nitrogen came from the soil, the amount would be quite small in comparison with the gain and loss in nitrogen which the soil sustains in the course of one year. Probably this explains why by growing rice year after year for centuries without adding any manure to the soil it has not been possible to deplete the latter of its nitrogen content.

It is difficult to suggest at the moment the cause for the observed gain in nitrogen. The figures in the above table tend to indicate that the crop itself has something to do with the gain, otherwise the latter would not stop so abruptly as soon as the crop matured. If that is so, the results obtained at Pusa claiming the presence of an anaerobic bacteria in paddy roots capable of fixing atmospheric nitrogen appear to be well supported. But there are also other possibilities of fixation in these soils. Unfortunately by the time this laboratory was brought into proper working condition, last year's season was over. Moreover, for want of apparatus biological works cannot yet be taken up in hands. It is expected, however, that this part of the problem will be thrashed out more fully during the coming season.

The uncropped plot South Ravina had to be rejected after periodic determinations of nitrogen were continued for a few months owing to the discovery of bad patches of soil in the plot having extremely variable composition. Another plot in East Ravina has been selected in its place. This plot is divided into two portions one of which is being kept fallow and the other will be cropped in due course.

Effect of air-drying.

In the course of the periodic determinations of total nitrogen it was found that the nitrogen content of soil samples changed irregularly when air-dried. In the following table some of the results obtained are given :—

TABLE IV.

Showing the changes in the nitrogen content of soil samples when air-dried.

Soil sample from—	Moisture in fresh sample.	Total nitrogen in—		Difference p. p. m.
		Fresh samples p. p. m.	Air-dried samples p. p. m.	
1. N. Hazi-low	27.0	925	962	37
2. Ditto	20.8	1,112	1,157	45
3. Ditto	18.8	1,008	996	—12
4. Ditto	11.5	1,016	1,032	16
5. Ditto	10.2	1,014	1,000	—14
6. Ditto	16.4	1,020	997	—23
7. Khoshkhana Byde ..	33.3	1,369	1,322	—47
8. Ditto	38.8	1,400	1,334	—66
9. Ditto	39.4	1,433	1,400	—33
10. Ditto	43.4	1,593	1,435	—158
11. Ditto	40.5	1,567	1,529	—38
12. Ditto	33.3	1,543	1,510	—33

It is clear from the above figures that during the process of drying certain changes take place in soil conditions involving loss or gain of total nitrogen. Attempt is being made to find out the cause for these changes. The work is of obvious importance since rice fields become practically air-dried in Summer.

Seasonal changes of nitrate and ammonia in soil.

Both Nitrate and Ammonia (free and saline) were determined in the fresh soil samples which were collected periodically for the estimation of total nitrogen. For nitrate Phenoldisulphonic acid method was used and for ammonia McLean and Robinson's method was followed.

The nitrate in soil decreased as soon as water was admitted into the field and practically disappeared when the latter remained submerged for a few days. The reappearance of nitrate took place only after the surface soil had begun to dry up but the accumulation was never large. Up till now (i.e., March) maximum amount of nitric nitrogen in the plots under investigation has not been found to be more than 4 p. p. m. of dry soil. Unless considerable amount of nitrate is formed during the next two months, it appears that the leaching of nitrate is not a factor in the animal loss of nitrogen in the two plots.

On the other hand ammonia was found to increase when the plots remained submerged in water and to disappear gradually as the soil dried up. During the water-logging period an average of 15 p. p. m. of ammoniacal nitrogen was present in the soil. The amount has now come down to 5 p. p. m.

From the figures for nitrate and ammonia in the soil, it appears that ammonia is the principal substance from which the rice derive their supply of nitrogen. The mechanism of the production of ammonia in water-logged soils is not yet fully understood but a recent work attributes it to the action of an enzyme (deaminase) of the microflora of the soil. Studies in this direction, therefore, appear to be profitable and will be undertaken in this laboratory in due course.

3.—Water Culture Experiments.

These experiments were carried out in the premises of the laboratory building as a separate pot culture house was not available. The results must therefore be considered as provisional. These experiments will be repeated in the pot culture house which has just been completed and it is hoped that more accurate data will be submitted in the next year's report.

Influence of reaction on the growth of paddy.

Complete nutrient solution, consisting of a mixture of $\text{Ca}(\text{NO}_3)_2$, KH_2PO_4 , MgSO_4 , was prepared using fractional gram equivalent of the substances so as to give one atmosphere osmotic pressure. The PH of this solution was 4.6. Other PH's with the solution were obtained by adding different quantities of normal KOH solution and in order that equal amount of potash was present in all, requisite amounts of normal K_2SO_4 solution were added to compensate the deficiency. Solutions having the PH's 4.6, 5.7, 6.2, 7.0 and 8.5 were prepared and taken into two-litre glass jars, two for each PH. Rice plants (transplanted Aman paddy) which were 7.8 weeks old were brought from the field and grown in these solutions, one plant to each jar. 5 c. c. of 0.5 per cent. ferric citrate solution were added from time to time to keep the supply of iron adequate throughout. It was found that plants thrived best at PH 4.6. On the other hand it was also found that in solutions having PH greater than 4.6 some precipitation of calcium and magnesium phosphate took place. Consequently it remains undecided as to whether the best growth at PH 4.6 was due to the favourable influence of the reaction on the plant itself or to the fact that at this reaction more plant food was available. Further water experiments will be undertaken during the coming season to settle this point.

Plant food requirements of paddy.

The purpose of this investigation is to make a systematic study of the effect of all the principal food elements on the growth of paddy. The season for Aman paddy being over experiments were tried with Boro paddy using as a start the following nutrient solutions having one atmosphere osmotic pressure:—

- | | | | | | |
|---|-----------------------------|--|-------------------------------------|-------------------|----------------|
| (1) Complete nutrient solutions | KH_2PO_4 | + $\text{Ca}(\text{NO}_3)_2$ | + MgSO_4 | + Fe | + B + Mn. |
| (2) No iron solution | .. | .. | .. | .. | B + Mn. |
| (3) No Boron + Manganese solution. | .. | .. | .. | .. | Fe |
| (4) No Ca, Mg + P solution | .. NH_4NO_3 | + K_2SO_4 | + Fe | + B | Mn. |
| (5) NH_4NO_3 for nitrogen | .. KH_2PO_4 | + NH_4NO_3 | + MgSO_4 | + CaSO_4 | + Fe + B + Mn. |
| (6) $(\text{NH}_4)_2\text{SO}_4$ for nitrogen | .. The same as (5) | but using $(\text{NH}_4)_2\text{SO}_4$ | in place NH_4NO_3 . | | |

NOTE.—The concentrations of Boron and also of Manganese in the above solutions were 4 p. p. m.

Boro plants which were about 8 weeks old were brought from the field and placed in the above solutions contained in two-litre glass jars, two for each solution. Except in the no iron 5 c.c. of 0.5 per cent. ferric citrate were added to the solutions from time to time to keep the supply of iron adequate throughout.

The following observations were made:—

- (1) There was fairly satisfactory growth of plants in all the jars except in the no iron and no Ca, Mg and P series.
- (2) Plants in the no iron series showed distinct signs of iron deficiency after about two weeks and in the course of the next few weeks most of the leaves became chlorotic and half dead.
- (3) Plants in the no Ca, Mg and P series did not thrive from the very beginning and developed no more roots than what they had when they were brought from the field.
- (4) The growth of plants in no B and Mn series was as good as that in other complete nutrient solutions.

(5) There was no visible difference in the growth of plants in the three different sets of complete nutrient solutions containing nitrogen as NO_3 , NH_3 and NH_4NO_3 , respectively.

(6) Analysis of the complete nutrient solution containing NH_4NO_3 showed that of the 105 p.p. m. of each of ammoniacal and nitric nitrogen originally present 25.2 p. p. m. of ammonia nitrogen and 75.5 p. p. m. of nitric nitrogen were left in the solution after the growth of the crop.

From the results of the above preliminary experiment it appears that rice plants can thrive equally well when nitrogen is available in the form of either ammonia or nitrate. Where both are present ammonia is taken up by these plants in preference to Nitrate. Furthermore, that iron is an essential element for the growth of rice plants is fully borne out by the results of the experiment which also show that it is not essential that traces of Boron and Manganese should be present in the medium for the good growth of rice plants. Lastly, the results do not support the recently published observation of Gerrick in America that paddy seedlings which have been grown in medium containing the necessary food elements for four weeks can grow subsequently to maturity in absence of Calcium, Magnesium and Phosphorus.

Programme of Future Work.

1. Continuation of the mechanical analysis of lateritic soils from different parts of India using a number of known methods.
2. Trial of new dispersion treatments suitable for laterites.
3. Work on the specification of cultural differences in soils.
4. Estimation of Silica, Aluminium and Iron in the typical lateritic soils collected from different parts of India for the work in (1).
5. The same as (4) but in the clay fractions of the soils.
6. Studies on the physical properties of the lateritic soils and clays.
7. Mechanical analysis of silt-laden river water taken at various places along the river and also of the silt soils deposited at those places. (This work has been kindly suggested by Mr. Finlow, the Director of Agriculture, Bengal).
8. Continuation of the periodical estimation of total nitrogen, ammonia and nitrate in three cropped and one uncropped plots.
9. The same as (8) but with paddy grown in plots.
10. Periodic estimation of NH_3 and NO_3 in the water standing above the field.
11. Estimation of total nitrogen in soil and in rice plants grown in pots at various stages in growth.
12. The same as (11) but using known solutions and sand.
13. Further sand and water culture experiments with paddy using increasing amounts of ammonia and also nitrate.
14. Water culture experiments to find the reaction most suitable for the growth of rice plants.
15. Continuation of the work on the plant food requirements of paddy.
16. Determination of the nitrogen fixing capacities of the field and pot soils, under experiments (8) and (9) at different periods throughout the year.
17. To parallel series of experiments in one of which, nitrogen fixing organisms will be grown alone and in the other same with algae.
18. Attempts to isolate organism from paddy roots capable of fixing nitrogen.
19. Studies on the mechanism of production of ammonia in soil under the waterlogged condition.
20. Estimation of the amount of silt, if any, and of the nitrogen therein which is deposited annually in the fields under experiment (8).

ANNEXURE II.

REPORT FOR THE YEAR 1931-32.

1. Mechanical Analysis of Lateritic Soils.

During the year under review a large number of samples of typical lateritic soils occurring in different Provinces all over India were obtained through the courtesy of the Provincial Agricultural Departments. The four methods of mechanical analysis described in detail in last year's report, were tried on these soils with a view to find out which of them gave the maximum dispersion without being drastic and without consuming undue time and labour. The methods were—

1. International method without peroxide treatment. .. (HCl-NaOH)—Pipette technique.
2. Puri method (NaCl-NaOH)—Pipette technique.
3. Direct NaOH method (NaOH)—Pipette technique.
4. Sudan method (Na₂CO₃)—Sedimentation procedure.

In this report, however, the results are given of the mechanical analysis of 18 soils which may be taken to represent the whole lot of the above soils fairly well. The colour of these 18 soils, their loss on ignition, organic matter determined by the wet oxidation method, carbonate content by Collin's Calcimeter, total exchangeable bases by electro-titration, p.H. values (by H-electrode, etc., are given in Table I below. It will be found from this table that Indian laterites generally contain little organic matter and are extremely poor in lime content and exchangeable bases.

TABLE I.

Showing organic matter, lime content, exchangeable bases, pH, etc., in Indian laterites.

Soil No.	Laboratory No.	Soil from.	Colour.	Organic matter-%.	Loss on ignition %.	Moisture in air-dry soil %.	Carbonate as Ca CO ₃ %.	Total exchangeable bases in mill-equiv. per 100 gm. air-dry soil.	pH.
1	34	Calicut, Madras ..	Red	1.9	16.5	4.0	Trace	1.4	5.1
2	58	Kumata, Bombay ..	.. ..	2.4	14.8	5.6	Nil	5.7	6.0
3	64	Tenasserim, Burma ..	Dark brown ..	4.1	10.8	3.0	..	2.0	5.7
4	74	Bhubaneswar, Orissa ..	Light yellow with tinge of brown.	0.9	5.8	2.6	..	4.5	5.5
5	24	Raipur, C. P. ..	Red	1.1	9.7	1.9	0.034	3.9	6.6
6	30	Teliparamba, Madras ..	Dark brown ..	10.2	26.0	6.3	Trace	2.7	5.4
7	80	Satgaon, Assam ..	Light red	1.8	11.9	4.2	..	0.7	5.0
8	1	Giridih, Behar ..	Deep red .. ..	..	5.6	2.9	..	4.6	7.2
9	5	Do.	Red .. ..	..	5.9	3.3	Nil	1.7	6.7
10	11	Deoghar, Behar ..	Yellowish brown ..	..	5.5	2.0	Nil	3.3	6.7
11	15	Do.	Red	0.4	7.4	2.9	Trace	2.5	6.8
12	98	North Haji Dacca Farm	Light yellow with a tinge of brown.	1.3	5.2	1.8	Nil	1.7	5.6
13	100	Khoskhana Dacca Farm	Light yellow with a tinge of brown.	1.9	7.8	2.8	Nil	1.7	5.0
14	26	Guntur, Madras ..	Deep red .. ..	..	3.8	1.4	Trace	4.2	7.7
15	20	Insein, Burma ..	Light red .. ..	..	4.0	1.0	..	1.3	5.3
16	38	Bankura, Bengal ..	Do.	0.3	4.7	1.5	Nil	3.1	6.4
17	44	Birbhum, Bengal ..	Light yellow with a tinge of brown.	..	2.8	1.1	Nil	2.7	6.1
18	53	Midnapore, Bengal ..	Do. .. ..	..	2.8	1.0	Nil	2.6	5.3

*Organic matter was not determined in this and other soils where the percentage loss on ignition was small.

