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SOIL CONSERVATION AND AFFORESTATION

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NATIONAL PLANNING, PRINCIPLES & ADMINISTRATION

K. T. Shah.

NATIONAL PLANNING COMMITTEE SERIES
(Report of the Sub-Committee)

SOIL CONSERVATION AND AFFORESTATION

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Secretary

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Edited by

K. T. SHAH

Honorary General Secretary

NATIONAL PLANNING COMMITTEE

VORA & CO. PUBLISHERS LTD.
3, ROUND BUILDING, KALBADEVI ROAD, BOMBAY 2.

First Edition, June, 1943

Price Rs. 6/- only

To
All Those.
MEMBERS OF THE NATIONAL PLANNING COMMITTEE
and of
Its Various Sub-Committees
A TRIBUTE OF APPRECIATION

प्रारब्धमुत्तमजनां न परित्यजन्ति

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PREFACE

The National Planning Committee, appointed in 1938, began its work early in 1939. After defining the nature of a National Plan, and determining the nature and scope of the work entrusted to them, the Committee issued an elaborate and comprehensive Questionnaire which was subsequently supplemented by specific details. Twenty-nine Sub-Committees, formed into eight groups, were set up with special terms of reference to deal with all parts and aspects of the national life and work in accordance with a predetermined Plan.

After some unavoidable delay in getting replies to the Questionnaire, the Sub-Committees began their work, and submitted Reports,—some of them Final, some Interim,—which were considered at the Plenary Sessions of the Parent Committee in 1940. Towards the end of that year the Chairman, Pandit Jawaharlal Nehru, was arrested and sentenced to a long term of imprisonment, during which the work of the Committee had necessarily to be suspended.

On his release a year later, hope revived for an intensive resumption of the Committee's work. But the outbreak of war with Japan, the threat to India's own safety, and the hectic march of political events, rendered it impossible to devote any attention to such work at that time. It, therefore, inevitably went into cold storage once again; and remained for the duration of the war.

When at last the War seemed nearing its end, Pandit Jawaharlal Nehru with other leaders was released. The moment seemed again opportune to resume the work of

the Planning Committee. Meetings of that Body were held in September and November 1945, when certain more urgent questions, already included in the programme of the National Planning Committee, were given a special precedence. A Priority Committee was appointed to report upon them. Changes and developments occurring during the War had also to be taken into account; and another Committee was appointed to review the general instructions, given six years earlier to the Sub-Committees. Revised instructions were issued to them following the Report of this Sub-Committee; and the Chairmen and Secretaries of the several Sub-Committees were once again requested to revise and bring up to date such of the Reports as had already been submitted—either as final or interim—while those that had not submitted any reports at all were asked to do so at an early date.

As a result, many of the Sub-Committees which had not reported, or had made only an Interim Report, put in their Reports, or finalised them. The Parent Committee has had no chance to review them, and pass resolutions on the same. But the documents are, by themselves, of sufficient value, prepared as they are by experts in each case, to be included in this Series.

The following Table shows the condition of the Sub-Committees' work, and the stage to which the Planning Committee had reached in connection with them.

Serial No.	Name of the Sub-Committee.	Final Report		Interim Report		No Reports
		N.P.C. Resolutions	Not considered by N.P.C.	N. P. C. Resolution	Not considered by the N.P.C.	
Group I.	Agriculture & other Sources of Primary Production	Handbook Pp.		Handbook Pp.		
1.	Rural Marketing and Finance	97-99				
2.	River Training and Irrigation Part I	83-85				
	Part II	118-115				
3.	" Conservation " and Afforestation	115-119				
4.	Land Policy and Agriculture			130-141		
5.	Animal Husbandry and Dairying	87-89				
6.	Crop Planning and Production				do.	do.
7.	Horticulture	102-103				
8.	Fisheries					
Group II	Industries or Secondary Sources of Production					
1.	Rural and Cottage Industries					
2.	Power and Fuel		do.			
3.	Chemicals					
4.	Mining and Metallurgy			77-79		do.
5.	Engineering Industries	75-77		130-133		
6.	Manufacturing Industries		do.			
7.	Industries connected with Scientific Instruments		do.			
Group III	Human Factor					
1.	Labour	89-92				
2.	Population	85-87				
Group IV	Exchange and Finance					
1.	Trade					
2.	Public Finance					
3.	Currency and Banking			122-126		
4.	Insurance			98-95		
Group V	Public Utilities			95-97		
1.	Transport					
2.	Communications	126-129		120-122		
Group VI	Social Services—Health and Housing					
1.	National Housing					
Group VII	Education					
1.	General Education			133-139		
2.	Technical Education				do.	
Group VIII	Woman's Role in Planned Economy					

To sum up, fourteen Sub-Committees had made final reports, of which ten have been considered, and Resolutions taken upon them, by the National Planning Committee. Twelve more have presented Interim Reports, of which nine have been considered by the Planning Committee, with Resolutions thereon, while three Sub-Committees have not yet presented any report on the reference made to them.

The idea that all this material, gathered together with the help of some of the best brains in India in the several departments of our national life, should be printed and published was before the Committee from the start. But the interruption caused by the war prevented its realisation. It was once again mooted in 1941; but the moment was not deemed ripe then for such action, partly because the leading spirits in almost every one of the Sub-Committees were unable to devote time and labour to bring their Reports up-to-date; and partly also because war-time restrictions or shortages had made scarcer than ever before the statistics and other facts, which particular sub-committees would need, to bring their work up-to-date. The war-time needs of Government had attracted several of them to work on Government Bodies, Panels, or Committees. For all these reasons it was deemed undesirable that material of this character—valuable as it must be—should be put out in an incomplete, inchoate, obsolete form, which may reflect unfavourably upon Indian capacity for such tasks.

The last four years of the War were thus a period of suspended animation for the National Planning Committee. Even after the end of the war, it has not been feasible, for obvious reasons, for the Planning Committee to resume its work and finalise decisions. Continuous sessions of that body are indispensable for considering and taking decisions on the Sub-Committee reports presented since 1940, and putting all the material into shape, ready for publication, not to mention making its own Report; but the political situation in the country made it impossible. Other conditions, however, are somewhat more favourable than in 1938-39, when the Central Government of the country were all but openly hostile to such attempts. Lest, however, the momentary difficulties make for needless further delay, it was thought advisable by the Chairman and the undersigned that no more time should be lost in putting this material before the Public. Following this advice, it is now proposed to bring out a complete Series of the National Planning Committee's Sub-Committee Reports, which will

serve as appendices to the Parent Committee's own Report. The Plan of the proposed enterprise is briefly summarised below.

Every Sub-Committee's Report, which is in a final form and on which the National Planning Committee has itself taken resolutions, will be edited and published, with an Introduction assigning their due importance to the suggestions and recommendations contained in that particular report, its proper place in the over-all National Plan; and following it up, wherever necessary, by a kind of Epilogue, summarising the developments that have taken place during the seven years, during which the work of the Planning Committee had been in suspension.

Those Reports, again, which, though in a final form, have not yet been considered, and no resolutions taken thereon, by the Planning Committee, will also be included in the Series in the form in which they were submitted, with such Introduction and Epilogue to each as may be deemed appropriate. And the same treatment will be applied to Reports which are 'Ad Interim', whether or not the Parent Committee has expressed any opinion on the same. They will be finalised, wherever possible, in the office, with such aid as the Chairman or Secretary of the Sub-Committee may be good enough to render. Sub-Committees finally, which have not submitted any Report at all,—they are very few,—will also find their work similarly dealt with. The essence, in fine, of the scheme is that no avoidable delay will now be suffered to keep the National Planning Committee's work from the public.

Both the Introduction and the Epilogue will be supplied by the undersigned, who would naturally be grateful for such help as he may receive from the personnel of each Sub-Committee concerned. The purpose of these additions is, as already stated, to assign its true place to each such work in the over-all Plan; and to bring up the material in each Report to date, wherever possible.

Not every Sub-Committee's Report is sufficiently large to make, more or less, a volume by itself, of uniform size, for this Series. In such cases two or more Reports will be combined, so as to maintain uniformity of size, get-up, and presentation of the material. The various Reports, it may be added, would not be taken in the order of the classification or grouping originally given by the Planning Commit-

tee; nor even of what may be called the intrinsic importance of each subject.

In view of the varying stages at which the several Reports are, for reasons of convenience, it has been thought advisable to take up for printing first those which are final, and on which the Planning Committee has pronounced some resolutions. Printing arrangements have been made with more than one Press, so that two or three Reports may be taken simultaneously and published as soon as possible so that the entire Series may be completed in the course of the year.

Two other Sub-Committees, not included in the list of Sub-Committees given above, were assigned special tasks of (1) preparing the basic ideas of National Planning; and (2) outlining the administrative machinery deemed appropriate for carrying out the Plan. These were unable to function for reasons already explained. The present writer has, however, in his personal capacity, and entirely on his own responsibility, published the "Principles of Planning" which attempt to outline the fundamental aims and ideals of a National Plan. This remains to be considered by the Planning Committee. Similarly, he has also attempted to sketch an administrative machinery and arrangements necessary to give effect to the Plan, when at last it is formulated, and put into execution. Notwithstanding that these two are outside the Scheme outlined in this Preface, they are mentioned to round up the general picture of the arrangements made for publication of the entire work up-to-date of the National Planning Committee and its several Sub-Committees.

The several volumes of Sub-Committee Reports, when published, will be treated as so many appendices to the Report of the parent body, the National Planning Committee. It is impossible to say when that Committee, as a whole, will be able to hold continuous sessions, review and resolve upon Sub-Committee Reports which have not yet been considered, and lay down their basic ideas and governing principles for an all over Plan, applicable to the country, including all the facts of its life, and all items making up the welfare of its people.

The disturbed conditions all over the country, and the Labour unrest that has followed the end of the War has caused unavoidable delays in printing and publishing the

several volumes in the Series, which, it is hoped, will be excused.

In the end, a word of acknowledgment is necessary to put on record the aid received by the Editor in the preparation and publication of this Series. All those who are associated in the task,—members of the Parent Committee, or as Chairmen, Secretaries or Members of the various Sub-Committees,—have laboured wholly, honorarily, and consistently striven to give the best that lay in them for the service of the country. Almost all Provincial Governments and some States,—the latter twice in some cases,—have made contributions towards the expenses of this office, which have been acknowledged and accounted for in the Handbooks of the Planning Committee, published earlier. Suitable appreciation of these will be expressed when the Parent Committee makes its own Report. At almost the end of its task, the expenditure needed to edit, compile, and otherwise prepare for the Press, the several Reports, has been financed by a Loan by Messrs. Tata Sons Ltd., which, even when repaid, will not diminish the value of the timely aid, nor the sense of gratitude felt by the undersigned.

Bombay, 1st July 1947.

K. T. Shah.

Note:—In the Scheme of this Series, originally given, more than one Report was intended to be included in one volume in some cases. The combinations indicated in the circular, of the 20th of June 1947, had had to be modified as the printing of several Reports proceeded.

When about half the volumes were printed, it was found that that scheme would not give a fairly uniform series. The new arrangement is given on the page facing the title page. Some changes have had to be made in that list e.g., the separation of the two Reports on Public Health and National Housing, intended to be in one volume, are now in separate volumes.

Conversely, only the two Reports on Animal Husbandry and Dairying and on Fisheries were intended to be combined. As now decided, the Report on Horticulture is also included in the same Volume.

Again, the original combination of the Report on Mining and Metallurgy with that on Engineering Industries has been modified. The latter now combined with the Report on Industries Connected with Specific Instruments, which was originally meant to be a separate volume, while the former is to be by itself.

31st January, 1948.

K. T. S.

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INTRODUCTION

The problems of Agriculture, the most important single industry in the country, are many and varied, they are closely inter-connected amongst themselves, and vitally affect all other facets of National Economy, and items of the National Plan. It is impossible, therefore, to consider each of these questions by itself, or even as a group.

For the purpose of convenience, however, and bearing always in mind their close inter-dependence, the several aspects and problems of Agriculture in the country have been considered by the National Planning Committee through eight Sub-Committees. One of the most important of these is that in connection with Soil Conservation and Afforestation, dealing with the very basis of more than 75 per cent of the total wealth produced in this country.

The Terms of Reference of the Soil Conservation and Afforestation Sub-Committee, as laid down by the National Planning Committee, are:—

- a) protection against erosion, floods and other detrimental factors affecting the soil;
- b) treating it with manure and fertilizers;
- c) providing drainage and other facilities needed to guard against water-logging, weeds, etc.;
- d) planting of new forests in areas denuded of forests;
- e) care of existing forests and silviculture;
- f) development of forest produce;
- g) establishing or developing industries founded upon forest produce;
- h) provision of transport facilities needed to develop forests;
- i) reclamation of land;

and all other pertinent questions connected with silviculture and industries founded on forest produce.

The Report of the Sub-Committee prepared by Experts deals with all these items, as the matter presented itself to them before the War. Considerable developments have, however, taken place since then; but these have proceeded mainly on the lines indicated by the Sub-Committee. The National Planning Committee has considered this Report and made its recommendations as given elsewhere in this volume.

For the purposes of this Introduction, it is enough briefly to summarise the main features of the problems in connection with the conservation and improvement of the soils in India, restoration of the forests and establishment of new industries founded upon forest produce.

There are four main varieties of soils in India, namely:—

- 1) The red soils derived from rocks of the Archaen system. These are found chiefly in Madras, Mysore and the South-East of Bombay, and extend through the East of Hyderabad and the Central Provinces to Orissa, Chota Nagpur, and the South of Bengal.
- 2) The black cotton or Regur soils which overlie the Deccan trap and cover the greater part of Bombay, Berar, the Western parts of the Central Provinces and Hyderabad with

extensions into Central India and Bundelkhand. In Madras these soils are less common but still important.