Experimental results and discussions.

In Table II below are given the percentages of clay and clay + silt obtained by the four methods of mechanical analysis as stated above, in the 18 soils under investigation.

TABLE II.
Percentage clay and clay + silt in air-dry soil.

Soil No.	Clay %.				Clay + silt %.			
	International method (HCl-NaOH).	Puri method (NaCl-NaOH).	Direct NaOH method.	Sudan method Na ₂ CO ₃	International method (HCl-NaOH).	Puri method (NaCl-NaOH).	Direct NaOH method.	Sudan method CNa ₂ CO ₃ .
1	43.8	9.0	43.5	44.2	57.5	17.5	57.6	56.9
2	43.6	16.3	43.4	43.8	65.1	31.4	66.3	64.5
3	19.5	5.7	19.2	19.9	27.3	16.2	28.8	27.7
4	17.2	12.6	16.3	17.1	36.4	35.8	38.6	36.4
5	17.1	14.4	16.6	14.9	31.3	23.7	32.7	..
6	41.9	6.4	41.2	42.6	66.9	14.8	64.8	63.5
7	27.3	15.0	27.9	..	47.9	41.0	48.6	..
8	21.2	21.8	22.1	20.5	29.4	31.3	31.8	29.7
9	30.3	29.9	31.7	31.3	42.8	43.5	43.7	43.5
10	21.1	21.3	21.4	22.3	36.4	38.2	37.5	36.7
11	29.2	31.1	31.1	30.3	41.8	44.3	44.2	42.0
12	18.4	18.8	17.7	17.2	51.1	52.9	53.6	..
13	25.3	25.4	25.6	24.2	56.7	58.8	59.9	..
14	12.0	12.8	11.1	..	16.0	16.0	15.0	..
15	12.6	10.7	10.8	..	18.9	19.2	19.6	..
16	19.0	17.7	17.7	..	30.0	27.0	29.2	..
17	9.2	10.1	9.6	..	23.7	24.9	25.1	..
18	10.5	10.3	10.0	..	22.1	23.7	22.3	..

It is evident from the above table that the International, Direct NaOH and the Sudan Methods gave almost equal results. Consequently for lateritic soils which contain little or no calcium carbonate and very little exchangeable bases (Table I), there is no obvious gain by introducing the HCl treatment as in the International method nor by following the sedimentation process as in the Sudan method. Puri method, however, failed to disperse the first seven soils adequately although it gave results as good as those obtained by other methods for the remaining soils. It should be stated here that the dispersion in the International and the direct NaOH method was effected by 24 hours shaking of the soil suspension made alkaline by 4 c. c. of normal NaOH solution whereas in the Puri

method the suspension was made just alkaline to phenolphthalein (about 1 c. c. of N.NaOH was required) and then left for 5 to 6 hours with occasional hand shaking. In order to see, therefore, whether dispersion by Puri method improved by employing the mechanical shaking and also by using a larger quantity of alkali four soils 1, 2, 3 and 6 were selected and dispersion treatments as stated in Table III below were tried.

TABLE III.

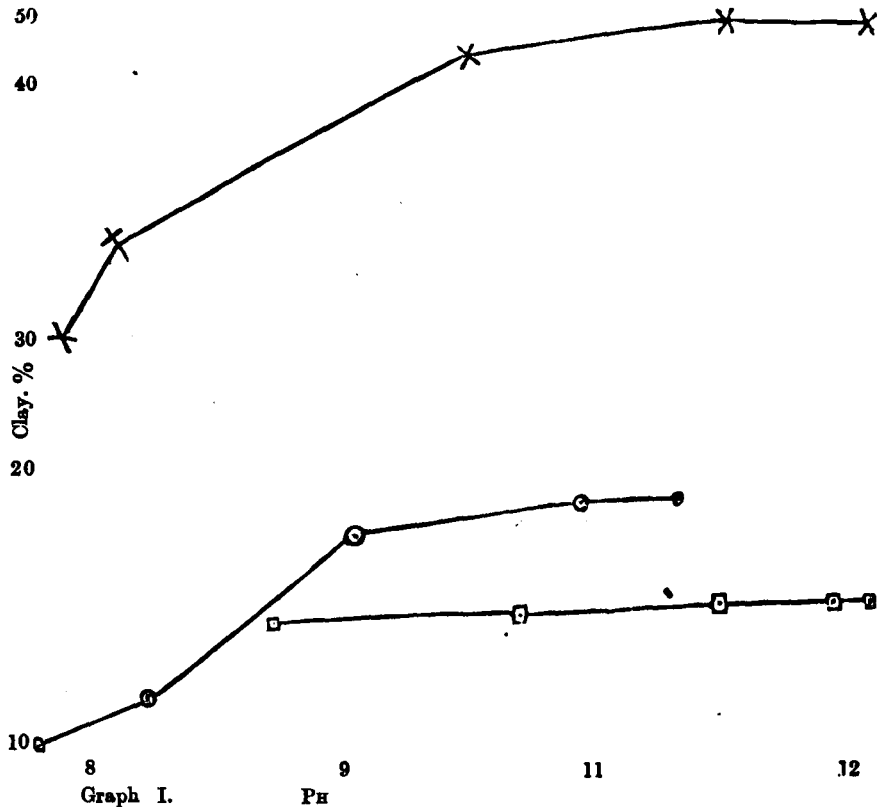
Percentage clay and clay + silt obtained by employing different dispersion treatments.

Soil No.	International method using 4c. c. N. NaOH.	Direct NaOH using 4 c.c. N. NaOH	Puri method suspension just alkaline.	Puri method suspension shaken 24 hrs. after making just alkaline.	Direct shaking of suspension for 24 hrs. after making just alkaline.	Puri method suspension shaker for 24 hrs. 4 c.c. N. NaOH.
			<i>Clay %.</i>			
1	43·8	43·5	9·0	22·7	26·1	43·4
2	43·6	43·4	16·3	31·8	25·7	44·2
3	19·5	19·2	5·7	12·2	11·3	19·1
6	41·9	41·2	6·4	26·3	28·0	38·2
			<i>Clay + silt %.</i>			
1	57·5	57·6	17·5	54·4	50·4	58·5
2	65·1	66·3	31·4	64·9	60·7	67·0
3	27·3	28·8	16·2	25·5	24·6	28·2
6	66·9	64·8	14·8	55·4	52·8	61·1

Comparison of results given in column 5 in the Table III above shows that better dispersion of soil is obtained by employing the shaking procedure in the Puri method. Even then the amount of clay so obtained is much smaller than that given by the International or the direct NaOH method. As a matter of fact it is almost equal to that given by shaking the soil suspension directly with that amount of alkali as has been used in the Puri method without the NaCl treatment (column 6). But when 4 c. c. N. NaOH and 24 hours shaking are employed in the Puri method the amount of clay thus obtained is practically equal to that given by the International or the Direct, NaOH method. It is clear therefore, that the incomplete dispersion of some of the lateritic soils obtained by following the Puri method as shown in Table II is obviously due to insufficient quantity of NaOH and mechanical shaking. When these are rectified the Puri method is as good as the International method.

It is also clear from above that dispersion is considerably affected by the quantity of NaOH used. Attempt was therefore made to find out the amount of alkali which would effect complete dispersion without being too drastic for lateritic soils. For this purpose suspension of 20 gms. lots of soils 1, 3 and 12 were shaken with 1, 2, 4, 6 and 8 c.c. of N. NaOH solution for 24 hours and the clay determined. The pH of the suspensions were measured with hydrogen electrode. In graph I the clay figures are plotted against the pH of the suspensions from which it will be found that the former practically reached the maximum value at pH 10·0-10·5. We have also found that the amount of soil material other than organic matter in solutions having pH up to pH 10·5 does not exceed 0·6%. Consequently we consider that the quantity of NaOH to be used for dispersion should be such that the resulting reaction of the suspension does not differ much from pH 10·5. Some 6 to 8 c.c.

Graph I.—Showing the dispersion of soil in aqueous suspensions of varying pH.



Graph I.

PH

11

12

Soil No. 1—X

Soil No. 3—O

Soil No. 12—□

Some 6 to 8 c.c. of N. NaOH to 20 gms. soil will be found suitable for this purpose with Indian laterites.

Use of H_2O_2 in the mechanical analysis of lateritic soils.

TABLE IV.

Percentage of clay obtained by the same quantity of alkali before and after H_2O_2 treatment.

Soil No.	Organic matter %.	Intern. Method NCl-NaOH 8 c.c. N. NaOH.	Direct NaOH method 8 c.c. NaOH.	Intern. method H_2O_2 — HCl— NaOH 8c.c. N. NaOH.	Direct NaOH method H_2O_2 — NaOH 8c.c. N. NaOH.
2.	2.4	45.5	44.9	46.2	45.5
3	4.1	21.9	21.5	18.4	18.9
6	10.2	45.7	43.5	48.1	46.9

It will be seen from the above table that after the H_2O_2 treatment higher clay figures for the soil Nos. 2 and 6 and lower clay figure for the soil No. 3 were obtained by both the International and the Direct NaOH method. It should be mentioned that as a result of the H_2O_2 treatment the percentage of clay for all the above soil was reduced by amounts equal to (i) % loss of clay by solution due to H_2O_2 (0.2%, 1.6%, and 3.1% for soils 2, 3, and 6 respectively) and (ii) % loss of organic matter (0.7%, 2.5% and 4.7% for soils 2, 3 and 6 respectively) which otherwise would have remained in solutions due to the alkali and been added, although improperly, to the clay figure. Obviously therefore, in the case of soil Nos. 2 and 6 improvement in dispersion due to the use of H_2O_2 has more than counterbalanced the losses mentioned above while in the case of soil No. 3 this has not been so.

Although it appears from the above that a considerable amount of organic matter comes in solution in the Direct NaOH method, nevertheless it has been found that this amount does not exceed 0.5% in case of soils containing organic matter 2% or less. Consequently the Direct NaOH method may be employed for the mechanical analysis of Indian lateritic soils which generally contain less than 2% organic matter (Table I). For soils with higher percentages of organic matter hydrogen peroxide treatment should be included in the method.

Short description of the Direct NaOH method.

20 gms. of lateritic soil are shaken with 500 cc. of water and 6 or 8 cc. of N. NaOH solution (so that the suspension has a pH about 10.5) for 24 hours in an end-over-end shaker. The suspension is then passed through a 0.2 m.m. sieve (standard 70 mesh I.M.M.) and made up to 2 litres. Clay and silt are estimated by employing pipette technique and fine sand by sedimentation. For soils containing more than 2% organic matter hydrogen peroxide treatment should precede the shaking with alkali. In this case however the loss by solution of sesquioxide, etc., should be determined, by igniting the ppt. obtained by addition of ammonia in the filtrate after the peroxide treatment, and added to the clay figure.*

General Remarks.

The results given in the preceding pages show that lateritic soils offer little difficulty for mechanical analysis. Statements have frequently been made in the past that lateritic soils were an admitted difficulty. It is believed that these statements were made from *a priori* reasoning since no data of mechanical analysis were available at that time for this type of soil which was known to possess a highly granulated structure. The few different methods of analysis that were tried here on Indian laterites gave the same amount of clay that is to say the dispersion in every case was complete or at any rate reproducible. Amongst these methods the Direct NaOH method a short description of which is given above has been found to be the most simple and the least time consuming and is therefore likely to prove very suitable for the mechanical analysis of Indian laterites where complete dispersion is aimed at. A paper containing the above results will soon be communicated for publication. Further work on the mechanical analysis of lateritic soils is continued in which attempt is being made to estimate the various soil fractions as they exist in the field. Also the clay fraction of a dozen lateritic and three ordinary soils have been separated and purified by electro dialysis. A thorough study of the colloidal behaviour of these purified clays are being made and some of their physical constants co-related with their silica/sesquioxide ratios. This study has been undertaken in view of the fact that the lateritic soils some of which contain 40—45% clay (Table II), can be cultivated in such a high state of moisture as would ruin their texture for a considerable period, if they contained anything like such large percentages of clay. Consequently it is of importance to distinguish between colloidal clay, i.e., Hydrated silicate of alumina and the finest fraction obtained in the mechanical analysis of lateritic soils.

2.—The problem of Nitrogen Supply to Rice Plants.

It was stated last year in an investigation of this kind that it is essential to find out the cycle of changes that take place in the various nitrogen compounds in paddy fields. Accord-

* Should the clay complex contain a large amount of exchangeable calcium the HCl treatment should be included in order to avoid the flocculating effect of the calcium hydroxide produced by the addition of alkali. So far as the Indian laterites are concerned, the HCl treatment has been found unnecessary.

ingly two plots in the Dacca Government Farm were selected and periodic estimations of total nitrogen, ammonia and nitrate in those plots were made. During the year under review one of the plots, North Haji low, was divided into two sub-plots, one of which was left uncropped and the other cropped as was done in the previous year, ploughing and other operations being identical in both sub-plots. Similarly a new unmanured plot, East Ravina was selected and divided into two sub-plots as above. In all therefore five plots were under investigation this year in which the periodic estimations of total nitrogen, etc., were continued.

Seasonal changes of total nitrogen in paddy fields.

Last year there was considerable gain of nitrogen in the soil while under the crop. The maximum gain took place in early November when the ears of paddy began to appear. Thereafter the nitrogen content of the soil gradually decreased reaching almost the same value in July this year (1931) as it was in June last year (1930). With the growth of the crop this year no increase but rather a decrease in total nitrogen with considerable fluctuation was found to take place in the soil, Table VI, below. In the case of one plot, north Haji, there was a slight gain of nitrogen during the period November-December this year but it was soon followed by a considerable loss.

TABLE V.

Showing seasonal changes in the nitrogen content of rice fields.

Date.	Total nitrogen as p. p. m. of oven-dry soil.		Remarks.
	Cropped plot.	Uncropped plot.	
North Haji 1930—			
June 21st	925		
November 12th ..	1112	..	Paddy flowered. Paddy harvested.
1931—			
January 9th	1016		
April 9th	991		
May 2nd	948		
July 23rd	933	..	Plot divided into cropped and uncropped sub-plots.
August 7th	904	904	Paddy transplanted.
September 3rd ..	875	886	
September 24th ..	866	913	
November 11th ..	923	921	Paddy flowered.
December 10th ..	933	956	Paddy harvested.
December 21st ..	840	841	
1932—			
January 22nd	883	893	
February 4th .. ..	..	917	
Khoskhana 1930—			
July 11th	1433		
November 12th ..	1593	..	Paddy flowered. Paddy harvested.
1931—			
January 16th	1543		
March 1930	1507		
April 23rd	1468		
May 14th	1493		

Date.	Total nitrogen as p. p. m. of oven-dry soil.		Remarks.
	Cropped plot.	Uncropped plot.	
July 10th	1414	..	Paddy transplanted.
August 26th	1474	..	
November 25th	1426	..	
1932—			Paddy flowered. Paddy harvested.
January 7th	1400	..	
East Ravina 1931—			Paddy transplanted.
April 16th	1399	1399	
May 14th	1387	1387	
July 2nd	1276	1276	
July 27th	1290	1298	
August 17th	1269	1336	
September 10th	1341	1335	
October 5th	1284	1336	
November 20th	1245	1278	
December 16th	1274	1294	
1932—			Paddy flowered. Paddy harvested.
January 28th	1366	1357	
February 16th .. ..	..	1321

The apparent contradiction between this and last year's results only point to the complex nature of the processes taking place in the soil. The fact that the total nitrogen of the cropped plot fluctuated in the same way as did that of the corresponding uncropped plot shows that there are other factors besides the crop which cause changes in the nitrogen content of the soil. The extent of changes by these factors may vary from year to year depending probably on the presence of straw and roots in the soil on the one hand and rainfall, temperature, humidity, amount of sunshine, etc., on the other. Consequently a study of the effect of water-logging at different seasons and the presence of straw and roots on the changes in total nitrogen in the soil has been started and some preliminary results obtained are given in this report later on. The periodic estimations, however, of total nitrogen in the above five plots are being continued.

Seasonal changes of nitrate and ammonia in soil.

As was observed last year the nitrate in the soil decreased as soon as water accumulated in the field and practically disappeared when the latter remained submerged for a few days. The reappearance of nitrate took place only after surface soil had begun to dry up but the accumulation of nitrate was never large.

On the other hand there was rapid ammonification in the soil when water-logged and in the uncropped plots ammonia continued to accumulate until the end of the water-logging period. With the drying up of the soil ammonia rapidly disappeared (*vide* columns 5 and 6 of Table VI below) but the loss was much greater than the corresponding gain in nitrate showing thereby that all of the lost ammonia was not converted into nitrate. In the cropped plots ammonia accumulated until the vigorous stage of crop growth when it suddenly and completely disappeared presumably due to its assimilation by the growing plants. It would appear from this that a top dressing of an ammonia fertilizer after about six weeks from transplantation is likely to improve the growth of crop considerably. It is also evident from the above table that ammonia is the principal nitrogenous food of the rice plant in the field. Consequently investigations on the mechanism of the production and loss of ammonia in soil is of fundamental importance for rice culture and will be undertaken in due course.

Table VI.

Showing the changes of nitrate and ammonia in cropped and uncropped soil.

Date.	Nitrate as p. p. m. of oven-dry soil.		Ammonia as p. p. m. of oven-dry soil.		Percent- age of moisture in un- cropped soil.	Remarks.
	Cropped soil.	Un- cropped soil.	Cropped soil.	Un- cropped soil.		
East Ravina—1931—						
April 16th ..	Trace	Trace	6.7	6.7	15.1	
May 14th ..	"	"	6.6	6.6	34.5	
July 2nd ..	Nil.	Nil.	8.6	8.6	40.7	Transplanta- tion.
July 27th ..	"	"	11.9	10.4	35.9	
August 17th ..	"	"	1.9	12.2	36.8	
September 10th ..	"	"	0.7	14.8	38.2	
October 5th ..	"	"	0.0	19.3	37.8	
November 20th ..	Trace	Trace	1.5	20.1	37.3	Flowering.
December 16th ..	"	"	2.7	19.3	32.7	Harvest.
1932—						
January 28th ..	0.4	1.3	3.0	4.8	21.5	
February 16th ..	"	"	2.2	2.7	21.9	
North Hazi—1931—						
May 2nd ..	2.4	2.4	1.8	1.8	6.3	
July 23rd ..	Nil.	Nil.	4.2	4.2	32.0	
August 7th ..	"	"	8.5	7.8	32.6	Transplanta- tion.
September 3rd ..	"	"	18.0	17.8	33.0	
September 24th ..	"	"	1.4	25.0	31.8	
November 11th ..	"	"	2.9	8.9	28.5	Flowering.
December 10th ..	1.3	8.3	2.0	1.9	14.7	Harvest.
December 21st ..	Trace	9.4	2.6	1.5	11.7	
1932—						
February 4th ..	"	"	1.9	1.9	14.7	
Kaoskhana—1931—						
April 24th ..	0.5	"	4.7	"	"	
May 14th ..	1.1	"	1.5	"	"	
July 10th ..	Nil.	"	10.9	"	"	Translanta- tion.
August 26th ..	"	"	0.0	"	"	
November 25th ..	"	"	1.5	"	"	Flowering.
1932—						
January 7th ..	"	"	1.5	"	"	Harvest.

Influence of rice straw and root on the fixation of nitrogen in paddy soil.

It has already been mentioned that the presence of straw and roots of rice plant may cause changes in the nitrogen content of the soil. After harvest rice roots and stubbles remain in the field which ultimately undergo decomposition in the soil. Some of the degradation products of these substances may serve as sources of energy to the N-fixing organisms and fixation of a certain amount of nitrogen may thus take place. To test this, 15 gm. lots of air dry soil were taken with varying amounts of straw, roots or mannite in 300 c. c. Kjeldahl flasks and left for 2½ months, in the open where it could get the sunlight. The moisture content of the soils in the flasks was maintained at about 15 per cent. throughout. At the end of this period, the total nitrogen was estimated by the Kjeldahl method. The results are given in the following table.

TABLE VII.

Showing the influence of rice straw and root and of mannite on the fixation of nitrogen in soil from a paddy field.

Quantity of straw, root or mannite added to 15 gm. soil.	Total N in the mixture at start.	Total N after incubation in mgm.		Gain in Total N.	Difference between the gains of total N. in treated and untreated soil.
		Actual.	Mean.		
	Mgm.			Mgm.	Mgm.
Untreated soil	21.07	{ (a) 21.42 (b) 21.42 }	21.42	0.35	..
Straw* 0.15 gm. ..	21.69	{ (a) 21.98 (b) 21.98 }	21.98	0.29	— 0.06
0.30 gm. ..	22.31	{ (a) 22.82 (b) 22.54 }	22.68	0.37	0.02
0.45 gm. ..	22.93	{ (a) 23.24 (b) 23.24 }	23.24	0.31	— 0.04
0.60 gm. ..	23.55	{ (a) 23.94 (b) 23.80 }	23.87	0.32	— 0.03
Root.* 0.15 gm. ..	21.85	{ (a) 22.82 (b) 23.10 }	22.96	1.11	0.76
0.30 gm. ..	22.62	{ (a) 24.64 (b) 25.06 }	24.85	2.23	1.88
0.45 gm. ..	23.40	{ (a) 25.90 (b) 26.04 }	25.97	2.57	2.22
0.60 gm. ..	24.18	{ (a) 27.72 (b) 28.00 }	27.86	3.68	3.33
Mannite 0.15 gm. ..	21.07	20.86	20.86	— .21	— .56
0.30 gm. ..	21.07	21.28	21.28	— .21	— .14
0.45 gm. ..	21.07	20.02	20.02	— 1.05	1.40

*Rice root and straw used in the experiment contained 0.518 and 0.413 per cent. of Nitrogen, respectively.

It will be seen from the above table that the rice straw has no influence on the nitrogen fixation—the difference between the quantities of nitrogen fixed in presence and absence of straw being negligible, last column of the above table. But the results obtained with the root afford positive evidence of the fixation of nitrogen—the gain over the control, in every case, being significant.

It is rather surprising that with mannite as the source of energy, there has not been any fixation of N—on the contrary, in one instance definite loss of N took place. This may be due to prolonged incubation—the fixed nitrogen having volatilised away as a result of the decomposition of the dead cells by other soil organisms. It may be mentioned in this connection that Ashby (J. Agri. Sci. 1910) observed similar loss of nitrogen from the culture solution on long standing.

Effect of water-logging on total nitrogen content of soil.

In order to gain some knowledge regarding the change in total nitrogen content of water-logged soils, the following preliminary experiment was carried out in the laboratory. 15 gms. portions of sieved soils were shaken with 200 c.c. of distilled water in 300 c.c. Erlenmeyer flasks. Some of the mixtures were incubated in sunlight and some in complete darkness for 3 months. A few more flasks containing similar soil-water mixtures were sterilised and a few others were treated with a solution of copper sulphate (1 : 250,000) which is known to possess an injurious effect on the growth of algae. These flasks were then incubated in the sunlight as above. During incubation there were moss and algal growths in the untreated and the copper sulphate treated flasks while in other flasks there were absolutely no such growths. The total nitrogen in the above soils was determined before and after incubation by the Kjeldahl method. The results are given in the following table—

TABLE VIII.

Showing the effect of water-logging on the total nitrogen content of soil.

Flask No.	Nitrogen expressed as parts per million.			Treatment.
	Nitrogen at start (a).	Nitrogen after incubation (b).	Difference (b)—(a).	
1	1409	1465	56	Treated with CuSO_4 . Incubated in dark.
2	1409	1484	75	
3	1409	1446	37	
4	1409	1456	47	
5	1409	1428	19	
6	1409	1316	—93	
7	1428	1409	—19	
8	1428	1446	18	Treated with CuSO_4 . Incubated in dark.
9	1428	1428	0	
10	1428	1278	—150	
11	1428	1409	—19	
12	1400	1400	0	Sterilised.
13	1400	1428	28	
14	1400	1437	37	
15	1400	1437	37	
16	1400	1316	—84	Treated with CuSO_4 . Incubated in dark.
17	1400	1372	—28	
18	942	1008	66	
19	942	1026	84	
20	942	1008	66	Sterilised.

Flask No.	Nitrogen expressed as parts per Million.			Treatment.
	Nitrogen at start (a).	Nitrogen after incubation (b).	Difference (b)—(a).	
21	942	980	38	Treated with CuSO_4 . Incubated in dark. Sterilised.
22	942	999	57	
23	942	1008	66	
24	942	989	47	
25	942	980	38	
26	942	886	-56	
27	942	952	1	

It has already been stated that there were moss and algal growths in the untreated and the copper sulphate treated flasks and it will be seen from the above table that soils in those flasks gained in total nitrogen. It appears therefore that nitrogen may be fixed in soils under water-logged condition.

The nitrogen content of the sterilised soil decreased in two out of three cases while that of soil incubated in darkness decreased markedly. No explanation for the latter fact can be given yet.

3. *Pot and Water Culture Experiment*.—The work under this head was divided as follows:—

- (1) The influence of reaction on the growth of paddy.
- (2) Plant food requirements of paddy.
- (3) Amelioration of lateritic soils.

Influence of reaction on the growth of paddy.

As was reported last year complete nutrient solution, consisting of a mixture of $\text{Ca}(\text{NO}_3)_2$, KH_2PO_4 and MgSO_4 was prepared using fractional gram equivalent of the substances so as to give one atmosphere osmotic pressure. A little of silicic acid was added to the mixture—since the presence of silica in the solution was found by trial to improve the growth of rice plants. The pH of this mixture was 3.4. Other pH's with this solution were obtained by adding different quantities of normal KOH sol. and in order that equal amount of potash was present in all, requisite amount of normal K_2SO_4 solution were added to compensate the deficiency. These solutions were taken in two-litre wide mouth glass bottles, three for each pH. Rice plants (transplanted aman paddy) which were 7-8 weeks old were brought from the field and grown in these solutions. One plant to each bottle. One bottle for each pH without crop served as control. Small quantities of 0.5 per cent. ferric citrate solⁿ. were added from time to time to the cropped solutions so as to keep the supply of iron adequate for the growing plants throughout.

During the early stage the growth of the plants were better in the very acid solutions. With time however, this difference in vegetation disappeared and when ears began to appear little or no difference was noticeable with the exception of the growth in the most alkaline solution which was visibly worse than the rest with no formation of grain. The figures for the yield of straw and root given in the following table support the above observation. It appears therefore that the rice plant can adapt itself to a wide range of pH. For the formation of grain, however, a neutral or a slightly alkaline reaction appears to be more favourable. Similar observation was also made in pot experiments to be described later. The result is of obvious importance and it is intended to verify it by a careful series of field experiments conducted with the help of the Bengal Agricultural Department during the next growing season.