- 3) The alluvial soil of Indo-Gangetic Plain and the Plains of the Indus Valley. They are the most important soil variety from the point of view of agricultural productivity yielding probably the largest quantity of food stuffs. These include Sind, Northern Rajputana, Punjab, United Provinces, Bihar, Bengal and half of Assam.
- 4) The laterite soils forming a belt round the Peninsula and extending into East Bengal, Assam and thence to Burma.

Besides these four main categories, there are other soils in India, such as the desert soils of Rajputana or Eastern Sind, which are not so rich in yield or extensive in area. Rajputana and Southern Punjab have other varieties of alkali soils, which go under various names in the different Provinces. These soils have a high degree of impermeability and "stickiness" together with heavy alkalinity and frequent presence of excess of free salts. These soils are usually poor in nitrogen and so are unsuitable for crop raising without previous reclamation.

Forest Soils make yet another category, and occupy large tracks of the country. The Soil Profiles in Chanbatta Hill and of the Kulu Forests have been investigated into and they show that these soils belong to the Brown Earth and Bordsol variety.

The soil of the country, speaking generally, is intrinsically rich, and suited to the particular crops sown thereon. The land of India has been under the plough for countless centuries but has shown no signs of exhaustion. It still continues to yield fairly large quantities of the crops sown thereon. The yield per unit is comparatively lower in this country than in some more advanced and scientifically better developed countries, employing superior technique and providing appropriate aids to keep the soil perennially rich. But that is due rather to social or economic factors, than to any inherent defects of the soil. It is not relevant to the subject matter of this Report to consider at any length those factors. But mention must be made of the fragmentation of land, and the scattered character of the holding which materially handicap the cultivation of land. Poor implements and somewhat archaic methods of tillage also account in some measure for the relatively poor yield per unit of cultivated land. Other causes tending in the same direction are to be found in uneven distribution of rainfall, its occasional scarcity or failure and frequent irregularity, which keep the soil very often lacking in nourishment that rainwater provides. Notwithstanding the fact that the soil has been in use for thousands of years, and notwithstanding the handicaps just mentioned, its native pristine richness in chemical as well as physical properties has continued to provide yield sufficient, until quite recent times, to meet all the food and industrial needs of the people of the country, and even a surplus for export of such materials as were required to pay for imports of articles not easily produced in this country.

Reference has been made to the shortcomings and somewhat archaic character and primitive methods of cultivation in vogue with the cultivator in India which account for the comparatively poor yield per unit. These, however, were suited to the peculiar character and circumstances of Agriculture in this country, until

quite recent times ; and so too much blame should not be attached to them. The practice, for instance, of taking two crops from most of the land under cultivation,—one the summer crop under monsoon rains, and the other the winter crop,—and allowing a period of fallow for the land to recoup itself, so to say, had its own utility in Soil Conservation and replenishment. Very considerable areas of land remain fallow every year, amounting in 1940-41 to as much as 45.25 million acres as against the total net area under cultivation of something like 214 million acres in round terms.

This is apart from some 98 million acres of other uncultivated waste land, which is intrinsically suitable for cultivation, and so may also be brought under the plough, adding substantially to the total Agricultural Produce available in the country. Even if the current fallows are necessary to maintain for the sake of resting and replenishing land, it is not equally unavoidable to allow such vast quantities of cultivable land remaining untilled. Because of the incessant increase in population and the consequent increase in demand, existing resources are already proving insufficient and acute food shortage results which threatens to be perennial. Unless, therefore, this available land is brought under the plough at the earliest opportunity possible, the deficit, already very acute in food stuffs produced in the country, would be progressively intensified, and the consequent distress or starvation as wide spread as it would be unavoidable.

No doubt such cultivable waste land would need to be reclaimed before it could be made fit for cultivation, and expected to add substantially to the produce raised therefrom. Some time—perhaps two or three years—will have to be allowed for the purpose as also a considerable volume of capital and labour investment for clearing, draining, planting, building tools and implements.

Reclamation of land, however, on a scientific basis, so as to permit of proper colonisation, is no new phenomenon. It has been tried on a large-scale in the Romagna Marshes in Italy, and has provided food and occupation for large numbers of people. That by itself would be sufficient reason for this country to follow the example at the earliest opportunity, and add at one stroke, so to say, 40 per cent to the actual physical volume of the soil available for cultivation. Any programme of National Planning which claims to be comprehensive would be sadly deficient and open to serious criticism if it omits to pay its due attention to this great source of new wealth in the country. The capital investment for all purposes of getting this land to yield additional crop is difficult to estimate. But even if it goes into hundreds of crores, it would be well worth incurring within five years at most to bring this land under the plough.

Apart from the social, economic, and physical difficulties or handicaps of Agricultural land in India, little blame can be attached to this primary factor of production for any deficiency in produce that has shown itself in recent years. There has been a heavy, continuous increase in population, which leads to ever increasing demands being made on the limited physical quantity and quality of soil. This would be impossible to meet unless the soil is systematically increased, improved or replenished from time to time.

Realising fully these handicaps, those concerned have, in recent years, begun a systematic attack on the problem of maintaining and improving the inherent properties of soil in India.

Considerable amount of scientific research, and practical application of recent discoveries, are being made in regard to all these groups of soils throughout the country, not only in regard to a fuller appreciation of the physical and chemical qualities of these soils, and the ways and means of their replenishment, but also in regard to their productive capacity. A new impulse has been given to a closer, systematic, and scientific study. A "Soil Profile" or a vertical cross section of the soil, is taken as the unit of study instead of only the superficial top-layer which supports the crop or vegetation. For instance, the black cotton soil of the Bombay Canal area has in recent times been classified more and more in accordance with the natural qualities; and systematic investigations have been started on that soil for sugar cultivation. Careful Soil Surveys and Soil Mapping are also being gradually recognised as important items in sound agronomy as integral part of the National Economy in the different parts of the country. In Bombay particularly a detailed survey and soil mapping of sugarcane land in possession of Sugar Factories have been taken up to provide advice to cultivators with a view to improve the quality as well as the quantity of cane yield per unit.

Similarly, at the Imperial Agricultural Institute in Delhi, all the data or information on soils available on the various Provinces has been collated, and the study based thereon has now been completed after three years of detailed work. Side by side, the important question of soil conservation and improvement is receiving further attention and considerable work is done in that field in the important Agricultural Provinces of Bombay and Punjab.

As already mentioned, whatever the inherent richness of the soils in India, the incessant exploitation by repeated cropping would necessarily exhaust the intrinsic richness, unless they are replenished from time to time, and the native qualities are further improved by proper treatment. The customary manuring of land in India has come down to us from ancient times; but the return of organic matter from farmland, fowl or cattle refuse, is restricted because of the practice to utilise cowdung for purposes of domestic fuel. This natural fertilising agency is, however, not lacking altogether. What is necessary, however, is that the night soil, city refuse as well as animal droppings must be collected and distributed on an organised scale, so that each bit of land receives its due share of such indispensable aid to Agriculture.

Artificial Fertilisers, such as ammonium sulphate etc. would be, generally speaking, beyond the means of the average Indian cultivator. Nevertheless in recent years, thanks to the intensifying need to have increased yield per unit in the country of the principal food crops, Government have taken up the problem to provide such artificial fertilisers in right earnest. Two Factories are being established in British Indian territory which are estimated to produce about 350,000 tons to 500,000 tons per annum of such artificial fertilisers. It has been calculated, however, that the country's need in regard to artificial aids to Agriculture is much greater, extending to at least a million tons per annum.

It is open to question, however, whether such fertilisers would be within the means of the average Indian cultivator; and whether for him they would be economic to apply. Further, even if they are made accessible to the average Ryot, it may be doubted if he would be able to make the best use of these, so long as the other factors like fragmentation and the general poverty of the

cultivator continue to affect the domain of scientific aids to Agriculture. But here, again, we come upon ground not strictly within the scope of this Report, and so no more need be added on the subject. The soil deficiencies, due to lack of uneven distribution of rainfall, are, likewise, being made up by large-scale Irrigation Works from the great, snowfed perennial rivers of India, as well as by means of water storage in reservoirs, tanks, and wells, which help to irrigate large tracts of land. Out of a total area under cultivation of something like 213.9 million acres actually sown in 1941-42, 56.75 million acres were under irrigation; and of these, something like more than half was provided for by canals, about 25 per cent by wells, about 11 per cent by tanks and the balance by other resources. Scientific study and use of "dry farming" is also being considered for years in areas where large-scale irrigation facilities are either unavailable or uneconomic.

One of the greatest handicaps that the agricultural soil in India has suffered from time immemorial has been the periodic floods in the great rivers. They sweep away millions of tons of most valuable soil, and so leave the land denuded and poorer than ever before. The Sub-Committee carefully considers ways and means of preventing this great loss by contour bunding, and afforestation with a view to preserving the soils. A new policy of training the rivers so as to minimise this danger and damage from floods as much as possible is also in hand. River-training, however, and development of the basins of the principal rivers of this country have yet to be taken up and integrated on a systematic scale, such as was attempted by the Tennessee Valley Administration in the United States. Since the establishment of the popular Interim Government in India, these matters have begun to receive more intensive attention. It may, therefore, well be hoped that, whatever the inherent or adventitious handicaps or deficiencies of the soil in India, they will be compensated for, side by side with the social and economic factors that cause additional handicaps, so that, within a reasonable period under Planned Economy, the yield from the soil may be substantially increased.

K. T. SHAH

SUMMARY OF INTRODUCTION

BY J. N. MUKHERJEE

Paragraph 1. Place of Utilisation of Land Resources in National Planning.

Paragraphs 2-5. In giving shape to a scheme of National Planning it is necessary to envisage the mutual relationships between the different parts of the programme of development. A list of sub-committees whose work is related to that of this Sub-Committee is given in appendix C. The subject of land utilisation should be visualised as a whole. Questionnaire (Appendix B) is based on this consideration. Terms of reference of the Sub-Committee are given in appendix A. This Report purports to give a general outline of the problems of soil conservation and of the steps required to improve the present situation. It has not been possible to give a comprehensive review or to make detailed recommendation. The basic statistics and information do not exist on many points.

Paragraph 6. An account of the intensive effort being made in the United States of America in the sphere of soil conservation is given in Appendix D.

Paragraphs 7 & 8. The problems of soil conservation require to be considered from the standpoint of the ryot, the land owner and the nation and in relation to the prevalent system of land utilisation. A balanced and coordinated use of the land has to be ensured. Trend of changes on the system of land utilisation requires to be watched. A rapid survey of land utilisation as it exists at present is an immediate necessity.

Paragraph 9. There are limitations regarding the working out of plans based on the needs of soil conservation alone. Soils and forests are national heritages. The State must accept responsibility for soil conservation and take all necessary measures to overcome these limitations and work out plans for conservation. Public cooperation must be obtained and it is therefore necessary to rouse public conscience and create soil and tree-sense in our people and more especially in our politicians and administrators.

Paragraph 10. Agricultural practices and, more generally speaking, methods of land use have for ages been based on empirical knowledge. Science can ascertain which of the practices prevalent at present are sound and which are unsound. It can also initiate better methods. The first step is to ascertain the extent and nature of present misuses and the extent and degree of the damage already wrought on our soils. The next step is to apply science through planned action to stop present misuses and to improve methods of land use in every possible way.

Paragraph 12. Soils and forests grow gradually but neglect and misuse lead to their deterioration, or partial or total loss, in a very short time.

Paragraph 13. Erosion by water, river, wind and wave lead to partial or total loss of soil. Destruction of forests and other

types of vegetation cover lead to erosion, floods and drying up of streams.

Paragraph 14. Forestry departments are not mindful of the position.

Paragraph 15. Forests are great national assets and should be uniformly distributed covering about 20 per cent of the land area and should be easily accessible. Only government forests are under control. Vast areas of forests (and also soils) are rapidly deteriorating or have already deteriorated.

Paragraph 16-20. Sheet erosion is an insidious form of erosion which contributes in no small measure to deterioration and loss of soil. River or bank erosion often produces great miseries and extensive tracts carrying towns and villages are drawn into the river bed. Wind and wave erosion are also going on for ages. All these have to be studied, their extent and degree noted. A survey of erosion is necessary. For purposes of erosion control as also of many other aspects of soil conservation, plans require to be formulated and worked out for units based on physio-graphic features. A coordinated programme for each such area is necessary and a statutory provincial organisation should be entrusted with proper powers and finances to undertake this work. A multiplicity of authorities are at present nibbling (and even that sporadically) at different points of the problem.

Paragraph 21-22. Depletion and recuperation of soils are discussed in relation to vegetation growing on them, climatic factors, and treatment with lime, manures, and fertilisers. Our soils require large annual doses of organic matter, farmyard manure, nitrogenous and other fertilisers.

Paragraph 23-24. Most of our soils between depletion and recuperation have struck a balance at a level of minimum productivity. Soil factors limiting our crop yields which are very low compared to those in other countries require extensive study so that the productivity can be improved.

Paragraph 25-27. Introduction of suitable systems of rotation and of mixed farming on an extensive scale will go a long way to remedy the deficiencies of our soils. Reafforestation, grasses and legumes, village forests and trees to serve the needs of rural communities offer the remedy for a bunch of major problems of soil conservation. Acid soils require special consideration in respect of animal and human nutrition.

Paragraph 28. Soil studies in India are very much behind the times. Soil science has a distinctive orientation of its own and the older agricultural chemistry has become only one of its important applied branches though it originated much earlier. Soil science and other basic agricultural sciences require to be fostered by the Universities. Its special orientation and importance must be recognised in all agricultural institutes and experimental stations.

Paragraph 29. Better correlation of soil characteristics to be obtained by soil survey, with results of manurial experiments and of soil treatments in general is very much needed. The present backward position of advisory work of Indian agriculture is to a large extent the result of the insufficient attention which has been paid to this.