TABLE IX.

Showing the pH of nutrient solution at start and at harvest and the yield of grain and straw plus root of rice plants grown in these solutions—

pH at start. Yield per bottle, average of two.			pH at harvest.	
Cropped and uncropped solutions.	Grain.	Straw and root.	Cropped sol.	Uncropped sol.
	gm.	gm.		
3.4	2.0	13.0	7.1	4.5
4.2	2.6	12.9	7.2	5.3
6.2	4.2	15.1	7.6	6.5
7.7	5.1	12.1	7.8	7.8
8.4	no grain.	10.7	7.9	8.4

It will also be evident from the above table that the reaction of the solution as a result of crop growth tends to attain a specific value, in this case pH 7.8, irrespective of the fact whether it was initially acid or more alkaline. Arrhenius working with rice plants observed a similar change of the reaction of the nutrient solutions to a specific value, in his case pH 6.2, due to the growth of crop for two days. He attributed this change to the excretion in the solution by the plant of carbon dioxide and other substances which act as amphoteric electrolytes, i.e., they can act both as bases and acids. He further believes that the decaying parts of the plant also act in the same way. During the coming season however, the nutrient solution will be renewed frequently so that the plant is allowed to grow at the same pH throughout. This is likely to give a better idea about the influence of reaction on the growth of paddy.

Plant food requirements of paddy.

Water culture experiments of last year showed that the presence of the elements phosphorus, calcium, magnesium and iron in the nutrient solutions were essential for the growth of rice plants while absence of Borax and Manganese did not affect the growth. A series of careful experiments was conducted this year to confirm the above results. The technique followed was precisely the same as of the last year, viz., rice seedlings were grown in the complete nutrient solutions and also in the nutrient solution in which the required element whose influence was intended for study was absent. The elements investigated were nitrogen, phosphorous, calcium, magnesium, potassium and iron.

TABLE X.

Showing the total yield (root, straw and grain, if any) of the rice plant grown in various culture solutions.

Nutrient solution containing.	Total yield per bottle average of two gm.
all elements	35.3 (only this bore grain).
no nitrogen	Nil.
no phosphate	0.5
no calcium	Nil.
no magnesium	1.3
no potash	1.1
no iron	3.6

The above table shows definitely that in absence of any one of the above elements, the growth of the plant is completely checked or in other words each one of these elements is essential food for paddy. It now remains to be seen whether these elements are required by the rice plants throughout its period of growth or certain elements are required only upto certain stage of its growth. It is also important to find out the most suitable concentration of the elements especially potash, phosphate and magnesium because lateritic soils with which we are concerned at Dacca are very poor in these elements. It is intended to take up these works during the coming session.

Amelioration of Lateritic Soils.

The low fertility of Indian laterites is believed to be due to—

- (1) the presence of inhibitors, *e.g.*, excessive H-ions, aluminium ions, etc. This could be corrected by treatment with lime.
- (2) deficiencies of some of the essential nutrient elements. These could be corrected by the application of suitable fertilizers.

(1) *Treatment of lateritic soil with lime.*—One dozen pots, each containing 40 lbs. of lateritic soil at Dacca, were set up in four series of three. The soil in the first series was untreated while those in the second, third and the fourth series were treated with phosphate (CaHPO_4), phosphate and lime (13 mds. per acre), phosphate and lime (=78 mds. per acre) respectively. The calcium phosphate was applied to correct the deficiency, if any, of calcium and incidentally of phosphate in the soil so that any increase in the yield in series three and four over that in series two could be attributed to the neutralisation of soil acidity by lime. Three rice plants about 12 inches long were transplanted in each pot. One pot in each series without crop served as control. The yield and the pH of the soils at start and at harvest are given in the following table.

TABLE XI.

Showing the yield of grain of rice plants grown in pots with and without lime.

Series No.	Treatment to soil.	pH. at start.	Yield of grain per pot average of two, calculated as mds. per acre.	Increase of yield over the untreated soil.	pH. at harvest.	
					Cropped soil.	Uncropped soil.
1	<i>Nil.</i>	4.8	123	..	5.6	5.7
2	Phosphate ..	5.3	142	15%	6.5	6.5
3	Do. and lime (= 13 mds. per acre).	6.0	158	28%	7.0	6.9
4	Do. and lime (=78 mds. per acre).	8.6	167	35%	7.6	7.5

During the early stage the growth of the plants in series 4, pH 8.6, remained checked for a considerable period. After about 8 weeks these plants started to grow rapidly and it will be seen from the above table that the yield of grain in this series eventually exceeded those in other series, although the vegetation in series 3 appeared to be the best throughout. It is clear therefore, that lime by neutralizing the acidity ameliorates lateritic soils.

It will be also seen from the above table that the pH of the cropped as well as of the uncropped soil in each series changed with time but reached the same value at harvest. This seems to indicate that the growing plant had no hand in altering the reaction of the soil, or if it had any, it was negligible compared to other factors at work. The result is, therefore, somewhat contradictory to those of water culture experiments given above where the plant was found to influence the reaction considerably by bringing the pH in all cases to slight alkalinity. One fact, however, remains common and it is that the change of

pH took place in the same direction both in water and pot culture experiments. Thus in both cases if the reaction at start were acidic or alkaline, they became less so at harvest.

(2) *Treatment of lateritic soil with fertilizers.*—It is a well known a practice to try to find out the essential elements whose deficiencies in a soil have become the limiting factor or nearly so for plant growth in order to be able to offer sound recommendations for the application of the manure to that soil. The procedure usually adopted is to determine the crop yield in soil supplied with fertilizer containing all elements but one and then to compare this yield with those in untreated soil and the one to which all the elements have been added. Accordingly a number of earthen flower pots each containing 6 lbs. of a Dacca laterite were arranged in series of two. The soil in the first series was left untreated. That in the second series was treated with 20 cc. of a complete nutrient solution used in water culture experiment (*vide infra*). That in the third series was treated with 20 cc. of nutrient solution containing all elements but nitrogen. This gave no nitrogen series. Similarly no phosphate, no calcium, no magnesium and no potash series were set up. It has been shown in the preceding pages that these elements and iron are essential for the growth of rice plants. Iron, however, cannot be the limiting factor of plant growth in a lateritic soil. In the above nutrient solutions nitrogen was supplied as nitrate of calcium. So two more complete nutrient series were set up supplying nitrogen in the form of ammonium nitrate and ammonium sulphate respectively. Three rice seedlings were transplanted in each pot. A glance at the following table will show that the deficiencies of potassium and magnesium have become more or less the limiting factor for the growth of rice plant in this soil. The nitrogen and phosphate deficiencies are also noticeable but the soil gives no indication of a calcium deficiency. Furthermore, nitrogen is more suitable for rice in the form of ammonia than as nitrate. For amelioration of this type of soil therefore, a dressing of potash and magnesium fertilizer is essential while a manure of the type of ammonium phosphate could be applied with advantage in this soil for rice culture.

TABLE XII

Showing the yield of paddy growing pot of soil, average of two, treated with complete nutrient solution or with nutrient solution in which one of the essential elements was omitted.

Series No.	Soil treated with nutrient solution containing—	Yield of grain
		Gm.
1	Nil	3.9
2	All elements, Ca (NO ₃) ₂ for nitrogen	8.4
3	No nitrogen	6.9
4	No phosphate	6.5
5	No calcium	8.7
6	No magnesium	5.3
7	No potash	4.2
8	All elements, NH ₄ , NO ₃ for nitrogen	8.0
9	All elements, (NH ₄) ₂ SO ₄ for nitrogen	13.9

Summary.

Mechanical Analysis :—

(1) The following methods of mechanical analysis were tried on 18 samples of lateritic soils from all parts of India—

- (i) International method without the peroxide treatment:—HCl-NaOH.
- (ii) Puri method—NaCl-NaOH.
- (iii) Sudan method—Na₂CO₃.

Since these lateritic soils were found to contain very little calcium carbonate and exchangeable bases—

- (iv) a Direct NaOH method was tried in which the soil was shaken directly with NaOH without the previous HCl or the NaCl treatment as in (i) or (ii) above.
- (2) The International, Sudan and Direct NaOH method gave equal amounts of clay and silt in all cases. Puri method, however, gave a lower clay figure for some of the soils. This was due to the insufficient quantity of alkali used for dispersion, and lack of mechanical shaking in the method as prescribed by the author.
- (3) Maximum dispersion of lateric soils was found to take place in suspensions having pH about 10.5. Consequently the quantity of NaOH to be used for dispersion should depend on this factor rather than any arbitrary amount. In most cases 6 to 8 cc. of N. NaOH to 20 gms. of soils was found suitable for the purpose without being drastic.
- (4) For lateritic soils containing more than 2 per cent. of organic matter it is desirable to include the peroxide treatment.
- (5) The Direct NaOH method is found to be reliable and less laborious for the mechanical analysis of lateritic soils. A brief description of the method is given.

Nitrogen supply to rice plants :—

- (6) Periodic estimations of total nitrogen, ammonia and nitric nitrogen in soils taken from the experimental plots were conducted elaborately during the year.
- (7) In all five plots were under investigation—two cropped plots, two corresponding uncropped plots, the fifth was a cropped plot.
- (8) The results of last year showing marked increase in total nitrogen in soil when the crop was growing were not confirmed this year. Instead of an increase there was rather a decrease this year with considerable fluctuations. Similar decrease and fluctuations were also noticed in the corresponding uncropped plots.
- (9) There was rapid ammonification in the soil as soon as the fields were waterlogged. In the uncropped plots ammonia continued to accumulate until the fields began to dry up when it disappeared rapidly. Only a small portion of the ammonia thus lost could be accounted for by the increase of nitrate in the soil. In the cropped plots ammonia accumulated until about six weeks from transplantation when it disappeared suddenly and completely presumably due to its assimilation by the growing plants.
- (10) There was very little nitrate in the paddy fields during the dry period. Under the waterlogged condition nitrate disappeared altogether.
- (11) There was marked fixation of nitrogen in soil in presence of paddy roots but no noticeable fixation took place in presence of either rice straw or mannite.
- (12) Evidence was obtained for the fixation of nitrogen in soil under the waterlogged condition.

Pot and Water Culture Experiments :

- (13) Rice plants were found to grow almost equally well in complete nutrient solution consisting of mixtures of calcium nitrate, potassium acid phosphate and magnesium sulphate and pH. values ranging from 3.4 to 8.4. However, the increased pH of the solution upto 7.8 gave increased yield of grain. At pH 8.4 no grain was formed.
- (14) As a result of crop growth, reactions of the nutrient solutions stated in 13 above, tended to attain a specific value, in the case investigated pH. 7.8,

irrespective of the fact whether the solutions were acid or more alkaline initially.

- (15) In absence of any one of the following elements rice plants did not thrive at all in nutrient solutions :—N, P, Ca, Mg, K and Fe.
- (16) Lateritic soil treated with lime gave increased yield of paddy grain and the greater the quantity of lime added (upto pH 8.6 of soil) the higher was the yield. The vegetation, however, was best at pH. 6.0.
- (17) Deficiencies of potassium and magnesium have become more or less the limiting factor of the growth of rice plant in the lateritic soil at Dacca while a dressing of phosphatic and nitrogenous (especially ammonium) fertilizer to this soil increased the yield of grain considerably.

Acknowledgment.

In conclusion, I wish to acknowledge my indebtedness to Mr. R. S. Finlow, the Director of Agriculture, Bengal, and to Dr. J. C. Ghosh, Head of the Department of Chemistry, Dacca University, for the constant interest they took in the progress of the work in this Section during year under review.

AGRICULTURAL RESEARCH SECTION.

DEPARTMENT OF CHEMISTRY

DACCA UNIVERSITY.

The 31st March 1932.

A. T. SEN,

Research Fellow in Agricultural Chemistry,

Dacca University.

ENCLOSURE V.

REPORT OF THE INVESTIGATIONS CARRIED OUT BY DR. A. N. PURI, ON THE STANDARDISATION OF PHYSICO-CHEMICAL 'SINGLE-VALUE' MEASUREMENTS MOST SUITABLE FOR INDIAN SOILS.

In response to this Department memorandum No. 1621/Agri., dated the 22nd July 1930, the Advisory Board recommended a grant of Rs. 5,250 spread over a period of 10 months to Dr. A. N. Puri, M. Sc., Ph. D., A. I. C., to complete his work on "The Standardisation of Physico-Chemical 'Single-Value' measurements most suitable for Indian soils". This recommendation was accepted by the Governing Body and the grant was made.

Dr. Puri has submitted a report of the investigation carried out by him which is now for the consideration of the Advisory Board.

CHARAN DAS,

Secretary.

SIMLA, S.W.;

The 30th June 1932.

Report of the investigations carried out by Dr. A. N. Puri with the help of a grant from the Imperial Council of Agricultural Research from October 1930 to August 1931.

The grant was applied for to enable me to complete my work on the standardization of methods for single value measurements for Indian Soils. The following methods had been suggested as tentative which needed investigation (*vide* my letter dated the 12th February 1930).

1. Base exchange capacity and exchangeable bases,
2. State of saturation.
3. Moisture absorption.

column at various intervals of time.

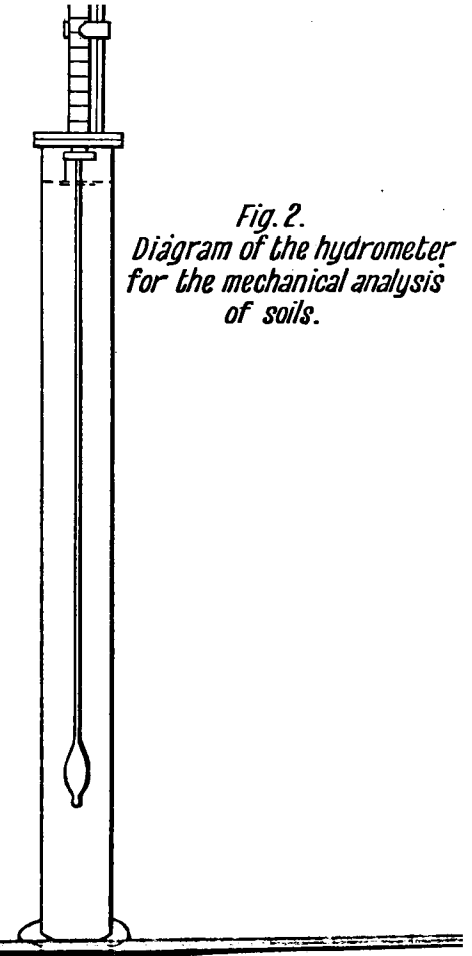
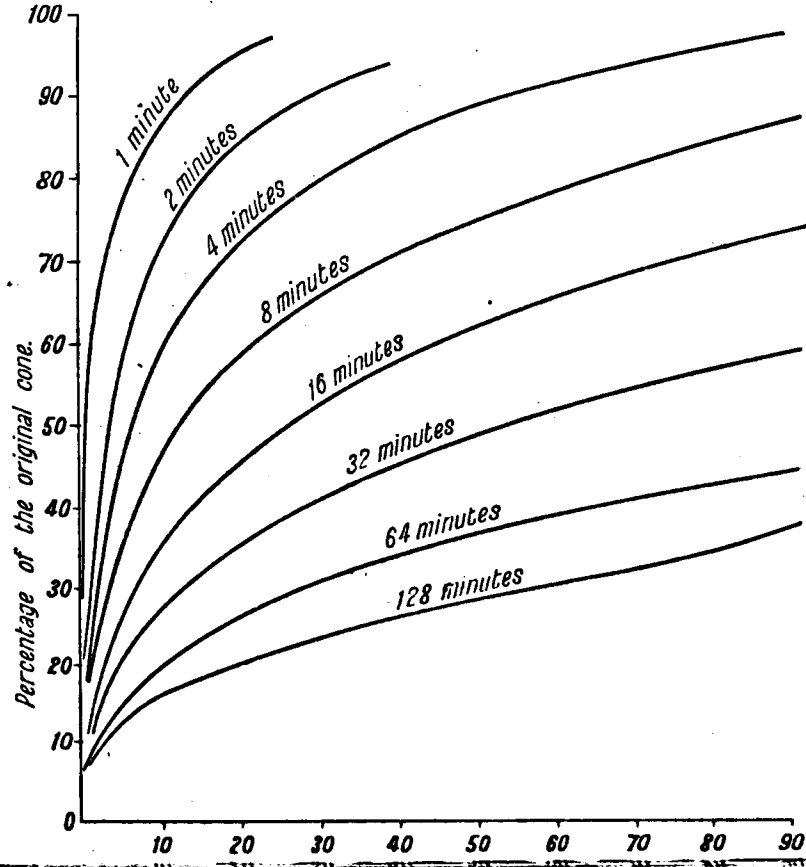


Fig. 2.
Diagram of the hydrometer
for the mechanical analysis
of soils.

4. Permeability to water.
5. Coefficient of dispersion.
6. Mechanical Analysis.
7. Sticky point.
8. Cohesion.
9. Soil reaction.
10. Available phosphorus and potassium.
11. Lime requirements of acid soils.
12. Gypsum requirement of alkali soils.
13. Loss on ignition (for humus and combined water).
14. Total carbonates.

The following measurements were selected for study with the object of simplifying the existing technique or devising a new method :—

- I. Mechanical Analysis.
- II. Moisture Absorption.
- III. State of saturation and soil reaction.

These are dealt with as follows :—

Mechanical Analysis.—A vast amount of literature has sprung up during recent years dealing with the methods of mechanical analysis of soils. The older elutriation and beaker methods have almost entirely been replaced by pipette methods, which are simpler and take very much less time.

There is no general agreement about the limits of size of the various fractions into which the soil particles are divided, and it is very difficult to choose between the various groupings prevalent in different countries, therefore the modern tendency has been to express the mechanical composition of a soil in the form of a continuous curve and many ingenious methods have been suggested for this purpose. All these methods depend on the variations in the settling velocities of particles of different sizes. It appeared that methods depending on the variations of the density or hydrostatic pressure from the surface in a sedimenting column, were capable of being simplified and were chosen for this investigation.

Two methods were devised : namely the hydrometer and the manometric method. The former for general routine analysis and the latter for special work requiring greater precision and detail in the mechanical composition of a soil.

The Hydrometer method.—The successful working of the hydrometer to be described here, depends upon the fact that the gradient of increasing density in the suspension of a sedimenting column becomes less and less steep as we go from top to bottom. In other words the average density of a column of suspension, the length of which is small compared with the total depth of the sedimenting column, may be taken without serious error as the density of its middle point. This is illustrated in Fig. 1, in which the density of a soil suspension in a setting column (from top to bottom) at different intervals of time from the commencement of sedimentation, is plotted against depth. It will be seen that there is a rapid decrease in density for the first 20-30 cm. after which the change is comparatively small.

The new hydrometer shown in Fig. 2 consists of a wide but short bulb (8-10 cm. in length) and a thin long stem (about 0.4 cm. diameter, and 60.70 cm. length). It, therefore, records density changes in a column 8-10 cm. in length, and situated at a distance of 50-60 cm. from the top. The settling depth is counted from the top of the sedimenting column to the mean position of the middle point of the hydrometer bulb. Another modification in the hydrometer technique is the arrangement for taking readings. The ordinary method of inserting a paper scale in the stem, is not very accurate, and an error of a few millimeters in the readings might be easily made,

due to the water surface not providing a sharp line of reference. In this case the tip of an ordinary pin attached to a thin brass cap fitting on to the top of the hydrometer stem forms the reference point, and the readings are taken against the graduations on a burette tube, held in a special clamp. The mouth of the burette tube is closed with a brass cap having a hole in the middle through which the hydrometer stem is passed. The edges of the hole are sharpened to prevent friction that might hinder the free movement of the hydrometer. All that is necessary is to tap the burette tube gently before taking a reading. This brass cap has also a pin attached to it which is required for fixing the position of the burette tube with respect to the water surface. The tube is gradually lowered till the pin point just makes contact with the water surface. The burette tube is held in brass clamps which keep it in position at the same time allowing it to be pushed up or down. The brass clamps are fixed on to an iron rod attached to an iron cap that can cover the top of the sedimenting cylinder, and has a hole in the middle to allow the free movement of the burette tube. This simple device enables one to take hydrometer readings within the fraction of a millimeter, and does away with the necessity of having a paper scale inside the stem. To avoid parallex the graduations on the burette tube should be all round the circumstances as in the Charlottenburg type.

The making and filling of the hydrometer is not difficult and a person possessing moderate skill in glass blowing can complete one in about three hours. The calibration is done by the help of a soil of known mechanical composition and a two per cent. suspension of such a soil can be kept for this purpose.

The hydrometer gives results closely agreeing with the standard pipette method and can replace the latter for routine mechanical analysis of soils affecting a great saving in time and labour. The results shown with several soils show a very good agreement between the pipette and the hydrometer method. There is some discrepancy in the case of very coarse fractions in certain soils, but the reliability of the pipette method for particles of a limiting diameter above 0.04 mm. is questionable; for the time taken up in actually pipetting out a sample is large as compared to the settling velocity of the particles and it is much more likely that the hydrometer might give more reliable values in the case of such fractions.

Manometric apparatus.—The apparatus shown diagrammatically in Fig. 3 is based on the principle of the differential liquid manometer, having a mixture of aniline and benzene (of density slightly higher than that of water) as the heavier liquid and water itself as the lighter liquid. Two cylinders of equal diameter and fitted with ground glass stoppers are used, one to hold the soil suspension and the other water, filled to the same height as the suspension. By the help of a three way tap the connection between the suspension and water column can be established directly or through the manometer as desired. The lower end of the tube that dips in the suspension is spiral shaped so that if the suspension enters it cannot rise above the level of the tip.

The suspension is well shaken and the cylinder placed alongside the one containing water. The apparatus is then lowered to the desired depth and direct connection is made between the two cylinders. Since the suspension can support a higher column of water, the level in the water cylinder rises by a few millimeters depending upon the concentration of the suspension, and the depth to which the end of the tube has been lowered. After about 3 minutes the tap is turned off and the apparatus taken out. If too much suspension has entered the spiral tube it is washed out by dipping the other end in a cylinder of water and syphoning out. The aniline-benzene mixture meniscus is also brought to the lowest point on the manometer tubes adjoining the suspension cylinder. The suspension is again shaken and set aside just when a stop watch is started. Since the preliminary levelling of the liquids in the cylinders has already been effected the connection is established through the manometer. At first there is a slight depression of the meniscus in the tube by the side of the suspension which soon begins to rise and steadily moves up as the particles settle down and its level is noted at suitable intervals of time, either directly by a scale attached to the manometer tube or by the help of a Kathometer.

The method of calculating the results, directions for filling the instrument and the results of mechanical analysis of soils, both by the manometric method as well as the pipette method using 2 per cent. suspension are given in the paper on the subject.

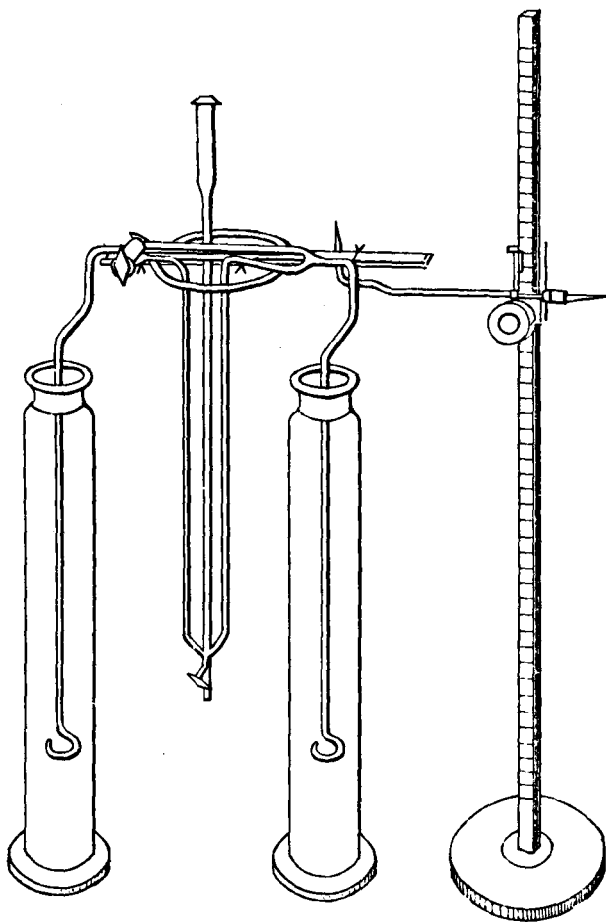
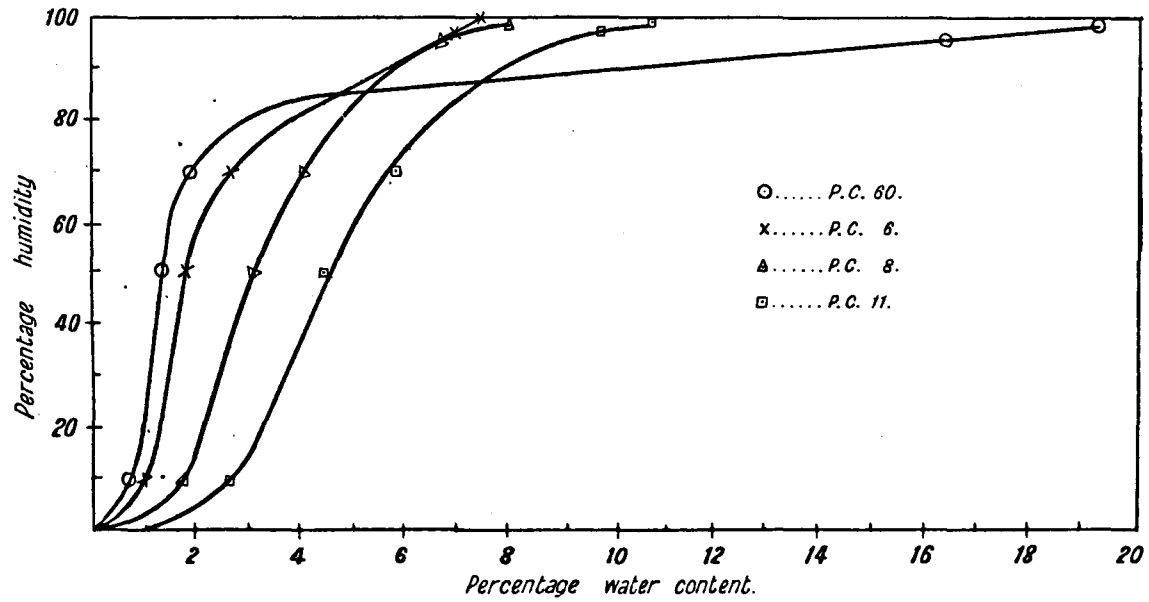


Fig. 3.