Paragraph 30-33. The services, individual and co-operative, of an array of soil-scientists, forest workers, agriculturists (agronomists) botanists and engineers are required to tackle the different aspects of soil conservation discussed in the preceding

paragraphs and for prevention of floods, for irrigation by river, wells or tanks, drainage, reclamation of waste lands, conservation of moisture, etc. Coordination between the work of experts in different subjects must be effected. No irrigation project should be undertaken without a preliminary soil survey. This is rarely done except in the Punjab though this proposition is recognised to be an axiom in soil science and it is known that great disasters have taken place where the preliminary survey has not been done. Soil surveys are necessary for almost all the above aspects of soil conservation. There should be two types of soil surveys:—a rapid soil survey of the reconnaissance type and fuller surveys in chosen areas. In the former should be included a survey of the extent and nature of waste and fallow lands in general. In British India (official agricultural statistics 1936-37) out of a total land area of 679 million acres as much as 203 million acres comprise current fallow and cultivable waste areas. Such colossal neglect of cultivable land is hard to explain in a country where the population is so high and the pressure in some areas is as large as 1,000 per sq. mile and is increasing. The statistics and information are mostly unreliable and have not been collected by trained men. The reconnaissance survey should be able to gather through its expert staff a general idea regarding (a) the area available for utilisation, (b) conditions for making it utilisable, etc.

INTRODUCTION

BY J. N. MUKHERJEE.

1. In any programme of National Planning the utilisation of land resources obviously must form a major item, especially in India where more than three-fourths of the population live directly on the land. A rapidly increasing population, a definitely insufficient level of nutrition of both man and live-stock and the poverty partly caused by the low acreage per capita require that utmost care should be taken of our land resources, and that they should be conserved against loss and deterioration and maintained at a level of optimum productivity.

2. In giving shape to a scheme of National Planning it is necessary to envisage the mutual relationships between the different parts of the programme of development. Unless the possible mutual reactions of the different parts can be visualised in a fair degree and in advance, financial loss, delay and perhaps misery may ensue if it is later on found necessary to modify to any large extent, or, stop the operation of any part of the scheme. These general considerations will no doubt receive the attention of the National Planning Committee and of the proposed Planning Commission. Of interest to the Sub-Committee is the need for visualising the problem of land utilisation as a whole. With this object in view the sub-committee decided to interpret the terms of reference (Appendix A) in the light of the brief review contained in this Introduction and draw up a questionnaire (Appendix B). Accordingly information was sought for regarding the following aspects:

A. **General:** This section of the questionnaire deals with certain general aspects of land utilisation and the steps which may have to be taken to make necessary readjustments. It also deals with such general questions as facilities for research and training, collection of information by survey or otherwise, advisory work, dissemination of technical information, propaganda, etc.

The other sections deal with specific aspects of land utilisation with special reference to conservation of soils and forests. They are:

- B. Soil Erosion and reclamation.
- C. Conservation of soil moisture and regulation of water supply.
- D. Soil fertility and crop production.
- E. Forests.
- F. Forest produce.
- G. Transport facilities in forest areas.
- H. Forest fires.

3. The questions considered by this Sub-Committee have some bearing on those considered by the following Sub-Committees and copies of the questionnaire were circulated to their chairmen and secretaries (See Appendix C). It is understood that the different aspects of related proposals made by one sub-

committee will be discussed and correlated with those made by others.

4. The Sub-Committee would point out that, with the limited facilities and within the time at its disposal it has not been possible to give a detailed and comprehensive review or to formulate their proposals in great detail. The Sub-Committee has however fortunately been able to secure the cooperation of the following persons who are fully conversant with their respective subjects; and it is believed that the findings and proposals recorded in this Report convey a reliable general outline of the present position and of the steps required to improve it:—

INTRODUCTION — By Prof. J. N. Mukherjee, D.Sc., F.C.S.,

F.R.A.S.B., F.N.I.

Part A. — General — By Prof. J. N. Mukherjee, D.Sc., F.C.S.,

F.R.A.S.B., F.N.I.

Part B. — Soil Erosion — By Dr. R. Maclagan Gorrie, D.Sc.,

F.R.S.E., I.F.S.

Part B. — Reclamation — By Prof. J. N. Mukherjee D.Sc., F.C.S.

F.R.A.S.B., F.N.I.

Part C. — Conservation of Soil Moisture and Regulation of

Water Supply — By Prof. J. N. Mukherjee, D.Sc., F.C.S.,

F.R.A.S.B., F.N.I.

(Incorporating suggestion in a Note by Rao Bahadur

V. A. Tamhane, M.Ag., I.A.S. (Retd.)

Part D. — Soil Fertility and Crop Production —

By Prof. J. N. Mukherjee, D.Sc., F.C.S.,

F.R.A.S.B., F.N.I.

(Incorporating suggestions in a Note by Dr. D. L. Sahasrabudhe,
D.Sc., M.Ag., I.A.S. (Retd.))

Part E. — Forests — By Mr. S. H. Howard, I.F.S.

Part F. — Forest Produce — By M. L. R. Subharwal, I.F.S.

Part G. — Transport — By Mr. L. R. Sakharwal, I.F.S.

Part H. — Fires — By Mr. K. P. Sagreiya, I.F.S.

5. It is the finding of the Sub-Committee that the basic statistics and information do not exist on many points. Even the information which is available in a scattered form requires critical examination and collation. The question of a comprehensive review and details will have to be tackled later by the Planning Commission. Several specific points have however been dealt with in our Report as they have arisen. In framing our Report we have naturally drawn upon the knowledge of individual members of the Committee and its collaborators but an attempt has been made to avoid individual bias or predilection. The different sections of the Report have been written by the members whose names are given at the top of each section and finally approved by the Sub-Committee after discussion. A certain amount of repetition and overlapping has been caused by the procedure followed; but it has the advantage of bringing together different aspects of the subject dealt with in each section and illustrating the inter-relationships of measures for conservation of the soils.

6. It is considered helpful to cite one instance of what is being done abroad with reference to soil conservation. It is hoped thereby to give a background which will enable our report to be considered in proper perspective. A brief account is therefore given at the end of this introduction (Appendix D) of the intensive effort which is being made in the United States of America

where the range of variations of climate and soil conditions and the scale of the problem is to a large extent similar to what obtains in our country. The main interest of this American endeavour consists in that they were faced with conditions which required prompt and energetic action and that they set to work with characteristic energy. Economic and social conditions however differ widely and it is not implied that we should follow blindly American methods of approach to the solution of our problems or their practices; but basic scientific methods and knowledge gained in America and other countries have obviously to be used at least so far as the application of science to the solution of our problems is concerned.

7. The following brief review is intended to convey an outline of the problem of soil conservation in India. Soil conservation connotes all methods of soil management and other measures required to preserve soil and soil fertility from total or partial losses caused by erosion by water and wind, by floods, by waterlogging, by the removal of the elements of fertility by leaching by water and by extractive cropping or grazing. The problems of soil conservation require to be considered from the standpoint of the ryot, the land owner and the nation and in relation to the prevalent system of land utilisation.

8. Apart from food and fodder there are other demands to be satisfied by a proper utilisation of land by agriculture and forestry such as, money crops, fruits, timber and other forest produce, fuel and other needs of the ryot and of rural communities and requirements of raw materials for industries. The existing system of land utilisation is partly the result of the mutual interaction of these demands and partly the result of limitation imposed by various causes. The present system is of great antiquity and interwoven into the social and economic fabric of the community. In planning a programme for the better utilisation of our land resources due cognisance has to be taken of the above demands, of various limitations and of the purposes other than those of forestry and agriculture for which land is utilised, such as, communications, mining and quarrying, town planning etc. The question of adjusting the distribution of lands over these various demands has to be faced. A system or method of land utilisation is not however static. Consequent upon social, economic and political reactions of the development of science, changes are taking place in all countries regarding the system and methods of land utilisation and our country is no exception to this. Economic factors such as variations in prices and accessibility to markets, special and even temporary demands, for example, those created by war, and protective tariffs, all bring in changes in the system of land utilisation. The drift of population from villages to towns, the development of mechanical transport, of mining and other industries, the need of an increasing population, of a balanced crop production with a view to meet different purposes, of mixed farming, of better nutrition for both men and livestock and of better social amenities; all these call forth a thorough examination of our present system and methods of land utilisation. For this purpose a rapid survey of land utilisation as it exists today should be immediately undertaken on as large a scale as possible by the governments of the Provinces and States. And maps of land utilisation should be prepared collating the information gathered by supplementary surveys with a view to form an idea of the trend of developments and the manner in which various factors

are operating. The trend of such changes requires to be watched, in order to control and regulate them and guide them along suitable paths. At present there is no definite machinery either in the Centre or in the Provinces for the coordination of land use. The importance of coordination of land use is obvious in relation to any practical programme of soil conservation. Land utilisation surveys have recently been made in several countries such as Japan, China, Korea and Great Britain. In many other countries the necessary information is available in a suitable form.

9. Improvements and adjustments which may be felt to be imperative or desirable from the point of view of soil or forest conservation have to be considered in relation to the interplay of various factors, and also from the point of view of their effect on the interests of the ryot and of the community. Limitations are also imposed by inadequate scientific information, by considerations of finance, by tenancy laws, by laws of inheritance, by the illiteracy, ill health and poverty of the ryot and by the density and location of the population. But our soil and forest resources constitute our most vital national heritage, and on their successful conservation depend the present and future of the nation. The State must therefore step in and accept responsibility for their conservation and reconcile the interests of the producer, the owner of the land (if he is also not the producer) and the nation. The producer and/or the landowner have to be encouraged to conform to planned action to conserve the soil by education and propaganda; by such financial inducement as is dictated by policy or equity; and by effective supervision, advice and demonstration based on scientific knowledge and backed by legal measures where need be. It is not that no efforts in these directions are being made by the Central and Provincial governments, but it is open knowledge that existing resources devoted to these purposes are very inadequate. They are not commensurate with the magnitude of the task and of its importance. Public conscience has to be roused and the full implications of the situation have to be brought home to all. This is an imperative duty of all those concerned with the administration of public affairs.

10. Guided by empirical knowledge, our people have developed a fairly balanced system of agriculture of great antiquity which is intended to meet their requirements—though as mentioned above they are subject to modifications in response to changing conditions. The farmer has in all ages a great regard for the soil. He lives on it and with it. Misuses under his management mostly arise from want of knowledge and from limitations beyond his control. Many of his traditional practices are based on empirical knowledge gathered from the experience of centuries, and can or should only be supplanted after adequate scientific investigation. The principles underlying his practices must be assessed on the basis of scientific knowledge and proved to be defective or capable of replacement by more fruitful practice. Empiricism has however its limitations. It proceeds blindfold by random hits rarely knowing the cause of a success or failure whereas methods of science are based on the sure foundation of experimentation, planned on scientific knowledge and of logical systematisation. It is definitely surer of a catch in its nets and the result has been that empiricism has been ousted by science.

11. The first step in the application of science to our problem consists in ascertaining the extent and nature of the misuses to

which our soils are subject and the extent and degree of the damage already wrought on them. The next step is to apply science to set right present misuses through planned action.

12. Failures of rains, floods, depopulation and loss of cattle caused by famine and pestilences, disturbances caused by war and interference with or change in the natural drainage system have had their deleterious effects on our soils at sometime or other. Soils and forests grow gradually. Even in favourable conditions a soil layer of suitable depth requires about a hundred years for natural growth and generally it takes longer. Forest cannot be created in less than thirty years. But both may be lost in an incredibly short time either as a direct consequence of injudicious interference by man, or indirectly from his neglect or lack of knowledge or of supervision. A hill top capped with a magnificent forest harbouring flora and fauna of inestimable economic and aesthetic value soon becomes a bare piece of rock through shifting cultivation or uncontrolled grazing or other unsound methods of utilisation. A flourishing farm, if deserted, soon becomes a ruin and it takes long to refashion it to its former state of productivity, where this happens to be at all possible. Even frequent changes of the human personnel managing it or their lack of interest have a deleterious effect on the soil. It is not impossible that during the period of political vicissitudes, beginning with the weakening of the central authority in the Moghul period to the settled state under British rule, the even tenure of Indian agriculture was greatly disturbed and considerable deterioration of our soils took place.

13. Erosion by water, river, wind and waves constitutes some of the most spectacular examples of total or partial loss of the soil and all that stands on it. Destruction of forest covers by deliberate human interference leads to increased run off of rain water and its diminished seepage and storage in the soil. The decomposing forest litter is no longer replenished by fresh falls of leaves or decaying roots and plant remains, and the soil organic matter and other plant nutrients gradually diminish. The structure of the soil suffers; the run off increases, loosens the soil and transports it, sifting the sand and heavier particles in the process which are deposited nearer the scene of destruction and the finer parts go to make the streams turbid to be deposited far away. The muddy waters of our rivers carrying large quantities of silt and clay tell their own tale. The soil and all that stands upon it have been lost. And one of the first effects of these is to block the streams. No longer can the rain water be stored to feed the streams gradually over long periods after the monsoons are over. The increased run off, especially after heavy downpours, comes in a sudden rush and often gets blocked in the silted streams. The water develops power enough to cause devastating floods. The effects catch the eye when erosion has wrought its destruction, but the initial processes began to work long before. This type of water erosion arising from destruction of forest and grass cover has been going on for ages. The forest cover or a cover of suitable vegetation, e.g. natural grasses, has to be recreated in these eroded regions and nature must be allowed to heal the wounds by setting in motion processes of soil formation and growth of vegetation.

14. The forestry departments are not unmindful of the gravity of the situation. In recent years several provincial governments have initiated definite measures with a view to improve the position. Periodic conferences and discussions of

forestry officers have been held. The Central Irrigation Research Board have also emphasised the evil effects of the destruction of forest cover on floods and water supply of streams and rivers. But only a fringe of the problem has so far been touched.