*Manometric Apparatus for the
mechanical analysis of soils.*

Fig. 4.
Vapour pressure curves of soils.



Moisture absorption.—There are many methods for measuring the hygroscopicity or the percentage of moisture taken up by dry soil from a humid atmosphere. Earlier workers used a saturated atmosphere for bringing the soil into equilibrium. Some prefer to use the partial pressure of water vapour afforded by 10 per cent. sulphuric acid others recommend 3.3 per cent. H_2SO_4 for the same purpose. It must be admitted, however, that these concentrations are fixed arbitrarily and there is no valid ground for the belief that they represent any fundamental advance on the original conception of hygroscopic coefficient.

Another difficulty about any moisture absorption experiment is the definition of "dry" soil. The usual practice is to dry in an oven at 100-105°C. This has the advantage of rapidity but much confidence cannot be placed in it. Drying over H_2SO_4 is to be preferred though the process is slow. Both these methods are not infrequently attended with permanent changes in the soil colloids.

It will be seen from typical vapour pressure curves of soils (Fig. 4) though smooth all along they are made up of three portions *i.e.* from 0 to 10 per cent., from 10 to 70 per cent. and from 70 to 100 per cent. humidity. The interval between 10 and 70 per cent. humidity is sensibly straight and thus could be used for expressing hygroscopicity of soils. By adopting 10 per cent. humidity equilibrium value as the "dry" basis we can be sure of a greater precision in the determination of this reference point. On this basis the vapour pressure curve up to 70 per cent. humidity being a straight line passing through the origin, the determination of a single value enables us to interpolate hygroscopicity at any other humidity between 10 and 70 per cent. humidity.

57 soils were examined for their moisture absorption between 10 and 70 per cent. humidity. The values thus obtained correlated so well with clay content that it is possible to calculate the percentage of clay (0.001 mm. diameter) in a given soil from moisture absorption between 10-70 per cent. humidity with a fair amount of accuracy by the help of an empirical formula. The agreement between the calculated values of clay and those found by direct determination in the case of 57 soils was found to be as good as could be expected from a highly complex body like soil. The few soils that show a discrepancy of more than 5 per cent. are invariably abnormal soils, *i.e.*, either highly acid or highly alkaline barren soils.

State of saturation and soil reaction.

Previously it has been shown by the writer that the interaction between soil and ammonia represents the neutralization of acidoid by a base. Since pH values of natural soils represent single points on their titration curves, it appeared reasonable to suppose that the difference between the amount of ammonia taken up by a natural soil and the same soil completely unsaturated, will be a measure of the state of saturation of that soil and consequently will be correlated with its pH value. The object of this investigation was to explore the possibilities of this reaction for characterising the state of saturation of a soil.

The amount of ammonia that a natural soil can take up is determined as follows:—

10-20 gms. of soil are taken in a dish and kept over normal ammonia in a vacuum desiccator for two days. It is then transferred to another desiccator and kept over 90 per cent. H_2SO_4 for two days. The ammonia retained by the soil is then determined by distillation with lime in the usual way.

The maximum saturation capacity of the soil for ammonia is determined as follows:—

Ten grams of soil is stirred with about 50 cc. of water. Enough 0.2 N HCl to break up all the carbonates is added gradually and the mixture set aside with frequent shaking till no more bubbles of C_2 are formed. The soil is then transferred to a filter paper and washed with 0.05 N HCl till the filtrate shows no reaction for Ca ions; this is followed by leaching with water till the soil is free from Cl ions. It is then washed with a little alcohol and air dried. The final washing with alcohol makes the soil loose and friable as well as easily detachable from the filter paper.

After being air dried the soil is transferred to a flat dish and kept over normal ammonia and subsequently over 90 per cent. H_2SO_4 exactly as in the case of natural soil. The state of saturation of the soil (V) is calculated from the formula.

$$(V) = \frac{100(T-S)}{T}$$

Where S. & T. are the amounts of ammonia taken up by the natural and acid treated soil respectively. All quantities of course being expressed in equivalents.

pH value measurements.

The greatest difficulty in correlating any physico-chemical measurement on soils with their pH values, lies in the choice of the method for determination of the latter. For the present investigation it appeared necessary to take measurements with all the available methods, in order to see which of them correlates best with the state of saturation of the soil as determined by the ammonia method.

57 soils from various parts of India were examined for their reaction by the following methods:—

1. Hydrogen electrode 1 : 5 soil water ratio 2 hours' shaking (H).
2. Quinhydrone 1 : 5 soil water ratio 2 hours' shaking (Q).
3. Quinhydrone 1 : 1 soil water ratio 2 hours' shaking (Q).
4. Quinhydrone 1 : 1 soil water ratio 2 hours' shaking and leaving overnight (Q).
5. Antimony electrode 1 : 1 soil water ratio 2 hours' shaking and leaving overnight (Sb).
6. Colorimetric method 1 : 5 soil water ratio, occasional stirring and leaving overnight (C).

The relation between (V) and various sets of pH values is brought out best by working the correlation co-efficient between them.

These are given below:—

(V) and H = 0.897.

(V) and (Sb) = 0.891.

(V) and (Q*) = 0.889.

(V) and (C) = 0.938.

It will be seen that the correlations are highly significant. The difference is not very great but with the colorimetric method slightly better correlation is obtained than with the other methods.

pH values of soils can be calculated from (V) values by the following empirical formulas:—

1. pH = 0.0274 (V) .. 5.4 for (V) values below 45 per cent.
2. pH = 0.0319 (V) .. 5.89 for (V) values between 45-81 per cent.
3. pH = 0.0319 (V) .. 7.11 for (V) values above 81 per cent.

The difference between the calculated values and those actually obtained is not greater than what might be expected from the nature of such measurements, and is of the same order as differences between direct measurements of pH values by any two methods. The calculated values of pH are therefore probably just as reliable as those obtained by any direct method.

Some very interesting facts emerge from a closer study of the (V) values for various soils. It is found that all soils having (V) values less than 33.3 per cent. respond to lime, the calculated pH value for which is about 7. The neutral point or pH 7, therefore, has a more fundamental significance than has been hitherto supposed. Most of the good agricultural soils have (V) values between 50 and 70 per cent.; soils having (V) values

above 70 per cent. invariably contain sodium and above 80 per cent. are all barren alkali soils. Soils that were in approximate equilibrium with CaCO_3 under field conditions gave values about 62-68 per cent. All soils having (V) values less than 40 per cent. were from humid regions where the rainfall is plentiful and those with above 70 per cent. (V) values were from arid regions where the rainfall is scarce.

The foregoing is a brief outline of the work comprising the description of the new, methods proposed and general scientific conclusions resulting from the investigation. Full discussion of results is given in the following papers that are in the press and reprints of which will be forwarded as soon as they are received.

1. A new type of hydrometer for the mechanical analysis of soils.
2. A new manometric apparatus for the mechanical analysis of soils.
3. A new method of determining clay content of soils by moisture absorption at 70 per cent. humidity.
4. Interaction between ammonia and soils as a new method of determining the state of saturation and pH value of soils.

Sd. A. N. PURI.

APPENDIX XLVI.

SUBJECT No. 30 (d).

REPORT FOR THE PERIOD 1ST JULY 1931 TO 31ST MARCH 1932 IN RESPECT OF THE SCHEME FOR INVESTIGATION OF THE "WITHER TIP" OF CITRUS TREES BY DR. H. C. CHAUDHURI.

At its meeting held in January 1931 the Advisory Board recommended a grant of Rs. 12,600 spread over a period of three years to Dr. H. C. Chaudhuri, Reader in Botany, Punjab University, Lahore, for investigation of the "Whither-tip" of citrus trees. This recommendation was accepted by the Governing Body at its meeting held in May 1931 and the scheme was accordingly started with effect from 1st July 1931. Dr. Chaudhuri has now submitted a report (Annexure) of the work done by him during the period 1st July 1931 to 31st March 1932.

The report is now for the consideration of the Advisory Board.

CHARAN DAS,

The 26th May 1932.

Secretary,

ANNEXURE.

REPORT ON THE WORK DONE ON "WITHER-TIP" INVESTIGATION OF THE CITRUS PLANTS FOR THE YEAR ENDING 31ST MARCH 1932.

The Imperial Council of Agricultural Research having accepted my scheme for the investigation of the "Wither-tip" of Citrus plants, the work was undertaken from 1st July 1931. S. Dyal Singh, M.Sc., who had been carrying on research work on Citrus diseases under my guidance was appointed Research Assistant from that date on a salary of Rs. 150—25—200. The attendant was appointed from 1st October 1931. A list of Citrus gardens in the Province was obtained from the Fruit Specialist at Lyallpur, and inspection of gardens in Lahore and 30 miles around it have been made periodically. Besides above gardens others at Amritsar, Ludhiana, Multan, Dehra Gazi Khan and in the Kangra Valley have been visited. A large amount of important material has been collected.

2. The casual organism of the "Whither-tip" *Colletotricum gloeosporioides*, has been isolated from the different species of Citrus plants growing at different localities. Study of the virulence of the different isolations is being made and we have over 20 different isolations from different localities and plants, growing in pure cultures. In nature, we have been able to collect 'perfect forms' so far unknown in India. In our cultures, also, we have been able to produce perfect forms of *Colletotrichum gloeosporioides*. When a complete collection of the disease during all the months of the year from different localities has been made, we hope to be able to establish the complete life-history of the casual organism. This will help us in combating the spread of the disease. So far a number of 'perfect forms' have been collected from various Citrus plants and these are also being grown in culture and investigated.

3. Simultaneously with the study of the "Wither-tip" which generally dries up the tips of the twigs and causes fruit fall, and other important diseases of the Citrus, like "fruit-fall" due to sooty-mould, etc., which sometimes cause great loss in Citrus industry, are being investigated, and the combined effect of the different fungi on the host plants is also being studied. It has been found during inspection work, that growers, not having any fruits for 3 years in succession have cut down valuable orchards altogether. This is due to entire lack of knowledge regarding plant protection among the growers. I may mention here, that I have been able to interest the proprietors of many orchards in scientific plant protection and I am glad to be able to say that some of them have taken up control measures according to my direction.

4. Regarding experiment on control measures :—We have one plot, in the Lawrence Gardens, Lahore, with over 350 plants under control measures. We are trying not only

Bordeaux, lime sulphur, Bordeaux-oil emulsion, Ammonical copper carbonate of different strengths prepared by us, but also the efficacy of several imported fungicides and insecticides, such as 'Arboretas,' 'Sulfinette' and 'Cooper's fungicide.' In every case strict record of the expenses involved has been kept. It is as yet too early to report on the efficacy of the different sprays.

5. From the equipment many different types of sprayers—Bucket Pumps, dusting machines of English, American and Indian make—have been purchased and are being tried. Besides the plot in the Lawrence Gardens I have a small plot in one of the biggest garden in the Punjab on the other side of the river near Lahore under control measures. I hope to open another control centre at Nurpur, at the foot of the hills, which is an important centre for Citrus cultivation and where the "Wither-tip" has just made its appearance in a rather virulent form.

6. The work is progressing satisfactorily and I consider the results obtained during the last nine months as quite encouraging.

H. CHAUDHURI.

LAHORE,

The 5th April 1932.

APPENDIX XLVII.

SUBJECT No. 41.

APPLICATION FROM THE GOVERNMENT OF THE PUNJAB FOR AN ADDITIONAL GRANT OF Rs. 5,000 FOR CONDUCTING EXPERIMENTS ON DESIGNING A SMALL POWER SUGARCANE CRUSHING MILL.

LETTER FROM THE GOVERNMENT OF THE PUNJAB, No. 581-D(S), DATED THE 16TH JULY 1932.

I am directed to forward herewith in original an application received from the Secretary, Punjab Council of Research, for a further grant of Rs. 5,000 for the construction of three small power crushing mills and to state that the Punjab Government (Ministry of Agriculture) recommends the scheme and to request that it may be placed before the Advisory Board of the Imperial Council at its forthcoming meeting for the provision of funds.

2. I am to add that the Punjab Government will not undertake any financial liability whatever beyond permitting the use of its agricultural engineering staff in the work of designing.

3. One hundred printed copies of the scheme are being forwarded under separate cover.

COPY OF A LETTER FROM THE SECRETARY, PUNJAB COUNCIL OF RESEARCH, TO THE DEPUTY SECRETARY TO GOVERNMENT, PUNJAB, DEVELOPMENT DEPARTMENT, No. 175-S., DATED THE 14TH JULY 1932.

Grant of Rs. 8,000 by the Imperial Council of Agricultural Research for conducting experiments on designing a small power sugarcane crushing mill.

With reference to your letter No. 261-D., dated 25th January 1932 conveying sanction of the Punjab Government (Ministry of Agriculture) to the expenditure of Rs. 3,000 from my budget for conducting experiments in sugarcane crushing over and above the grant of Rs. 8,000 given by the Imperial Council of Agricultural Research for this purpose, I have the honour to say that no money has yet been spent from the Government grant mentioned above, but certain bills are awaited.

2. The convener of the sub-committee appointed by the Punjab Council of Research to devise a satisfactory small power sugarcane crushing mill, has submitted a report, copy attached, of the results up to date. It will appear from paragraph 19 of the report that an additional grant of Rs. 5,000 is required for the design, construction and testing of three small power crushing mills. This report was received on 23rd June 1932 and as it was not possible to convene a meeting of the Punjab Council of Research before next cold weather, the opinions of the members were solicited by post, so that if the proposal to apply for the additional grant from the Imperial Council of Agricultural Research is accepted the application may go before that body at their forthcoming meeting.

3. Of the 24 members of the Provincial Council of Research who are in India 18 have approved of the proposal to ask for the additional grant from the Imperial Council of Agricultural Research; five have not yet replied, and one (Dr. McKenzie Taylor) has dissented, as in his opinion the work is largely the concern of the firms which are interested in such machinery. As, however, the proposal has been approved by the large majority of the members I shall be glad if it is approved by Government and if the Imperial Council of Agricultural Research is requested to give an additional grant of Rs. 5,000 as recommended by the sub-committee.

The matter may kindly be treated as very urgent. The Advisory Board of the Imperial Council of Agricultural Research meets from 18th to 23rd July 1932 and if the proposal is not considered at that meeting, the scheme will be held up for a year, since the January 1933 meeting will take place too late to enable the machinery to be constructed and the experiments to be continued during the next cane crushing season.

No. 2280
7-36 B.

Dated Lyallpur, the 20th June 1932.

From

The Agricultural Engineer to Government, Punjab and the Convener,
Cane Crushing Sub-Committee, Lyallpur.

To

The President,
Punjab Council of Research, Lahore.

Sir,

With reference to the meeting of the Punjab Council of Research held in the office of the Financial Commissioner, Development Department on 26th April, 1930 at which a Sub-Committee was formed to deal with the grant of Rs. 8,000 made by the Imperial Council of Agricultural Research for experiments in devising a satisfactory small power sugar cane crushing mill, I have the honour to submit the following report of the work of the Sub-Committee.

2. The members of the Sub-Committee were :—

1. Mr. T. A. Miller Brownlie, Convener,
2. Captain H. Whittaker,
3. Mr. D. P. Johnston,
4. K. B. M. Fateh-ud-Din,
5. Dr. Carter Speers.

3. The first meeting of this Sub-Committee was held on 3rd May 1930 at which it was decided to collect information regarding existing types of small power crushers from various users in India and after tabulating the information received to select three of the most promising makes for detailed tests.

4. By 10th November, 1930 this information was received and copies circulated to members of the Sub-Committee and a meeting arranged to be held on 12th November to discuss the performance of the various crushers and to select the three most likely to give the best results.

5. The machines selected were the Broadbent, the Massey and the Acme and an estimate was prepared amounting to Rs. 7,000 for the provision of three electric motors with power measuring instruments, necessary wiring to the Jullundur Farm and the provision of countershafting pulleys foundations, etc., leaving a balance of Rs. 1,000 towards the cost of energy and the hire charges and conveyance of crushing machines.

6. Messrs. Greaves Cotton of Bombay kindly agreed to loan a Boardbent 3 roller crusher for test purposes, packing and conveyance charged to be met by the testing committee and Messrs. Carey and Daniel of Calcutta made a similar concession with regard to the Acme four roller crusher. The third mill required for the test was Massey 10" x 14" three roller crusher and this the Saran Engineering Co. of Cawnpur offered at a cost of Rs. 1,700.

7. The three firms were asked to send the crushers to Jullundur and the final arrangements regarding the supply of electrical energy, etc., were completed at a committee meeting held on 14th January, 1931 and at this meeting it was agreed to apply for the services of Mr. S. R. Kohli, Ph.D. to superintend the tests at Jullundur.

8. The Director of Agriculture was asked to apply for the services of Dr. Kohli but

The main tests could not be held as Messrs. Brownlie and Johnston, Members of the Sub-Committee, who were to deal with these trials were out of India on leave
(Sd.) D. MILNE,

considered that as it was late in the Season the main tests could not be held until next cane season and the matter should be postponed meanwhile.

Director of Agriculture, Punjab .

9. The Massey and Broadbent crushers arrived and were erected at Jullundur in March, 1931 but the Acme did not arrive until 9th April 1931 and was too late for tests to be carried out with it during the season 1930-31, but trials were carried out with the Massey and Broadbent machines in March and April 1931 and a meeting of Committee was held at the site of the trials and instructions were issued regarding the manner in which the trials were to be carried out and the information to be recorded.

10. As no money was left by the end of the 1930-31 cane crushing season the Director of Agriculture was requested to enquire if additional funds could be obtained for a continuation of trials in 1931-32. A sum of Rs. 1,500 was allotted from the ordinary budget provision of the Agricultural Department in February 1932 and the trials were resumed.

11. The Director of Agriculture did not agree to the proposal to appoint Dr. Kohli to superintend the trials and therefore an assistant to the Agricultural Chemist was sent to Jullundur during the period of trials to carry out the required analysis-- the work of crushing was carried out under the direction of the Deputy Director of Agriculture, Jullundur and the Sub-Divisional Officer, Boring, Ferozopore was in attendance to see that the mechanical arrangements were properly maintained and that the necessary records were being kept.

(Sd.) D. MILNE,
Director of Agriculture, Punjab.

Dr. Kohli, an Assistant Professor of Chemistry in the MacLagan Engineering College, was not employed as he was to cost Rs. 300 p. m. and it was considered that the Agricultural Chemists staff could do this work at no extra cost.

12. The Sub-Committee met at Jullundur on 18th February 1932 and studied the machines in detail and the records of work done. The conclusions arrived at with regard to the crushers are as follows :—

13. *Acme 4 roller crusher.*—The type and arrangement of framework of this machine was approved but the machine generally was considered too light and the type of rollers employed were unsatisfactory. The cleaning teeth fitted to the machine caused obstruction and the percentage of juice extraction was exceptionally low being approximately half that obtained on the other machines, adjustment of the rollers is made by increasing or decreasing the pitch diameters of the gear wheels which is unsatisfactory and avoidable in a four roller mill.

14. *Broadbent 3 roller crusher.*—This machine gave a satisfactory outturn of juice but was difficult to feed and to improve the feeding the rollers were refaced and slight longitudinal cuts were made on the rolls. This removed the feed difficulty entirely and the juice extraction percentage was not affected thereby. The frame of this machine is of cast iron and as it is subjected to tensile stresses it was considered doubtful if the machine would work for a full season without rupture. Actually the machine ruptured during the tests when the Committee were present. As in most three roller mills the adjustment of rollers is made by increasing or decreasing the pitch of the gear wheels and therefore the refacing of the rolls from season to season cannot be carried out.

15. *Massey 3 roller crusher.*—The 1931 pattern of the Massey crusher was supplied for the tests and this is a considerable improvement over the patterns of previous years but cast iron is used in the frame of the machine and is subjected to tensile stresses. The Massey machine appeared to be very nearly substantial enough to carry out the season crushing without mishap but parts indicated that a very small factor of safety had been provided and actually a shaft broke before the trials were completed confirming the view that sufficient factor of safety had not been provided for in the design and this view has further been confirmed by breakages of similar patterns of the Massey crusher in use elsewhere in the Province.

16. A more detailed criticism of the three crushers is embodied in the minutes of the sixth meeting of the Sub-Committee and a copy of this was sent to the Director of Agriculture together with a report from the Convener suggesting that further trials be stopped for the present and attention be devoted to the design of a more substantial form of mill eliminating if possible the defects noted ; this was agreed to by the Committee. The Director of Agriculture suggested that he would like to consult Mr. R. C. Srivastava the Sugar Technologist, Imperial Council of Agricultural Research, and that they with Mr. Brownlie might visit the trials at Jullundur.

17. This meeting took place on 26th April 1932 and it was agreed that new designs for crushing mills be prepared with a view to eliminating noted defects. Mr. Srivastava favoured the three roll mill although this type is unsound in principle but agreed that the four roll mill should also be tried and it was agreed that spare sets of rolls with various finishes be made for each mill. Mr. Srivastava kindly offered to scrutinise the plans of the proposed mills and to suggest any alteration which might occur to him and be of advantage.

18. The result of this conference was communicated to the members of the Sub-Committee and with the exception of Dr. Carter Speers from whom no reply was received, the members agreed to the proposals put forward. It was estimated in May last that the cost of making up two machines with the necessary spare rolls would cost Rs. 3,000 and that a further sum of Rs. 1,000 would be required for testing out the machines. Since that date investigations of the problem have shown that the construction of three mills instead of two will be necessary in order to secure an adequate trial of the modifications required and therefore a sum of Rs. 4,000 will be required for construction of the machines plus Rs. 1,000 for testing purposes.

19. If the Punjab Council of Research accepts the proposal it is requested that the Imperial Council of Agricultural Research be asked to contribute a further sum of Rs. 5,000 for the construction of three small power crushing mills each of different design and provided with spare rolls and for the testing of these. It is hoped that constructions may be taken in hand by 1st September in order that they may be complete during December if at all possible and permit of tests being carried out during the oncoming crushing season.

20. In framing the rough estimate of Rs. 5,000 for the construction and testing of the three mills it is pointed out that no provision has been made for the designing of these and it is assumed that the Punjab Government will bear the cost of this.

I have etc., etc.,

(Sd.) T. A. MILLER BROWNLIE,

Convener,

Cane Crushing Sub-Committee.

Enclosure.

The test results analysis etc., 6 sheets.

NO. 2281/7-36-B., DATED LYALLPUR, THE 20TH JUNE 1932.

Copy of the above forwarded to the Director of Agriculture, Punjab, for favour of information, with reference to demi-official, dated 9th June, 1932, from the Assistant Director of Agriculture, Punjab.

(Sd.) T. A. MILLER BROWNLIE,

Agricultural Engineer to Government, Punjab, Lyallpur.

Note by Mr. R. C. Srivastava, Sugar Technologist, Imperial Council of Agricultural Research, dated the 19th July 1932.

The grant of Rs. 8,000 given to Punjab has been utilized entirely for purchasing and testing a number of existing cane mills, with the object of finding out their good and bad points, and using the information thus collected in designing a new mill. A further grant of Rs. 5,000 is now asked for for actually manufacturing and testing three improved cane mills (the cost of designing these being presumably left to be borne by the Punjab Government).

2. When I visited Jullundur I saw the plant under trial and also a record of the data collected. Unfortunately a copy of the record has not been supplied and hence it is difficult to correctly appreciate its value. But from what I saw, I feel that the testing work has been done systematically.

3. As to whether the grant of Rs. 5,000 now required is justified or not, I think the following points should be kept in view :—

- (i) Is there a time limit for these experiments ? Theoretically there would be, but where there is prospect of good results being obtained (as appears likely in the present case) the time limit may be safely extended.
- (ii) Other provinces which have received grants may be coming up for additional grants, and should this happen, preference will have to be given to those who have already made satisfactory mills and now want to give finishing touches, and also to those who have made mills of a certain size and now wish to make larger or smaller ones to suit local needs. In this respect Punjab will find itself at a disadvantage or, per contra, if Punjab's present application is accepted, the case of the other provinces instanced above, will become irresistible.
- (iii) Should this case not be considered in the first instance by the Sugar Committee ? It would obviously be desirable to do so, but as the Committee is not likely to meet for some months, the resulting delay will have the effect of putting off the actual testing of the new mills till the cane season 1933-34—that is by full one year. It is desirable to avoid this delay.

APPENDIX XLVIII.

SUBJECT No. 36.

CLASSIFICATION OF RESEARCH SCHEMES.

Attention is invited to the attached extract (Enclosure I) from the proceedings of the meeting of the Advisory Board, held in January 1932, on the subject of classification of research schemes recommended by the Board according to importance and urgency in view of the prevailing financial position. It will be seen that it was then suggested that the Secretariat of the Council should circulate a list of the schemes recommended by the Board at its meetings held in June 1931 and January 1932. It was intended that each member of the Board would then mark his order of priority on the list and the Advisory Board would at its next meeting on the basis of the suggestions received from members and of the schemes recommended at that meeting draw up an order of priority for the consideration of the Advisory Board.

2. On carefully examining the suggestion referred to in the preceding paragraph, the Chairman of the Board has come to the conclusion that it would be more practical and convenient if in consultation with the Agricultural and Animal Husbandry Expert Advisers to the Council he arrived at a general grouping of schemes in time compartments and thereafter placed it before a meeting of the Board for any specific proposals for amendments.

In this connection, the Vice-Chairman is also of the view that in preparing a programme of schemes according to their importance and urgency the following considerations of a general nature must be borne in mind :—

- (i) In view of the fact that in the course of the debates in the Central Legislature on the Sugar Industry (Protection) Bill the Government of India have given an assurance that they will be prepared to consider favourably the question of allotment of funds for Sugar research, it has been decided that the expenditure on account of Sugar Schemes should not be a drain on the general finances of the Council. These schemes need not, therefore, be considered in the present connection.
- (ii) Whatever might be the order of preference of schemes, some elasticity is necessary so that schemes might be taken up as and when funds became available. The Secretariat of the Council no doubt constantly effects small economies in the sanctioned schemes but it would not be worth while to bind them by any hard and fast procedure under which a minor scheme for which money was available must be postponed solely because a costlier scheme stood ahead of it on the list. Some discretion should, therefore, it is suggested, be left to the Vice-Chairman of the Council in the matter.
- (iii) Each set of schemes placed in one time compartment should represent in reasonable proportion each branch of agricultural and veterinary Science respectively having due regard to the funds allotted previously.

3. The financial position of the Council may now be stated for the information of the members. Excluding the grant of Rs. 10 lakhs for aid to the Sugar Industry made by the Government of India in 1930-31, but including the sum of Rs. 10 lakhs due from Government out of the initial grant of Rs. 25 lakhs, the funds at the disposal of the Council amount to Rs. 40 lakhs. As against this the commitments already entered into by the Council amount to Rs. 29,40,000 so that the amount available for financing new schemes is Rs. 10,60,000 approximately (Enclosure II).