15. Forests are one of the most prized assets of a nation. The climatic conditions in large parts of our country are very favourable to their growth. Excluding those under government management, which are looked after as well as the resources placed at the disposal of the forestry departments permit, there are equally large forest regions which are not under government management and are not properly cared for. The forestry departments of most provinces have definite working plans for managing forests under their charge. Our forests meet a large range of needs, and their economic value cannot be over-emphasised. They can certainly be made to yield much more if losses and misuses are stopped. A minimum of about 20 per cent of the land area should be covered by forests. This does not obtain in many provinces.* Even the existing forests are ill distributed and are not easily accessible in many cases. The needs of rural communities on timber, fuel, fodder and many other items will be more cheaply and easily met than at present by a more even distribution of forests and a greater encouragement of the plantation of trees. This will certainly conduce to a diminution in floods and erosion losses, a more even supply of water in streams and rivers, conservation of moisture in soil and colder summer temperatures. The utilisation of many items of forest produce for industrial purposes remains to be initiated. More attention should be paid to it and there is no doubt that considerable benefit will accrue from it.

16. There are other types of water erosion though not so spectacular in their effects excepting some form of river or bank erosion. The latter has been responsible for sweeping away flourishing towns and villages which have stood for hundreds of years covering considerable areas, as for example in Eastern Bengal. The resulting misery to a settled population can be easily imagined. It is not enough to conserve and recreate forests and trees for catching and storing rain water. It is also necessary to train rivers and make them serve better the purposes of drainage, communications and water supply for irrigation and other uses. It is necessary also to take into account the nature of the soils and their utilisation in connection with schemes or river training, drainage and irrigation. These considerations afford another of the many instances which bring out the importance of coordination of policy, research, efforts and programmes of land use.

17. A much less spectacular and slower form of water erosion which is cumulative in its effects and is therefore insidious, is that going on in gently sloping lands and in the plains all through the country. Cross country railway journeys bring home to us the extent of such erosion. Apart from partial or total loss of soil, these gentler forms of water erosion remove the colloidal matter and soluble salts and their effects on loss of soil and its fertility can be very serious. The tendency to erosion in cultivated lands and areas without adequate forest cover depends on agricultural practices, as also on the soil, topography, the cover of vegetation and distribution and intensity of rainfall. These conditions vary according to locality, and control measures

*See Appendix E. Part 1.

must be adapted to suit them. A good cover of vegetation and suitable methods of soil management aiming at a diminution of the velocity and volume of run off, such as bunding, terracing, contour cultivation, strip cropping, tanks and ditches, drainage channels with a good grass cover, or of brick and cement or concrete, and preservation of soil structure, form the basis of measures for the control of water erosion.

18. Erosion also results from wind or wave action but much less information exists regarding their extent in India partly because they are not so extensive as the others. Sand dunes are known in several parts of the country. Dust storms in summer are common experiences. One can see from the hills, e.g. in Simla, thick palls of dust resembling clouds, which hang in the air and stretch over considerable distances.

19. It is thus evident a survey has first to be made to ascertain the types, extent and intensity of erosion losses and to gather information on which control measures are to be based. Some of the provinces, e.g., the Punjab, have undertaken erosion control measures in Government managed forest areas. A central organisation is required for pooling of information, to act as a coordinated body in matters which touch the interests of more than one province, to coordinate research and to advise the Central or Provincial Governments. Sir John Russell in his report to the Imperial Council of Agricultural Research recommended the creation of a Soil Conservation Committee, one of whose functions would be "to watch closely regions liable to erosion, calling periodical conferences of the Departments concerned, with a view to working out schemes based on the physical rather than the political boundaries." The Board of Agriculture (Crops and Soils Wing) at its meeting in December 1939 has adopted a resolution purporting to recommend to government the creation of an anti-erosion committee. The various economic and social factors, methods of land utilisation, agricultural practices, nature of soil and climatic conditions—all have a local colour. It is, therefore, necessary to take the village or a group of villages and the surrounding land managed by its inmates as a unit for a coordinated programme of soil conservation and a better system of land utilisation. The programme should be evolved after investigation and research guided by a body of experts and put into operation by an intensive drive from a provincial or state organisation vested with due authority by the State. This organisation should have powers to look into and coordinate all aspects of soil conservation and land use. Better planning of villages with a view to improve sanitary conditions, communication, etc., should with profit be linked up with the activities of this organisation. Similarly plans should be worked out for each forest area by the provincial organisation in association with the forestry department. There should also be a Central Organisation for the whole of India for dealing with those questions which are of more than provincial interest, for pooling information, encouragement of research, publication, and broader questions of policy, survey and methods. A multiplicity of boards and committees and similar organisations should be avoided; and existing organisations should be coordinated into one body at the Centre and corresponding bodies in each Province or State.

20. Conservation of soil fertility is another fundamental aspect of soil conservation. Crops and plants extract their nutrients from the soil. And the losses thus caused together with those caused by erosion, by climatic factors and by leach-

ing by water must be made good in order that its productivity can be raised to and maintained at its optimum. Different plants make different demands on the soil. The immediate and reserve powers of different soils to meet these demands vary. The soil has also its natural powers of transformation and recuperation regarding some aspects of its fertility. These powers also show variations.

21. Plants growing in natural associations with soil and climate ensure a balance between depletion and recuperation. The ideal condition is often attained in virgin forests and in steppes or prairies. The richer types of soils develop under suitable climatic and geological conditions under deciduous forests and perennial natural grasses. Grasses and legumes conserve soil organic matter and nitrogen and enrich soil both physically and chemically. Cultivated crops make a great demand on the soil, thereby causing depletion of the stock of nutrients in the soil and deterioration of soil structure—the latter factor renders it more liable to erosion losses.

22. In temperate climates blessed with an even distribution of a moderate annual rainfall, natural forces are favourable to the maintenance of organic matter (humus) and nitrogen at a high level and of microbial activity. These are inter-related. Lime, manures, and fertilisers supply the needs of extractive farming. When soil depleting crops are used, rest and recuperation from their depleting effects have to be ensured also by suitable systems of rotation which allow soil conserving crops to act in turn with soil depleting ones. The peculiarities of Indian climatic conditions—determined by a rainfall, often in heavy downpours, concentrated within about four months; by a high mean temperature over the major part of the country; and by a relatively dry winter and a dry summer both accompanied by bright sunshine, which follow the rainy season—are most favourable to the destruction of organic matter and soil nitrogen, to leaching by water, to deterioration of soil structure, to erosion, and to interruption of beneficial microbial activity. These peculiarities together with the failure of rains, especially a succession of such failures, excessive rainfall localised in short periods of time, floods, and insect pests constitute the most important limiting factors in our crop production*. Every effort has therefore to be directed to find out and use all possible methods aiming at the control of erosion, the maintenance of optimum humus and nitrogen status of our soils, and also optimum moisture relationships. Cultivated crops are in general an unavoidable evil so far as conservation of soil is concerned. Continuous attempts have to be made to evolve better methods of rotation and soil management, including treatment with lime, manures and fertilisers so as to secure not only the optimum yields and quality** of crops but also the conservation of soil fertility and soil structure.

23. The different types of losses and deterioration of the soil briefly enumerated above have been going on for a very long time. Our soils appear to have mostly struck a balance between

*This Sub-Committee is not concerned with aspects of crop production not related to soil conditions or land utilisation.

**Nutritive or for commercial purposes. The nutritive value of a crop depends to a certain extent on the soil and its cultural treatment and requires as much attention as the yield.

deterioration and recuperation on a level of minimum productivity. There is a belief amongst some sections of the population that our soils are becoming poorer. Only careful investigations will show how far this is true. But this is a matter which can not be brushed aside without such investigations. Efforts for the improvement of crop yields have been made through the provision of water by irrigation and the introduction of better yielding or drought resisting varieties. But it has been pointed out in a paper at the recent meeting (December, 1939) of the Crops and Soils Wing of the Board of Agriculture, that the average yield of crops has not materially improved. That is, no very definite improvement in yield has resulted from better irrigation facilities, introduction of better varieties and the other improvements effected by the agricultural departments. From the scientific standpoint attention should be directed not only to averages but also to the highest and lowest yields, especially of the same variety of a crop noticeable in a given locality with a view to determine the soil conditions and other causes such as availability of good seeds, incidence of pests, insects and diseases responsible for the difference. While sweeping conclusions drawn only from a consideration of averages are likely to be misleading, the facts give food for thought. Judging from experience and available scientific information, it is not unsafe to draw the conclusion that rapid destruction of organic matter and possibly unsatisfactory microbial activity associated with the resulting low humus and nitrogen content constitute perhaps two major limiting factors in our crop production. The relative merits of fertilisers and manures have often been discussed by our agricultural chemists. While the great need of farmyard manures has been emphasised, there seems to be a tendency in some quarters to underestimate the benefits of increased use of fertilisers. In assessing the utility of fertilisers it is necessary in the first instance to remove the limitations mentioned above by using farmyard manure and organic matter. More extensive experiments are needed.

24. A comparison of the yields of wheat and rice in different countries is very elucidating. In some parts of China the age old settled practices of Chinese agriculture have maintained the yield of wheat at a high figure for tens of centuries. It seems that political vicissitudes have not materially affected the even tenor of China's agricultural system. In fact in some places in China the yield is reported to be still one of the highest in the world. Apparently losses have been made good during all this long period and productivity maintained at a very high level. Manures and fertilisers and improved methods of soil management have enabled European countries to increase materially the yield of crops including rice. The yield of wheat in the United States of America, though not on an average as great as in Europe, is definitely increasing as a result of scientific improvements.

25. The introduction of mixed farming on an extensive scale and of suitable rotations will go a long way to remedy the deficiencies of our soils. Better nutrition of cattle is also a desideratum of first rate importance as the conditions of cattle nutrition are appalling. The introduction of stall feeding will be of great help. Cheap and easily available fuel is required to stop the colossal misuse of cattle dung now going on throughout the country, when our soils need every bit of organic matter and nitrogen contained in it. It is absolutely necessary to in-

crease the quantity of fruits grown in the country, as they form an important nutritive element of our food and their present supply is wholly inadequate. To sum up: greater cultivation of fodder crops, especially grasses and legumes, through the introduction of rotations and otherwise, encouragement of planting of suitable trees in hedges, boundaries, and in village areas to meet the needs of the rural community, for fuel, timber, fruits, fodder, etc., constitute some of the most important measures required in connection with several aspects of soil conservation. They also serve as a link coordinating the needs of soil conservation with those of better nutrition of livestock, better supply of milk and milk products, better nutrition of men, increased supply of farmyard manure and an efficient control of grazing.

26. Mention must be made in connection with the preceding, of acid soils. They are generally deficient in available phosphorous and are deficient in lime. The nutritive value of the grasses and crops and of the milk of cattle feeding on them suffer in consequence. Livestock do not get sufficient lime and phosphorous for their proper growth. These deficiencies have to be made up in order to render them more suitable for growing grasses, legumes and other fodder crops, and fruit trees. Experiments are necessary to study this question in all its bearings including the effect of suitably designed treatments on the yield and nutritive value of paddy and fodder crops.

27. A systematic study should be taken up of grasses and grass lands with reference to the selection of best types of grass, and to the conditions of their growth suited to different localities. Much attention is now being paid all over the world to grass and grass lands.

28. Great improvements have been effected by intensive scientific enquiry in our knowledge of soils, plant breeding, plant growth, crop production and soil and forest management. Expeditions have been led to distant corners of the earth for the discovery of newer varieties of plants which are capable of utilisation in one way or other. Research and teaching institutions dealing with soils and various aspects of soil management and soil conservation have multiplied in a phenomenal degree during the last twenty years. Recent wars and changes in economic outlook have made national self-sufficiency and fullest utilisation of national resources a main plank of State policy. Increased attention has consequently been devoted amongst others to the basic sciences whose promotion would help a better utilisation of soil resources. The emergence of soil science from the tutelage of its applied branch, namely agricultural chemistry, has been ushered in by the contributions of Russian pedologists and has helped in no small degree the furtherance of our scientific knowledge of soils. Compared to the scientific information about soils available in many countries what is available at present regarding Indian soils makes a very poor show. Until very recently most of the information has been collected from an older point of view often in a disjointed manner, and not always by very reliable methods. This is illustrated by the comments of Mme. Schokolasky. She is the first to propose a provisional scientific classification of Indian soils and to prepare a soil map of India (only one so far available). Her work was carried out under the guidance of Prof. Polynov who was entrusted by the International Society of Soil Science to prepare a soil map of Asia. The Geological Survey of India has prepared a useful map of the rocks under Indian soils. It is not however a soil map.

Schokolasky's soil map is based on information supplied by Indian workers and publications. Broadly speaking the scientific study of soils has passed through three stages, each recognising respectively the importance of (1) chemical analyses of soils (and of plants), (2) the microbiology of soils (3) the natural factors controlling the formation, the growth and decay of soils, the soil profile as a unit for study, and the utility of the methods of colloid science, physical chemistry and mineralogy. Soil studies in India until recently were mainly confined to the first stage. Soil microbiology is still greatly neglected. Even within its narrow sphere, the available information is far from being complete and has not been critically examined and collated. Sir John Russell, in his report already referred to, has drawn attention to it and made definite recommendations for the collation of information and relevant matters with a view among other things to its utilisation for the preparation of a soil map of India. This is necessary for purposes both of advisory work and of teaching in agricultural colleges. An intensive study of our soils is urgently required. Existing teaching institutions and experimental stations, though few in number, are seldom well equipped and are languishing for want of financial help. The basic agricultural sciences, namely entomology, cytology and plant genetics and soil science require to be fostered through the universities. Different stages of agricultural researches—the research in the basic agricultural sciences, which should be carried out in the universities; the research in agricultural colleges and experimental stations; the experiments in demonstration farms and in the ryots' plots—all require to be taken up in right earnest and coordinated. It is not intended to convey the idea that nothing is being done. The Imperial Council of Agricultural Research has definitely given an impetus to agricultural research in general and to soil research in particular. But much remains to be done. It should be possible with proper effort to effect tangible improvements in the existing situation within the next ten years.