4. The Vice-Chairman in consultation with the Expert Advisers suggests the following grouping of schemes in order of priority :

- (a) Schemes already sanctioned for less than 5 years with the intention of development and continuation, as detailed in Enclosure III. These involve approximately an expenditure of about Rs. 1,29,000.
- (b) Schemes sanctioned by the Governing Body but postponed for some reason or other. A list of these schemes is enclosed (Enclosure IV). In most of the cases the cost has not yet been estimated but provision has to be made for

interim expenditure on the undermentioned two schemes (Nos. 4 and 5 of the list).

- (1) Investigation on virus diseases of plants.
- (2) Appointment of a special officer for investigating Tuberculosis and Johne's diseases among animals at Muktesar.

Pending improvement in the financial position of the Council which would enable it to finance, the main sanctioned schemes regarding these, it is considered necessary to take the following preliminary action in connection with these schemes. As regards (1), Bombay has suggested that an officer be deputed for training in the special technique of virus investigation expenditure involved being about Rs. 5,000, similarly as to (2). Two officers are to be trained for the Tuberculosis and Johne's diseases investigation, the cost being about Rs. 20,000.

- (c) The schemes recommended by the Advisory Board at its meetings held in June 1931 and January 1932 have been grouped (Enclosure V) into time compartments, bringing together at the same time those schemes which form part of a co-ordinated whole so that the Council's research programme as a whole may be clear from a technical standpoint. In this connection the views of Mr. B. C. Burt, Agricultural Expert Adviser to the Council, recorded prior to his deputation abroad, with which the Chairman is in agreement; will be found in Enclosure VI.

5. The cost of the schemes referred to in items (a) and (b) of the preceding paragraph, will amount to Rs. 1,54,000. In view of the smaller previous allotment to animal husbandry, it is considered that all the schemes shown under group I in Enclosure V which amount to Rs. 1,26,000, should also be provided for forthwith. The total amount required in respect of the items mentioned above comes to Rs. 3,80,000 leaving Rs. 6,80,000 available for the remaining Agricultural schemes other than Sugar schemes and it is proposed to finance them in order of priority as shown in Enclosure VI.

6. The proposals are now submitted for the consideration of the Advisory Board.

CHARAN DAS,
Secretary.

SMMLA :

The 30th June 1932.

ENCLOSURE I.

EXTRACT FROM THE PROCEEDINGS OF THE MEETING OF THE ADVISORY BOARD HELD IN JANUARY 1932.

"Classification of research schemes recommended by the Advisory Board into classes according to importance and urgency in view of financial position.

Colonel Oliver stated that out of about 37 lakhs worth of schemes sanctioned by the Council, as much as 29·31 lakhs had gone for agricultural schemes and only 7·96 towards those dealing with animal husbandry. He therefore, proposed that the two small animal husbandry schemes, items Nos. 4 and 29, should be given preference. Professor Gangulee suggested the following order of priority :—

1. No. 5 (a) of the Agenda.
2. No. 29 of the Agenda.
3. No. 11 of the Agenda.
4. No. 12 of the Agenda.
5. No. 13 of the Agenda.

Mr. Milne varied the above as follows :—he would suggest No. 25 first, and Nos. 4 and 29 as second and third respectively.

Mr. Main suggested that the Secretariat should circulate a list of the schemes recommended by the Advisory Board at the present meeting to each member of the Board who would note his own order of priority. Mr. Coleman supported the proposal and added that in this list should also be given the schemes recommended at the last meeting of the Advisory Board. Each member would draw up his order of priority on the combined list which would be placed before the next meeting of the Advisory Board. He presumed that a few more schemes would be recommended at that meeting which would be followed after an interval by a meeting of the Governing Body. The next meeting of the Advisory Board would therefore on the basis of the suggestions received and on the schemes recommended at that meeting draw up an order of priority for the consideration of the Governing Body.

The Board agreed to this proposal."

ENCLOSURE II.

Statement showing in abstract form the position of the research funds of the Council.

<i>Assets.</i>	Rs.	<i>Liabilities.</i>	Rs.
Investments	15,00,000	1. Agricultural scheme sanctioned by the Council ..	17,25,000
Donation from H. E. H. the Nizam	2,00,000	2. Veterinary schemes sanctioned by the Council ..	7,89,050
Donation from the Government of H. H. the Maharaja of Mysore	1,00,000	3. International contributions ..	3,00,000
Interest on investments	2,00,000	4. Representation at International and Imperial Conferences and Congresses ..	15,231
Remainder of initial grant due from the Government of India	10,00,000	5. General	1,00,000
Recurring grant received for 1930-31 and 1931-32	10,00,000	6. World's Grain Exhibition and Conference	10,000
Total	40,00,000	Total	29,40,225
		or say	29,40,000

ENCLOSURE III.

List of Schemes sanctioned for less than five years but with the intention of development and continuation.

	Rs.
1. Investigations on rusts of wheat and barley by Dr. K. C. Mehta, M.Sc., Ph.D., 1933-34 and 1934-35	50,000
2. Grant to the Dacca University for Agricultural Research :	
(a) Laboratory Assistant (?) at Rs. 720 per annum for 3 years	2,160
(b) Apparatus for 3 years	6,000
3. Investigations on the relation between the Physico-chemical properties and fertility of soils by Dr. S. S. Bhatnagar, University of the Punjab at Rs. 4,500 per annum for further 3 years	13,500
4. Rice Physiology Scheme by Professor R. H. Dastur, for further 2	7,000
5. Reserve for Locust Research	50,000

6. Appointment of Mr. Kartha for six months to compile statistics showing the comparative efficiency of the different feeding scales adopted in military dairies and of the effects of disease and other necessary factors on dairying	Rs. 1,000
Total	1,29,600
	or say 1,29,000

ENCLOSURE IV.

List of Schemes sanctioned by the Governing Body but either not yet started or postponed.

1. Award of an annual prize for the most striking agricultural improvement of the year	No cost estimated.
2. Establishment of a Bureau of Agricultural Intelligence in India.	No cost estimated.
3. Committee for Mechanical Cultivation in India	No cost estimated.
4. Investigation on virus diseases of plants	Rs. 65,390 (5 years).
5. Appointment of a special officer for investigating Tuberculosis and Johne's diseases among animals at Muktesar.	Cost about Rs. 2,30,000, spread over a period of 5 years.

ENCLOSURE V.

Statement showing the grouping of schemes in time compartments.

(1) *Veterinary and Animal Husbandry Schemes—*

	Rs.
* 1. Research regarding diseases of poultry	1,02,860 (2 years).
" 2. Research into indigenous drugs of India with special reference to the Toxicology	73,040 (5 years).
† 3. Application from the Government of Madras for a grant for the extension of work on Animal Nutrition in the Madras Presidency	49,930 (5 years).
Total	1,25,870
	or say 1,26,000

(2) *Special Crop Schemes—*

‡ (i) Production of new (seedling) varieties of potatoes (Madras)—Rs. 20,000 (5 years).
† (ii) Bengal, Madras, Burma and Punjab co-ordinated tobacco improvement Schemes—Rs. 1,40,804 (5 years).
† (iii) Scheme for the improvement of Castor crop in India submitted by the Government of H. E. H. the Nizam—Rs. 32,825 (5 years).
Total say Rs. 1,94,000.

* Schemes recommended by the Advisory Board in June 1931.

† Schemes recommended by the Advisory Board in January 1932.

‡ New schemes not as yet recommended by the Advisory Board.

The tobacco scheme has been approved by all provinces, the potato scheme will be of value to 7 provinces and the castor scheme to several.

(3) *Dry farming and water requirements studies—*

* (i) Bombay dry farming scheme (omitting the sub-stations)—Rs. 2,50,000 (5 years).

‡ Madras revised dry farming scheme—Rs. 1,00,000.

Central Provinces and Hyderabad—(not yet estimated).

† (ii) Water requirements of crops at Lyallpur—Rs. 4,06,000 (5 years).

‡ (iii) Punjab dry farming scheme—Rs. 1,65,430, a new scheme—not part of the main co-ordinated scheme mentioned above.

(4) *University and General Schemes—*

* (i) Scheme for research on plant physiology at the Benares Hindu University—Rs. 1,26,000 (5 years).

† (ii) Scheme for the development of methodology in rural research submitted by the Vishwa Bharathi Institute of Rural re-construction, Sriniketan—Rs. 18,750 (3 years).

‡ (iii) Marketing of the ground-nut crop of the South Arcot District (Annamalai University)—Rs. 1,000.

† (iv) Investigation of the Indian Fish poisons and their insecticidal value—Rs. 15,288.

* (v) Application from Dr. N. R. Dhar, I.E.S., Allahabad University, for work on the photo-chemical aspect of the nitrification in soils—Rs. 3,440 (1 year).

* (vi) The statistical basis of the production of crops in India—Rs. 5,000 (2 years).

* (vii) The investigation of the Chemistry of Malting Cholam (Sorghum)—Rs. 15,256 (3 years).

* (viii) Experiments on tractors at the Pusa farm—Rs. 10,000.

(ix) Indian Institute of Science Schemes :—

† (a) Synthetic manure investigations—Rs. 4,950 (2 years).

† (b) Sewage farm investigations—Rs. 18,340 (3 years).

† (c) Work on quality in crops—Rs. 5,400 (2 years).

‡ (x) Lieutenant-Colonel Chopra's scheme for indigenous drugs investigation (for 2 years in the 1st instance)—Rs. 25,144.

* Schemes recommended by the Advisory Board in June 1931.

† Schemes recommended by the Advisory Board in January 1932.

‡ New schemes not as yet recommended by the Advisory Board.

* (xi) Preliminary Soil Survey of India—no cost estimated—Say Rs. 10,000 (over 2 years).

‡ (iii) Professor J. B. Sethi's Scheme—Rs. 3,600.

Total Rs. 2,62,168.

* Schemes recommended by the Advisory Board in June 1931.

† Schemes recommended by the Advisory Board in January 1932.

‡ New schemes not as yet recommended by the Advisory Board.

6. Appointment of Mr. Kartha for six months to compile statistics showing the comparative efficiency of the different feeding scales adopted in military dairies and of the effects of disease and other necessary factors on dairying	Rs. 1,000
Total ..	1,29,600
	or say 1,29,000

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3. Committee for Mechanical Cultivation in India ..	No cost estimated.
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	Rs.
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" 2. Research into indigenous drugs of India with special reference to the Toxicology	73,080 (5 years).
† 3. Application from the Government of Madras for a grant for the extension of work on Animal Nutrition in the Madras Presidency	49,930 (5 years).
Total	1,25,870
	or say 1,26,000

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‡ (i) Production of new (seedling) varieties of potatoes (Madras)—Rs. 20,000 (5 years).
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Total say Rs. 1,94,000.

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Central Provinces and Hyderabad—(not yet estimated).

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‡ (iii) Punjab dry farming scheme—Rs. 1,65,430, a new scheme—not part of the main co-ordinated scheme mentioned above.

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* (vi) The statistical basis of the production of crops in India—Rs. 5,000 (2 years).

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Total Rs. 2,62,168.

* Schemes recommended by the Advisory Board in June 1931.

† Schemes recommended by the Advisory Board in January 1932.

‡ New schemes not as yet recommended by the Advisory Board.

(5) *Horticultural Schemes—*

	Rs.
* Madras (Plains)	66,064 (5 years).
* Bengal	57,030 (5 years).
* Punjab	11,070 (2 years).
† United Provinces (Plains)	62,660 (5 years).
† Assam (not examined)	78,656 (5 years).
† Revised Hill Scheme United Provinces.. .. .	1,00,000 (5 years).
† Bombay fruit storage scheme (Central Provinces will co-operate)	1,00,000 (3 years).
† Bihar and Orissa	47,890 (5 years).
Total	<u>5,23,370</u>
or say	5,25,000

APPENDIX VI.

Note by Mr. B. C. Burt, regarding time compartments.

Group I.

The Council might concentrate at first on the following schemes :—

	Rs.
(i) Veterinary and Animal Husbandry schemes	1,26,000
(ii) (a) Special crop group	2,00,000
(b) Dry farming schemes	3,50,000
(c) University and General group (items 1 to 5 only)	1,64,000
Total	<u>7,14,000</u>

This is perhaps as close as is necessary. It may be possible to fit in the Madras and Bombay dry farming schemes into about Rs. 3,00,000 by a careful scrutiny of expenditure and rigorous economy.

2. Group II.

If the Council receives its full grant of Rs. 5 lakhs for 1933-34 together with the arrears for 1932-33 or Rs. 10 lakhs in all we shall have waiting :—

	Rs.
(a) Punjab water requirements of crops scheme	4,06,000
(b) Hyderabad castor scheme	32,000
(c) Group 2 of University and General schemes	1,08,000
(Items 6—12 of 4 Encl. V).	
(d) Fruit schemes, say	4,75,000
Total	<u>10,21,000</u>

* Schemes recommended by the Advisory Board in January 1932.

† New Schemes not as yet recommended by the Advisory Board.

In the prevailing financial stringency it is too much to hope that the Council will get Rs. 10 lakhs in 1933-34. It is very doubtful whether it will get even Rs. 5 lakhs. If that is the case all these schemes may have to wait till 1934-35, when the list will be further swelled by Rs. 2,60,000 on account of postponed schemes (*vide* Encl. IV) which will take precedence. Though the Punjab water requirements scheme is the most important one it will still be necessary to re-examine it in due course with a view to further reduction as in its present form it takes too large a share.

3. *Horticultural Schemes.*

There is no option but to postpone these schemes except the Bombay fruit storage scheme. All the schemes require to be re-examined completely.