29. Manurial experiments have been carried out in considerable numbers throughout the country. In the more recent experiments statistical methods have been used in planning field experiments and in assessing their value. But for advisory work, for teaching in agricultural colleges and for stimulating further researches, the results require to be correlated with the characteristics of the soil. This implies a knowledge of the types and other sub-classifications of soils in a locality. The view is held by most of our soil workers, that a soil survey of the nature of a reconnaissance survey is of immediate necessity and should be carried into action by Government. It will go a long way to clear up various matters. We must have, in a form easy of access, reliable information regarding the more important variations in our soils, their fertility status, their manurial requirements, their present condition and their possibilities. A fuller scientific survey should also be undertaken without delay in specially chosen areas and on the basis of the information afforded by the collation of existing information. The scientific basis of soil conservation measures has to rest on the fullest knowledge of our soils. Visualising its scope and the time in which it is possible and it is, therefore, necessary to chalk out a scheme of soil survey work desirable to complete it. These problems are receiving the attention of the Imperial Council of Agricultural Research who have

accepted a proposal of setting up a Soil Survey Committee in which all bodies interested in soil work are to be represented.

30. Prevention of floods, irrigation by rivers, well or tank water, drainage, conservation of soil moisture and reclamation, where possible, of waste lands, constitute other important aspects of soil conservation. The first three are interrelated to a great extent. In dealing with them cooperation is often needed between different provinces and states. The destruction of a forest cover in one province affects the river system and produces floods in another. Water used injudiciously in the upper reaches of a river affects in several ways the quantity of supply lower down its course. This again raises the question of coordination. In tackling these problems as also in connection with several aspects of erosion, the services of engineers are required. Engineers, forest workers, soil scientists, agriculturists, and botanists have often to be brought to deal with our problems of common interest. Such co-operation between all such interests as exists at present materialises in a round about way with great loss of time and efficiency. Effective co-operation between them should be secured through the establishment of suitable committees in each province and at the centre.

31. It is an axiom in modern soil science that no scheme of irrigation should be undertaken without a preliminary survey of soils of the region concerned. Irrigation water from rivers or wells contain varying quantities of salts. Rain water generally contains negligible amounts. Further irrigation may result in water logging and/or a rise of salts to the upper layers of the soil depending on the nature of the soil profile. The preliminary soil survey is intended to supply relevant information. Further the changes produced in the soil regarding these and other aspects require to be watched which means continuous soil studies while the area is under irrigation. It is well known that disastrous consequences have resulted from irrigation projects carried out without a preliminary soil survey. Irrigation is not merely a problem of the revenue department and of engineering. It is indeed strange that except in the Punjab, soil studies have very rarely been related to irrigation projects. The proposed soil surveys should be of help in this matter.

32. These surveys are also necessary in connection with the reclamation of waste lands. There are vast areas of alkaline and saline lands, e.g., *usar* and *reh*. Compared to the scientific studies on such soils in other countries, the progress made in India regarding their study is hardly worth mentioning and the lack of knowledge is indeed hard to believe. The absence of basic scientific information is nowhere more disconcerting and appalling than with regard to our soils. A soil survey is needed to understand the extent of such lands, their genesis and possibilities of reclamation and to devise methods for it. It has also to be found out whether they are increasing in extent or not.

33. A survey of the extent and nature of waste lands in general should of course be incorporated in the rapid reconnaissance survey of soils. In the figures published in the official Agricultural statistics for 1936-37* the total land area is given to be approximately 679 million acres in British India. Of this the 'net area sown' is about 232 million acres, 'forests' comprise, 89; 'current fallow', 49; 'cultivable waste' other than 'fallow' 154; and the area shown as 'not available for cultivation' is 155 million.

* See Appendix E. Part 1.

SOIL CONSERVATION AND AFFORESTATION

acres. In the Indian states** the total area is given as 147 million acres of which 'net area sown' is 69; 'forests' 19; 'current fallow' 13; 'cultivable waste other than fallow' 19; and that 'not available for cultivation' 27 million acres. Doubts have been expressed as to the accuracy of the figures 'for cultivable waste other than current fallow' and for 'not available for cultivation.' It does not seem that the figures, excepting those given for forests under government management and also to some extent those for 'net area sown', have been compiled on the basis of reliable information or by scientifically trained men. 154 million acres are shown as 'cultivable waste other than fallow' and 49 million acres as 'current fallow'. They together, and ignoring for the moment the area shown as not available for cultivation, make up 203 million acres as compared to 232 million acres shown as 'net area sown'. Considering the magnitude of these figures, it is certainly desirable that the reconnaissance survey should be able to gather through its expert staff a general idea regarding (a) the area actually available for utilisation (b) the conditions which must be fulfilled in order that they may be utilised, (c) the area which can be utilised for each specific purpose and (d) the causes why so large a proportion is 'current fallow.' The area shown as 'not available for cultivation' includes towns and villages, rivers, roads, etc. But it also does include some

34 It is necessary for all concerned to think hard and to visualise in terms of trained men, research institutions and central, provincial and local organisations, the scale of operations required in order that a reasonable proportion of the area covered by the problem is adequately tackled in a reasonable span of time. The Imperial Council of Agricultural Research and the Departments of Agriculture and Forestry are alive to the magnitude of the problem. A considerable amount of valuable work is being carried out, though its scope and extent vary in the different provinces and is entirely limited by the resources at their disposal. What is required is an acceleration of existing efforts into a co-ordinated and planned drive of a magnitude commensurate with the social and economic implications of the subject.

**Appendix E Part 11. There is no reference to the Eastern States, e.g. in Bengal Orissa and Assam.

Part A

GENERAL

By

J. N. Mukherjee

SUMMARY

Paragraph 1: The present system of utilisation of our lands requires the closest investigation. An examination of the systems and methods of land utilisation affords very important data regarding prevalent misuses of land, and also adjustments necessary to ensure a balanced utilisation. Village and town planning, as also drainage, water supply, communications and similar matters must loom large in future in plans of rural reconstruction. Reliable information is also necessary regarding the requirements of land for each of these purposes. Informations on these points must be available for units of suitable size based on physiographic features. Existing and potential industrial demands on the produce of the land have also to be taken into account.

Paragraph 2: The information given in the periodic publication entitled "The Agricultural Statistics of India", though useful in some respects is of little help. Doubts have been expressed as to the accuracy and significance of the figures published in this periodical. The figures are collected through the district officers' staff, not infrequently through village chowkidars and patwaris, and very often not by trained men nor directly by agricultural officers.

Paragraph 3: Out of a total of 827 million acres the 'net area sown' in 1936-37 was 301 millions while 61 millions were 'current fallow' and 173 millions were reported to be 'cultivable waste other than fallow'. Considering the population of cultivable land lying waste an enquiry should be conducted by a body of experts to ascertain (a) the area actually available for utilisation, (b) the conditions which should be fulfilled in order that they may be utilised, (c) the area which can be utilised for each specific purpose. Investigation is also desirable in order to ascertain the reasons why 61 million acres out of a total of 827 million acres lie fallow and what should be done to ensure their better utilisation. The area (123 million acres) shown as 'not available for cultivation' also requires closer inspection.

Paragraph 4: The effects and trend of changes taking place in our system of land utilisation have to be studied and taken into consideration in formulating plans of soil conservation. An intensive and sustained effort is necessary to remedy present maladjustments existing in the distribution of land over the various purposes.

Paragraph 5: The most apparent feature of the present maladjustment in relation to soil conservation is the small proportion of the total area devoted to village or minor forests, fodder crops, pastures, fruit trees and other trees e.g. for fuel, timber etc.

Paragraphs 6-10: The deplorable condition of livestock in India is due to insufficient production of fodder crops, bad conditions of grazing grounds, unmanageable number of cattle and the neglect of proper methods of breeding. Production of fodder on a much larger scale is a necessity. Uncontrolled grazing constitutes one of the most serious factors leading to deterioration of soil and its loss by erosion. The present unmanageable number of inefficient cattle must be replaced by more efficient cattle, fewer but sufficient in number to meet all purposes. The grazing areas in forests are capable of improvement and expansion with proper control. Minor forests in villages, hedgerows and roadside trees are helpful in the conservation of soil and its moisture; and should be looked for to contribute substantially to the increase in the production of fodder. Better methods of soil management, including the use of manures and fertilizers should bring in an increased production of fodder, by inclusion of natural grasses and legumes which are soil conserving crops in suitable systems of rotation based on research. The area under grass and fodder crops has to be materially increased. But this cannot be easily done at the expense of that under food crops in most places since the population is large and increasing. The closest attention must be paid to the areas shown as 'cultivable waste other than fallow,' to 'current fallow' and also to the area shown as 'not available for cultivation' for finding ways for much better utilisation of these areas.

Paragraph 11: Most of the food and cash crops are responsible for depletion of fertility, for deterioration of soil structure and for erosion. Cultivation of food crops has to be planned in relation to the nutritional requirements of the people and the existing distribution of food crops also requires adjustment. The first and foremost aim should be to develop and introduce systems of rotation and of mixed and balanced farming suited to local conditions; and to take all steps to increase the yield of food crops with due safeguards against soil depletion by these crops. More knowledge than available at present will have to be gathered by systematic research and study.

Paragraph 12: Forests should cover 20% of the land area. They should be more uniformly distributed over the entire land. Village or minor forests should be established to secure this uniform distribution. Trees of economic importance should be planted wherever possible. In drier or arid regions, denuded areas and near inhabited localities, grass lands also acquire great importance.

Paragraphs 13-14: Forests in British India under state management are better looked after than private forests. Private forests offer great scope for improvement and should be placed under effective control and management. This is an urgent necessity. Even in government forests there are considerable possibilities of greater exploitation but measures of conservation must have the first consideration.

Paragraph 15: Want of coordination between the activities of the forest departments with those of other departments stand in the way of effective protection and development of forests and control of floods and erosion.

Paragraphs 16-17 : The area under fruit trees and vegetables is low compared to the total acreage and to the requirements of the people. Attention should be paid to trees of economic importance which are likely to bring a cash return. This present situation has arisen owing to a lack of private enterprise and governmental action. The people should be encouraged by propaganda and demonstration to take active interest in conservation of soils, forests and trees and in land utilisation.

Paragraph 19 (a) : Different departments of a provincial government tend to work in watertight compartments. The problems of soil conservation are tackled by a multiplicity of authorities in a disjointed and sporadic fashion. Such attempts are likely to do more harm than good. These activities must be coordinated and the problem visualised and grappled as a whole. It is high time to settle down to work through a permanent statutory organisation.

(b) An intensive and sustained drive is required to improve the very unsatisfactory condition.

(c) Measures of soil conservation depend for their successful operation, on the active and intelligent co-operation of the producer—the ryot. By education, propaganda, demonstration and financial inducement his active co-operation has to be secured.

(d) The state should make an earnest beginning with all lands under its own control, permanent or temporary.

(e) Big land owners should be persuaded to adopt measures for conservation. At least they must not be allowed to permit loss and deterioration to continue through their neglect and apathy.

(f) All possible efforts should be made to create a class of 'gentlemen' farmers with a proper background of education so that they can utilise the information, scientific and otherwise, available for good farming and soil conservation.

(g) Holdings must be of economic size and sub-division and sub-infeudation which interfere with this objective should be stopped. Consolidation of holdings and of plots by mutually agreed transfer should be encouraged in every possible way and such transfers should be made easy and inexpensive.

(h) More systematic attention should be paid to the best and complete utilisation of the produce of the land by large scale, medium size and cottage industries.

(i) Cheap credit is required. It should be repayable in instalments with postponements when found necessary on account of the vagaries of the climate or of prices. Manures and fertilisers should be made locally available at the lowest possible price.

(j) Reliable advice by experts must be made available to cultivators and farmers. Advice must be based on results of proved value secured by investigation and research.

(k) Much larger numbers of trained personnel of various grades and categories are required for research and investigation ; for collection and dissemination of technical information ; and for demonstration, education and propaganda.

(l) The basic sciences, soil science, entomology and plant breeding require to be fostered by the Universities in cooperation with the technical institutes such as the agricultural colleges.

(m) Much more attention must be paid to soil studies and investigations.

(n) More research stations of the usual type are required and should be spread as a network throughout the country. A number of research stations with specialised outlook should be established.

(o) Agricultural colleges and experimental stations and universities should be encouraged to work more effectively in mutual association in research matters.

(p) Every province should have its due quota of research stations, agricultural colleges and institutions, demonstration centres and organisations for dissemination of technical information, education and propaganda.

Paragraphs 20-21: For the purposes of coordination and of formulation and working out of programmes of conservation, statutory organisations which may be called Land Development Boards must be established both at the centre and in the provinces and states. The provincial organisations should look after the provincial aspects and the organisation at the centre should take up matters of interest to more than one province. It should also have the power and funds to supplement, where considered necessary, the activities of the Provincial Boards. All matters appertaining to the broader aspects of land utilisation in general and soil conservation and afforestation in particular should have to be handed over to these bodies.

Paragraph 22: The constitution and functions of these Boards are given. The Board should work through a number of committees. There should be a committee solely devoted to one of the following subjects:

(a) Soil conservation, including surveys, maps, fertility, reclamation; (b) Anti-erosion; (c) Afforestation; (d) Irrigation and drainage; (e) Grass lands and pastures; (f) Land Utilisation coordination; (g) Industrial utilisation of the produce from agriculture and forestry; (h) Marketing of produce from the land.

Corresponding organisations with the same titles should be set up in the provinces by provincial legislatures.

Paragraph 23: A liaison should be provided between the provincial Board and the Rural Reconstruction Department (or rural development board) where it exists. Plans should be worked out for individual villages and they should have sufficient area for the existing population and their needs and for expansion.

Paragraph 24: Legislation is necessary to give effect to the above plans and to put into operation the various measures of conservation. But the most important question is one of finance. Soils and forests are national heritages. And the state has obviously its own responsibilities and must bear a substantial portion of the cost. The Provincial and Federal Governments must come to help where necessary.

Paragraph 25: In order to effect improvements the following surveys must be immediately taken in hand: (a) Survey of land utilisation as it exists to-day. The information collected by properly trained men should be made available for purposes of reference and study in the form of land utilisation maps. The position should be reviewed and changes noted every ten years with a view to watch and if considered necessary, control and guide the trend of these changes: (b) A 'rapid reconnaissance survey of soils'. An attempt has to be made simultaneously to determine the fertility status and general characteristics of the soil mostly by field methods and to obtain a rough estimate of the extent, intensity and type of erosion and of the possibilities

of improvement and reclamation; (c) A systematic survey of soils in selected areas including forest areas in each province should be begun on the basis of the information in (a) and (b); (d) A fuller erosion survey in selected areas based on the information in (a) and (b). There should be a Central Institute for the study of erosion problems under the direction of a really first class physicist.

Paragraph 26: The Raw Material Utilisation Committee set up under the Development Boards should ensure that sustained and intensive research and enterprise are devoted to the exploitation of the produce from the land. It will be necessary to set up a research laboratory wholly for this purpose. Assuming earnestness of purpose and an energetic drive from the State it is possible to increase the direct produce of the land by 100 per cent and the income from industrial utilisation by tens of crores in ten years. The potential increase is colossal. Large scale expenditures for such development purpose should be regarded as investment for the improvement of national income and well-being.

Paragraph 27: It is necessary to critically review the work of the departments of agriculture, forestry, irrigation, communications, industry, and revenue with a view to ascertain what adjustments are necessary in their functions and organisation so that (a) the Land Development Boards can function with energy and promptness and obtain the active cooperation of these departments; and (b) an efficient coordination of their work so far as it relates to development questions can be effected. It is absolutely necessary that the problems of land utilisation and expert scientific knowledge are given fullest weight in the administration and organisation of these departments.

Paragraph 28: The scales of pay and the conditions of service of the personnel should be attractive enough for desirable types of men. Recruitment of these men should be on the basis of efficiency alone.

Paragraphs 29-30: Our Agricultural practices are based on the age-old empirical experience of generation, but not on any systematic or scientific study of the soils. In the past a fairly large number of soils obtained from the different parts of the Provinces have been analysed by the agricultural chemists to governments. But most of the results cannot be correlated with agricultural practices prevailing in the part from where these samples were obtained.

Paragraph 31: A Central Institute devoted to Soil Research with a first class library containing a complete collection of books and journals should be established. One of the main functions of the library should be to supply translations or copies of literature to soil workers. The Institute should co-operate in the surveys discussed earlier, in the preparation of a soil map of India and in publications for education and propaganda.

Paragraph 32: A forum should be provided for the promotion of scientific discussion and of publication under the control of a non-official scientific organisation. It is necessary that our soil workers should have the widest field experience and the opportunity to compare notes regarding methods of survey, analysis and classification of soils.

Paragraph 33: There should be provision in each province for at least one research station of a complete complement of all the recognised branches of soil science and the requisite laboratories, appliances and trained personnel.

Paragraph 34: An enquiry should be conducted in each province by a committee of experts including non-official scientists and appointed by Government to take stock of the progress made and to suggest improvements in the organisation of research and advisory work.

Paragraph 36-37: The existing information regarding even the main types of soils of a province is rather meagre excepting a few solitary cases. Field and laboratory studies of soils must be taken up by the agricultural departments in right earnest and on a much wider scale than at present.

Paragraph 38: The surveys mentioned in the preceding pages are considered necessary by all soil workers. It is difficult to give an idea about the cost and time. One estimate is given.

Paragraph 39: Encroachment by industries, mining and quarrying on forests and arable lands has not yet taken place on any appreciable scale, excepting certain parts of Chotanagpur and of the Burdwan division of Bengal. An enquiry conducted in these regions will be of interest.

Paragraph 40: Interference with natural drainage in many parts of the country has been undoubtedly caused by Railways, Communications, Revenue and Irrigation Departments have been so far a law unto itself. This position should without question give way to one of mutual understanding and obligatory co-operation in matters affecting soil conservation.

Paragraph 41: Villages form subunits in the plans of soil conservation. It is necessary that attempts in rural reconstruction should be based on thorough investigation and research by several types of experts.

PART A

GENERAL

BY

J. N. MUKHERJEE

QUESTION 1: Do you think that there is a balanced and proper distribution of the available land area of your province for the following purposes?

(a) Food Crops, (b) cash crops including market gardening (c) fodder crops, (d) grazing for cattle, (e) forests, (f) orchard and fruit trees, (g) trees of economic importance with special reference to needs of rural communities.

Give the area under each category wherever possible. What are your suggestions for remedying present maladjustments, if any?

1. Measures for the conservation of soils and forests have to be correlated with the system of land utilisation and the latter must ensure a balanced allotment of the land for various purposes. An examination of the systems and methods of land utilisation affords very important data regarding prevalent mis-uses of land, and also of adjustments necessary to ensure a balanced utilisation. Village and town planning as also drainage, water supply, communications and similar matters must loom large in future in plans of rural reconstruction. Requirements and schemes under these heads require to be coordinated with other aspects of land utilisation and with conservation measures. Reliable information is also necessary regarding the requirements of land for each of these purposes. Information on these points must be available for units of suitable size based on physiographic features. Average estimates for very large areas are of little help for purposes of plans of conservation. Existing and potential industrial demands on the produce of the land have also to be taken into account. One of the main objects of National Planning is to secure an all round increase in the production of the necessities of life of about 100 per cent in ten years. With a rapid increase in population, and the necessity for better nutrition of man and livestock and the progressive demands of industries, the present system of utilisation of our lands requires the closest investigation.

2. Information of a more or less general character is given in the periodic publication entitled "The Agricultural Statistics of India" published by the Department of Commercial Intelligence and Statistics. This information though useful in some respects is of little help for our purpose. It enables us however to consider in general terms the possibility of utilising land which is left unutilised at present.

In the figures published for 1936-37*, the total land area is given as 679,482 thousand acres, in British India distributed as under :

'Net area sown'	231,884	thousand acres
'Current fallow'	48,638	" "
'Cultivable waste other than fallow'	154,301	" "
'Not available for cultivation'	155,301	" "
'Forests'	89,173	" "

In the Indian States **the total area is approximately 147,389 thousand acres of which

'Net area sown'	69,426	thousand acres
'Current fallow'	12,699	" "
'Cultivable waste other than fallow'	18,715	" "
'Not available for cultivation'	27,557	" "
'Forest'	18,677	" "

Doubts have been expressed as to the accuracy and significance of all these figures. 'Cultivable waste' includes area 'out of cultivation' and 'cultivable assessed waste available for cultivation' as also area under trees and scrub jungle. 'Forests' often include all the reserved forests as also Zemindari lands. Private forests are not well defined. The figures, for 'forests under government management' are the most reliable of these. The figures are collected through the district officers' staff, not infrequently through village chowkidars and patwaris and very often not by trained men nor directly by agricultural officers.

3. Considering that out of a total of about 827 million acres 173 millions are shown as 'cultivable waste other than fallow', and 61 millions as 'current fallow', a detailed enquiry should be conducted with promptness in each Province and State by trained men guided by a body of experts acting under the authority of a statutory organisation. The enquiry should be directed to ascertain (a) the area actually available for utilisation, (b) the conditions which should be fulfilled in order that they may be utilised, (c) the area which can be utilised for each specific purpose. Investigation is also desirable in order to ascertain the reasons why 61 million acres lie fallow and what should be done to ensure their better utilisation. It is possible that a portion is kept fallow for purposes of recuperation of fertility or improvement of the soil; but it does not seem that this can form more than a very small fraction of the total. As Rao Bahadur Ramaswami Sivan states "this phenomenon of non-utilisation of waste lands will be hard to imagine in countries other than India." The area of 183 million acres shown as 'not available for cultivation' also definitely requires closer inspection. The private forests and free-grazing lands are often inextricably mixed up with the area shown under this head as also with that shown under 'cultivable waste other than fallow.'

4. Great changes in our system of land utilisation have been going on for years. The increase in the acreage under tea, coffee, cotton, jute, sugarcane, and also under rice and wheat, progressive deforestation facilitated by easier transport and pressure of population, the drift of population from villages to towns and cities, growth of industrial areas—illustrate these changes.

*See Appendix E—Part I.

**See Appendix E—Part II. There is no reference to the Eastern Agency States, e.g., in Assam, Bengal and Orissa.

The effects and trend of such changes have to be studied and taken into consideration in formulating plans of soil conservation. The existing distribution of land over the various purposes is not a balanced one, and no effort worth mentioning has been made to assess the nature and magnitude of maladjustments. The question of remedies would come later when the data are available and an organisation with necessary powers financial and otherwise has been set up to tackle the subject in right earnest. An intensive and sustained effort is necessary to remedy present maladjustments. But first of all the importance of conserving our national heritage of soils and forests has to be brought home to all concerned.

5. The most apparent feature of the present maladjustment in relation to soil conservation is the small proportion* of the total area devoted to village or minor forests, fodder crops, pastures, fruit and other trees to meet the needs of rural communities, such as fuel, timber and other purposes. Unequal distribution of forests and neglect of private forests constitute another important feature of this maladjustment*. These features have also a great significance for the nutrition of man and livestock.

6. The deplorable condition of livestock in India is due to insufficient production of fodder crops, bad conditions of grazing grounds, unmanageable numbers of cattle and the neglect of proper methods of breeding. The following illustrations will convey an idea of the situation.

(a) Mr. Nicholson, the Forest Conservator of Orissa, states that "under most land settlements only 5 per cent of the village area is kept for grazing. Assuming that one head of cattle must be maintained per acre of cultivation in a village of 100 acres and since per 100 acres of village land 95 acres are under cultivation, only 5 acres of grazing remain available for 95 heads of cattle. These figures indicate the need for outside forest grazing or fodder production."

(b) According to the chief conservator U.P. an average estimate of "even 10 mds. of fodder per acre per annum" is a liberal estimate, and less than 6 million tons is estimated to be the total fodder at present available. Reckoning a starvation diet of 5 seers per head per day the bovine population (excluding calves) of U.P. alone require 56 million tons of fodder and food per annum. The remaining 50 million tons will have to be collected from the cultivated food, cash and fodder crops of the province."

(c) The following has been taken from a note by Mr. K. P. Sagreiva, Conservator of forests, C.P.:

"The total area of the province is 63 million acres, and the human and bovine population 17 millions and 13 million respectively. The average acreage per pair of working bullocks is 10.5 acres (it is much less in many other parts of the country, whereas it is estimated that a much larger area could be tilled with more efficient animals. The total number of animals in milk is 0.4 million cows, 0.3 million buffaloes and 0.25 million goats, giving on an average only 22,500 maunds of milk per day. The value of milk and its products, including imports, per person, per year, is Rs. 2-8; the daily quota being only 4.5 tolas in urban and 1.5 tolas in rural areas. The average quantity of fodder consumed per animal has been literally estimated at nearly 12 lbs. per day. This consists of coarse grass and straw of crops, and

*See Appendix E—(Parts I and II).

about half the quantity must be left unconsumed as being too coarse and unpalatable. The supply is also very ill-distributed both from place to place and from season to season. Cattle residing in close proximity to the forests are as a rule not stall fed and are invariably far inferior to these in the 'haveli' tract where they are mostly fed at the stall." In forest areas one finds "an average incidence of one animal for every 2 acres of very poor pasture, and in easily accessible forests the incidence is as heavy as 2 animals to an acre, whereas the optimum area considered necessary is from 3 to 8 acres depending on the quality, and even then the animals must be stall-fed in the hot weather when the pastures are bare."

7. It is obvious that production of fodder on a much larger scale is a necessity. Uncontrolled grazing constitutes one of the most serious factors leading to deterioration of soil and its loss by erosion and measures for countering its evil effects must include adequate production of fodder. The importance of the elimination by some unobjectionable means of the large numbers of inefficient cattle is a matter of the greatest importance in relation to this problem. Milk and milk products must also be produced in much greater quantities (about six times more than that available at present for the country as a whole) for proper human nutrition, and a sufficient number of efficient cattle must be maintained for this and other purposes.

8. The grazing areas in forests are capable of improvement and expansion with proper control. Much attention is now being paid all the world over to suitable grasses for purposes of soil conservation and utilisation. Also more tree fodder should be available from existing forests although it has the disadvantage that four parts by weight of it are equivalent to one of grass. But forests alone cannot meet the whole demand. Besides they are not well distributed and are not always easy of access. Minor forests in villages, hedge rows and road side trees are helpful in the conservation of soil and its moisture, and should be looked for to contribute substantially to the increase in the production of fodder. The Taungya cultivation in the United Provinces is an important measure of soil conservation which would help local problems of fodder production.

9. Better methods of soil management including the use of manures and fertilisers should bring in an increased production of fodder, by inclusion of natural grasses and legumes which are soil conserving crops in suitable systems of rotation based on research. Rotation is of special importance for conservation of soils under the soil depleting food and cash crops. And basing on experience in other countries measures for soil conservation will require the transfer, apart from rotation, of some of the bad lands under cultivation from soil-depleting to soil-conserving crops. The total contribution to fodder production from all these sources is likely to be considerable. But a big gap will still be left between what is considered necessary and the total thus available. The area under grass and fodder crops has to be materially increased, but this cannot be easily done at the expense of that under food crops in most places since the population is large and increasing.

10. The closest attention must, therefore, be paid to the areas shown as 'cultivable waste other than fallow', to 'current fallow' and perhaps also to area shown as 'not available for cultivation.' Systematic investigation should be able to find ways for much better utilisation of these areas. (An experiment in U.P. has

shown that the worst type of Usar lands can yield 15 maunds of grass per acre under proper management, i.e., five times more than it ordinarily does).

11. The competition of cash crop, e.g., tea, sugar, cotton and intense methods of extractive farming are used for the production of cash crops. The position varies from province to province, but cash and food crops are growing in extent. Most of these food and cash crops are also responsible for deterioration of soil structure and for erosion. As an example, mention may be made of wheat in the Punjab. In areas where it is the only crop the ground lies fallow in the monsoon and serious sheet erosion results in consequence. Since wheat is the main food crop in the Punjab losses by such erosion are probably extensive. The remedy of this and many other problems consists in a better balanced mixed farming. There are considerable tracts in some parts of the country, e.g. in Assam, where a better distribution of food crops is a great necessity. Cultivation of food crops has also to be planned in relation to the nutritional requirements of the people and the existing distribution of food crops also requires adjustment. The first and foremost aim should be to develop and introduce systems of rotations and of mixed and balanced farming suited to local conditions and to take all steps to increase the yield of food crops with due safeguards against soil depletion by these crops. This means more knowledge than available at present which has to be gathered by systematic study and research.

12. The forest area is not sufficient in many provinces excepting Central Provinces, Madras, Sind. Forests should cover 20 per cent of the land area. They should be more uniformly distributed over the entire land. Village or minor forests should be established to secure this uniform distribution. Trees of economic importance should be similarly planted wherever possible. These are necessary to conserve soil moisture, regulate run off, prevent erosion and rejuvenate soils. In drier or arid regions denuded areas and near inhabited localities, grass lands acquire great importance for purposes of soil conservation and regeneration as also of utilisation.

13. Uncontrolled grazing and shifting cultivation constitute by common consent the greatest menace to forests and soils in forest areas. Free grazing, abolition of grazing fees for cattle belonging to the province and other forms of uncontrolled grazing are the factors which have materially helped to increase the number seeking grazing in forests. The quality of the cattle, the quality and quantity of grazing, all have become miserable. Inadequate cover of forests and forest litter and of grass have led to the deterioration of the soil and to erosion on a vast scale. Forests in British India under state management are better looked after than private forests. Much valuable information is available for the former. Government forests have been in many provinces classified according to their suitability for timber, for fuel production or for pasture and maximum grazing incidence has been prescribed for each class. Conditions however differ in different provinces.

14. Private forests and forests in States (excepting perhaps some of the bigger States) are not so well managed. The area under private forests is not inconsiderable. In Bihar which may be an exceptional case, private forests are said to comprise about 6,000-7,000 sq. miles (the exact area is not known), com-

pared to 1,700 sq. miles managed by government. Private forests offer great scope for improvement and should be placed under effective control and management. This is an urgent necessity. They should be looked upon as an important factor in relieving present maladjustments. Even in Government forests there are considerable possibilities of greater exploitation; but measures of conservation must have the first consideration.

15. Political divisions and want of co-ordination between the activities of the forest departments with those of other departments in matters of common interest stand in the way of effective protection and development of forests and control of floods and erosion. For example in the Punjab, Government forests form only 5 per cent of the land area, and are mostly, in inaccessible hills. Rest of the hill lands are held either by the Indian States or are common lands subject to every abuse. Only 12 per cent of the major hill catchments are under any control.

16. The area under fruit trees and vegetables is low compared to the total acreage and to the requirements of the people. The rate at which existing trees of all types are being utilised for various purposes or are disappearing from natural causes and the lack of effort to replace them constitute a menace. Attention should also be given to trees of economic importance which are likely to bring a cash return. Orchard and fruit trees are insufficient for lack of private enterprise and governmental action.

17. This absence of enterprise and apathy are only too common, and are matters of great moment in connection with most measures of soil conservation in which the cultivator as also the land owner big or small, must play a very active part. Apart from ancient prejudices affecting food and habits and conservative outlook, the root causes of this lack of enterprise and apathy are the poverty of the soil, caused by too many cattle and consequent overgrazing and by inadequate attention to manures and fertilisers, the reduction of pasture caused by increasing encroachment of food and cash crops, the increase of population and poor crops and consequent insufficient nutrition, lack of energy and ideas, low vitality and disease and illiteracy. To this long list may be added the decline in the interest taken by the richer classes in the land. These are all inter-related and form vicious circles. No widespread and rapid improvement can be effected unless education of a practical nature is imparted to change the mentality of the people and to bring home to them the misuse of the land. They should also be encouraged by propaganda and demonstration to take an active interest in conservation of soils, forests and trees and in land utilisation as it concerns them.

18. Paragraphs 5 to 16 bring out that some of the most important measures of soil conservation also constitute remedies for maladjustments in the present system of land utilisation enumerated in para 5.

QUESTION 2: What broad lines of improvement would you suggest for the improvement of the existing system of land and forest utilisation in your province? What changes, if any, in respect of the following would you suggest to give effect to your proposals?

- (a) Government policy;
- (b) legislation;
- (c) agricultural advisory work;
- (d) organisation of research;

- (e) training in agriculture and forestry ;
- (f) collation and dissemination of technical and scientific information ;
- (g) general propaganda.

19. Improvements on the following lines are suggested in addition to those discussed in the preceding paragraphs :

(a) **A co-ordination of all efforts for conservation of soil :** The Central and Provincial Governments maintain most of the necessary departments. But concerted action between them is slow and difficult and they tend to work in watertight compartments being under different ministers. One sees a multiplicity of authorities nibbling discontinuously at different points of the problem of conservation. Such attempts are likely to do more harm than good. Their activities must be co-ordinated and the problem visualised and grappled as a whole. Otherwise little benefit will ensue. There have been committees ad galore, and it is high time to settle down to work through permanent statutory organisations.

(b) **An intensive and sustained drive is required :** There is no doubt that the efforts now being made are not commensurate with the magnitude of the colossal losses going on all round and of the measures necessary to improve the very-unsatisfactory condition of most of our lands.

(c) **Measures of soil conservation depend, for their successful operation, on the active and intelligent sympathy of the producer—the cultivator:** Without this, it is not possible either to stop existing misuses of the land or to effect real improvements. By education, propaganda, demonstration, and financial inducement his active cooperation has to be secured. He has to be convinced of the benefit that will accrue to him. Quite a number of these measures may not benefit the producer immediately or even in the near future, and the state has to bear its share of financial burden in effecting improvements.

(d) **The state should make an earnest beginning with all lands under its own control, permanent or temporary :** There is little excuse for the State to allow loss and deterioration to continue.

(e) **Big land owners should be persuaded to adopt measures for conservation. At least they must not be allowed to permit loss and deterioration to continue through their neglect and apathy :** Where they fail to effect desirable improvements, the state should be enabled to step in under conditions equitable to both parties.

(f) **All possible efforts should be made to create a class of 'gentlemen' farmers with a proper background of education so that they can utilise the information, scientific and otherwise, available for good farming and soil conservation :** This will lighten the burden on the State, and ensure a wholesome check on, as also stimulate the activities of, research stations, and demonstration farms run by the Government, and local officers entrusted with conservation measures. They will themselves be centres of propaganda and education. The tradition is not completely lost although political, social and economic changes have almost destroyed it in many parts of the country. It should not be impossible to eke out a decent living according to prevalent standards of this class by hard work. They should not be looked upon as an evil. Their presence is most likely to hasten progress and the general tone of rural areas.

(g) The pressure on the land is too great in most provinces and this pressure is increasing. Holdings must be of economic size, and sub-division and sub-encroachment which interfere with this objective should be stopped. Consolidation of holdings even of plots by mutually agreed transfer should be encouraged in every possible way, and such transfers should be made easy and inexpensive. Investigations should be made as to what would constitute a model holding for the requirements of a reasonable standard of living of a normal cultivator's family or that of a middle class farmer.

(h) More systematic attention should be paid to the best and complete utilisation of the produce of the land by large scale, medium size and cottage industries: In these days of national self-sufficiency, large numbers of scientists are working in teams in all advanced countries to achieve this end. Those countries which do not follow suit will lose in the struggle for existence. Such efforts are most likely to stabilise prices of agricultural produce; and together with the development of mineral and other industries they will relieve the pressure on the land.

(i) Cheap credit is required. It should be repayable in instalments with postponements when found necessary on account of the vagaries of the climate or of prices. Manures and fertilisers should be made locally available at the lowest possible price.

(j) Reliable advice by experts must be made available to cultivators and farmers: This must be based on results of proved value secured by investigation and research and not on disjointed efforts of individual workers. The greatest drawback of the present situation is that there are very few publications, collating after critical examination by an authoritative body of experts what can be relied upon in the knowledge at present available regarding the fertility status and other conditions of the soils, and effects of manurial treatments. There is still less information about basic scientific matters concerning our soils on which only the structure of advisory work can be soundly based. It is not science which has failed but attempts at practical application of it divested from the basic scientific information.

(k) Much larger numbers of trained personnel of various grades and categories are required for research and investigation; for collection and dissemination of technical information so that scientific workers of different grades can keep in touch with latest developments of their subject; and for demonstration, education and propaganda.

(l) The basic sciences, soil science, entomology and plant breeding require to be fostered by the Universities in co-operation with the technical institutes such as the agricultural colleges, so that there is a continuous supply of best trained men for teaching and for research in these institutions and the level of technique and research is kept up-to-date. The highest types of research which is not of immediate practical interest, but is, after all, the source of most improvements and provide the scientific background for all other types of investigation or practices, should be fostered through the Universities; so that advice and guidance on these matters are available inside the country, and have not to be borrowed wholesale secondhand through publications of work done in other countries.

* See Appendix F. Part I. (The structure of Agricultural Research in Great Britain.)

***(m) Much more attention must be paid to soil studies and investigations. Until recently most of our soil studies have not gone much beyond the purely chemical stage. Microbiological studies have been very restricted in scope, being mostly of a chemical nature, whereas their practical interest cannot be gained. Investigations and research from the point of view of modern soil science have only recently begun—even then the number of trained men and the centres taking part in them are wholly insufficient. Attempts at the improvement of agricultural practices so far made centre largely round data obtained by chemical analyses of top soils by methods which have been found to be inadequate and are now supplemented in other countries by a large range of tests and determinations even in ordinary routine practice.**

***(n) More research stations of the usual type are required and should be spread as a network throughout the country. It is the rate of progress that matters. A number of research stations with specialised outlook should be established. The latter should devote their attention to all aspects of production and utilisation of particular crops and of selected products of animal husbandry. There are provisions already on this basis for cotton, jute, sugar and tea.**

(o) Agricultural colleges and experimental stations and universities should be encouraged to work more effectively in research matters in mutual association.

***(p) Every province should have its due quota of research stations, agricultural colleges and institutions, demonstration centres and organisations for dissemination of technical information and propaganda. The area covered by a province and its income determine the scope of studies and investigations. Vast areas remain to be improved and developed and this cannot be done unless the necessary knowledge is gathered, and this must be done in reasonable time. Each province has its own problems of a local character and these must be solved in its own institutions. Several provinces, e.g., Assam, North West Frontier, Sind, have practically no facilities in this direction, and most others have not got a sufficient number of such institutions or of trained men. More often than not the standard of equipment etc. is definitely low.**

20. For the purposes of coordination and of formulation and working out of programmes of conservation, statutory organisations which may be called Land Development Boards are necessary both at the Centre and in the provinces and states. A somewhat similar organisation at the Centre, but with limited functions, has been suggested by Sir John Russell in his report to the Imperial Council of Agricultural Research. The activities of the latter should be linked up with the Development Board at the Centre.

21. The provincial organisations should look after the provincial aspects and the organisation at the centre should take up matters of interest to more than one province, co-ordinate work being done in the provinces and states, act as a clearing house for the pooling and exchange of information, foster researches which are beyond the scope of provinces and arrange for advice where needed. It should also have the power and funds to supplement, where considered necessary, the activities of the provincial Boards. All matters appertaining to the broader

***See Appendix F. Part II. (Research Institutions in Great Britain).**

aspects of land utilisation in general and soil conservation and afforestation in particular should have to be handed over to these bodies.

22. An outline of the constitution and functions of these Boards is given below :

I. The Land Development Board at the centre should be connected with the ministry of lands and the Imperial Council of Agricultural Research, and include representatives of central organisations and institutions dealing with agricultural research, irrigation, forests and communications ; non-official scientists ; representatives of the central legislature and the whole time secretary of the Board. It should be a statutory organisation set up by the central legislature, and not merely advisory but intended to initiate measures and control and guide them. The board should work through a number of committees. It is suggested that there should be a committee solely devoted to one of the following subjects :

(a) Soil Conservation : This committee will deal with (i) soil surveys, soil maps, conservation of soil fertility and (ii) land reclamation.

(b) Anti-erosion.

(c) Afforestation.

(d) Irrigation and drainage

(e) Grass lands and pasture

(f) Land utilisation co-ordination

(g) Industrial utilisation of the produce from agriculture and forestry.

(h) Marketing of produce from the land.

II. Corresponding organisations with the same titles should be set up in the provinces by provincial legislatures. They would co-ordinate and give final sanction to all measures to be taken in the provinces for the purpose of soil conservation including afforestation proposed by different departments. The whole area in a province would require to be divided into physiographic units each consisting of groups of villages and having a co-ordinating programme of work suited for its special needs. The programme to be followed should be based on thorough investigation and research in typical localities. The Provincial Boards should consist of representatives of the departments of agriculture, irrigation, land revenue, forest, communications and health ; non-official scientists ; representatives of the legislature and the principal executive officer of the Board. The Board should have a whole time staff working under the direction of a Scientific Advisory Committee consisting of experts representing agriculture, irrigation, forests, soil science and botany, and the principal executive officer of the Board. The existing Provincial Agricultural Research Committees and similar bodies, if any, might be amalgamated and developed into the Scientific Advisory Committee with suitable modifications in their constitutions and functions.

23. A liaison should be provided between the Provincial Board and the Rural Reconstruction Department and Rural Development Board where they exist. Plans should be worked out for individual villages and they should have sufficient area for the existing population and their needs and for expansion. Steps should be taken to establish, under statutory authority, district and village organisations representing landowners and tenants who are interested in soil conservation. The Land Development Board should nominate representatives on them and ensure their co-ope-

ration for purposes of education and propoganda and for working out plans of conservation.

24. Legislation is necessary to give effect to the above and to put into operation the various measures of conservation. But the most important question is one of finance. The ryot may partly pay through his labour and through payment by instalments covering a long period if he has definitely benefited by the measures. But his possible contribution can only form a fraction of the total cost. The land owners, especially those whose ownership extends over large tracts, have a proper contribution to make. Soils and forests are national heritages. And the State has obviously its own responsibilities and must bear a substantial portion of the cost. This should take the shape of provision for research, training, education and propoganda and for all forms of technical advice which may entail payment of fees in certain cases. In addition it should make a direct contribution towards the cost of improvement. The forms and extent of state contributions is a matter which cannot be decided a priori. Offers of financial help as inducement to effect improvements seems to be one very suitable form of contribution. If a majority of the people of a locality agree to co-operate in measures of conservation they should be encouraged in all possible ways, and the minority should not be allowed to hinder progress. It is inevitable that the state must look on this problem in the same way as it does on health, education, irrigation or railways. The measures will be partly productive and partly protective. A large loan amounting to several crores should be floated by each province for development purposes. The Federal Government must come to help where necessary.

25. In order to effect the improvements discussed in the preceding paragraphs it is of utmost importance to get information regarding utilisation of land and of land itself. To get this information the following surveys must be immediately taken in hand :

(a) Survey of land utilisation as it exists today. The information collected by properly trained men and after examination and collation by the relevant committee should be made available for purposes of reference and study in the form of land utilisation maps on as large a scale as possible. The position should be reviewed and changes noted every ten years with a view to watch and if considered necessary control and guide the trend of those changes.

(b) A 'rapid reconnaissance survey of soils' * to collect and supplement existing scientific information regarding our soils which will also be utilised by the Central Board for a provisional map after critical examination and collation by the relevant committee. An attempt has to be made simultaneously to determine the fertility status and common features, mostly by field methods, and to obtain a rough estimate of the extent, intensity and type of erosion and of the possibilities of improvement and reclamation.

(c) A systematic survey of soils in selected areas including forest areas in each province should be begun on the basis of the information in (a) and (b) to provide for the training of personnel for this type of work which is highly technical and implies team work and to gain basic scientific knowledge with a view to determine the more important types of soils in the pro-

*See Appendix G regarding the types of determinations to be included.

vince. The types and smaller sub-divisions of soils have to be determined before one can expect to establish a satisfactory correlation of the properties of a soil with results of experiments on crop response to soil management and manurial treatments, and to assess possibilities of reclamation and improvement. The absence of this knowledge and of attempts to correlate responses of treatment with fullest information of soils is very likely responsible for the present unsatisfactory position of advisory work carried out by the agricultural departments.

(d) A fuller erosion survey in selected areas based on the information in (a) and (b).

The dependence of erosion on various factors such as topography, velocity of runoff, erodibility of soils, and methods of soil management have to be studied in connection with this survey. Part B of this report deals in detail with the question of erosion.

The services of competent physicists, engineers and soil scientists are required for working out measures for the control of erosion. There should be a Central Institute for the study of such erosion problems under the direction of a really first class physicist.

26. In paragraph 22 of this part it has been suggested that a Raw Material Utilisation Committee should be set up under the Development Board. There is a great scope for an expansion of the national income and of employment from the industrial utilisation of the produce from the land, including forests. It will be seen from figures given in section 'F' that the income from forests under State management in British India for the period 1929-31 was on an average about rupees 4 crores per year. The average for the years 1933-37 was about 2.75 crores, a decrease of 1.25 crores. These figures do not include the value of produce not charged for including free grazing. The average expenditure per year for the period 1927-31 was about Rs. 2.8 crores, and that for the period 1933-37 was about Rs. 2.15 crores. About 2 million people are employed in State managed forests. Large quantities of material are imported which could be substituted by produce from our forests or by their industrial utilisation. To take one item roughly 3 crores of rupees worth of paper are imported per year. Very large quantities of raw materials are exported which should feed our industries and give employment to large numbers and increase the national income; instead they are exported and mainly enrich other countries. Sustained and intensive research and enterprise are necessary to exploit these resources. It will be the function of the Utilisation Committee to assess these possibilities and to supply through the Land Development Board information regarding these possibilities to the department of industries, the public, industrial associations and the universities; and to ensure that Government has got a definite policy and an efficient organisation to develop these resources in every possible way. This Committee should also consider all suggestions and enquiries made by the Department of Industry; or, by industrialists, and by the public regarding sources, availability and cost of raw materials and possibilities of increasing their yield or of production from new sources. It will be necessary to set up a Research laboratory solely for this purpose, to supplement and co-ordinate the work which may be done in the universities and private institutions. It is difficult to give an estimate of the probable increase in national income from such endeavours. But there is no doubt that it will run into tens of crores if the forests only are considered, including the in-

come from industrial utilisation of their produce. Out of an area of 1,25,000 sq. miles of state managed forests 54,335 sq. miles are either inaccessible or profitless. Equally extensive areas of private forests are in a very deplorable condition. The utilisation of starch, cellulose, medicinal plants, essential oils, milk products and hundreds of other items remain practically untouched for one reason or other. Tea, coffee, jute, and sugar offer examples of what can be achieved by organised research and efforts. As in other cases a policy of drift and want of sustained research and effort is the root causes of our backwardness. When one takes stock of the various possibilities discussed in this and following sections, and assumes earnestness of purpose of the governments and efficient political leadership, an increase in the total income direct from the land by more than 100 per cent within ten years does not at all appear difficult of achievement. The ultimate possible increase in income from the land including industrial utilisation of its produce is colossal and there is no reason why India with her resources should continue to be the home of poverty, ignorance, endemic diseases and of dirt and filth. Large scale expenditures for such development purposes are fully justifiable and should be regarded as investments for the improvement of the national income and well being.

27. It emerges from the discussions in the preceding paragraphs that it is necessary to critically review the work of the departments of agriculture, forestry, irrigation, communications, industry, and revenue, with a view to ascertain what adjustments are necessary in their functions and organisation, so that (a) the Land Development Boards can function with energy and promptness and obtain the active co-operation of these departments; and (b) efficient co-ordination of their work, so far as it relates to development questions, can be ensured. It is also necessary to ascertain what internal changes and additional facilities are required in order that the departments of forests, agriculture, industries and irrigation can undertake with efficiency their responsibilities in the matter of national planning. This should be one of the first items of work of the Land Development Board. Revenue and administrative points of view have for long dominated the outlook of the Government; and it is absolutely necessary that the problems of land utilisation and expert scientific knowledge are given fullest weight in the administration and organisation of these departments. Non-official scientific opinion in the country is unanimous that there is much that is effete in the working of some of these Government departments; and they often show a spirit of exclusiveness even in purely scientific matters and look upon scientists and technical men outside their coterie with definite prejudice. The average technical man in Government service mostly gets rusty in course of years so far as his scientific knowledge is concerned. The pooling of available technical knowledge and the association of scientists outside the Government departments in their work are thus matters which should be included within the scope of the review suggested above.

28. The method of recruitment and pay and prospects of the different categories of workers should be reviewed. The scales of pay and the conditions or service should be attractive enough for desirable types of men. The higher types of research and administration require the services of the best brains. The work of men of these departments should not be considered to be of secondary importance and limelight focussed wholly on

the administrative and revenue officers. The public are very sensitive to the status of an officer implied by governmental action, and the influence of an officer on them is proportional to his status and his pay. The forest officers act in isolation and ways should be found to bring them in more direct contact with the public. His association with the schemes for establishing village forests and anti-erosion work will partially serve this purpose. The results actually achieved and the rate of progress depend on the contented work of competent men who are not dubbed inferior to others while doing equally onerous and skilful work, simply because of old prejudices and traditions of the Government. Recruitment of these men should be as free from 'graft' of all sorts and considerations other than efficiency, if rapid and enduring achievements are desired. Otherwise the numbers of government employees will only continue to swell and the problem will remain where it is. These are questions of political leadership which are only of indirect interest to the sub-committee.

QUESTION 3 : How far do you think our agricultural practices are based on reliable and adequate knowledge of the soils derived from systematic studies? What are your proposals to improve the present position of our soil management and advisory work?

29. The following quotation from the reply of the Usar Reclamation Committee, U.P. sums up the general consensus of opinion :

'This knowledge' of the cultivators 'is certainly based on experience of hundreds of years, but is 'not derived from any systematic or scientific study of the soils. In the past a fairly large number of soils obtained from the different parts of the Provinces have been analysed by the agricultural chemists to governments; but most of the results cannot be correlated with agricultural practices prevailing in the part from where these samples were obtained. Steps have, however recently been taken to have a survey made of the soil with a view to obtain adequate knowledge for basing our agricultural practices on actual soil conditions. There is ample evidence to show that the introduction of money crops, like sugarcane, has in many parts of the province caused impoverishment of the soil because the land is allowed "very little rest and no effort is made to return sufficient amount of plant nutrients to the soil." "Insufficient attention to the type of manure (and/or fertilisers) to be used forms another vital cause of land deterioration."

30. Other aspects have been discussed in earlier sections of this part and in the Introduction.

QUESTION 4 : What are your views and suggestions regarding the promotion of soil studies in India?

31. It has been suggested by many of our collaborators that there should be a Central Institute devoted to Soil Research. It should have a first class library containing a complete collection of journals and books dealing with all aspects of soil studies. One of the main functions of the library should be to supply translations or copies of literature to soil workers. The work done by the Imperial Bureau of Soil Science need not be duplicated. Soil science has at present not much chance of developing on its independent lines in any of the existing institutions either at the centre or at the provinces. The Institute should be

linked with the Imperial Council of Agricultural Research, but must be independent of its control regarding internal administration. It should cooperate in the surveys discussed in the previous sections, in the preparation of a soil map of India and of reviews of recent development either in India or abroad, and in publications for education and propaganda. It should be able to supplement soil studies in the provinces and states.

32. A forum should be provided for the promotion of scientific discussion and of publication under the control of a non-official organisation. The Indian Society of Soil Science has been established under the inspiration of the Imperial Council of Agricultural Research and is intended to serve the above purposes. It should be put in a position to hold frequent meetings at different parts of the country and the soil workers, forest officers, botanists in agricultural departments and agronomists should be encouraged to attend these meetings. Very few of our soil workers have opportunities of directly acquainting themselves with the types of soils in different parts of the country. It is necessary that our soil workers should have the widest field experience and the opportunity to compare notes regarding methods of survey, analysis and classification of soils so that they may arrive at agreed conclusions.

3. Soil Science has several recognised branches. At present quite a number of them are very much neglected. There should be provision in each province in at least one research station of a complete complement of these, and the requisite laboratories, appliances and trained personnel. A Faculty of Agriculture should be established in every University which has not yet been done, and Soil Science must be recognised as a major subject in this Faculty and not a part of agricultural chemistry but vice-versa. Other aspects of soil studies have been dealt with elsewhere in this report.

34. An enquiry should be conducted in each province by a committee of experts including non-official scientists and appointed by Government, to take stock of the progress made and to suggest improvements in the organisation of research and advisory work, especially with reference to soil studies and their practical applications.

QUESTION 5 : (a) Do you consider that the present facilities for research and training in the basic agricultural sciences are adequate?

(b) Do you think the facilities offered in our agricultural institutions have been properly co-ordinated with those which the universities are in a position to afford? How, in your opinion, could the position be improved upon?

35. This subject has already been dealt with.

QUESTION 6 : (a) Could you give a summarised statement enumerating the main types of soils of your province and giving information regarding their :

- (i) chemical composition including contents of plant nutrients.
- (ii) mechanical compositions,
- (iii) physical properties including moisture relationships,
- (iv) nature and content of exchangeable bases,
- (v) conditions of acidity and alkalinity,
- (vi) composition of acid and water extracts,
- (vii) conditions of drainage.

Kindly mention the points including those not mentioned above on which information is not available, and on which you consider information should be gathered by investigation or otherwise.

36. Complete information on those general and essential points does not exist excepting a few solitary cases. The lack of information regarding our soils is hard to believe. Some valuable work has been done at the instance of the Imperial Council of Agricultural Research and of the Irrigation Research Laboratories, Lahore. Some valuable work has also been done by officers of the agricultural departments; but these are the results mostly of individual initiative and rarely of the normal organised work of these departments.

37. It is no wonder that as yet the cultivator has not much to gain by the application of science. Field and laboratory studies of soils must be taken up by the agricultural departments in right earnest and on a much wider scale than at present.

QUESTION 6: (b) Do you consider that a systematic survey of the soils should be made? If so, what should be the scope and purpose of such survey? What is the minimum period of time required for such a survey? What are your views regarding the desirability of a rapid survey of land utilisation as it exists at present?

38. The surveys mentioned in the preceding pages are considered necessary by all soil workers. The scope and purposes of the surveys have been already discussed. It is difficult to give an estimate of the cost and time required for each of these surveys. The time depends on the number of trained men available and appointed and on the money spent for these purposes. The following extract from the reply of the Secretary of the Usar Reclamation Committee will convey some idea of the cost and time.

"The minimum period of time required for a rapid survey of soils in the United Provinces will naturally depend on the staff and resources available. The Punjab is the only province where systematic and detailed soil survey has been undertaken primarily for project purposes, namely, to find out the possible reaction of different types of soils in the Punjab to intensive gravity-flow canal irrigation, and secondarily for ascertaining the relationship of soil texture and composition with measures of reclamation that could be undertaken on economic lines. In the opinion of Mr. M. L. Mehta, Land Reclamation Officer, attached to the Punjab Irrigation Research Institute, Lahore, the cost depends upon the time factor. At the instance of the Punjab Government, he had to prepare an estimate for a soil survey of 1 million acres. On the basis of 1,000 acre units and assuming that every foot samples had to be taken up to the water table (average depth 30 ft.) at each site, the estimated cost came approximately to Rs. 62,000. If, however, a preliminary survey by means of aerial photographs was made and soil samples taken from the groupings on the photographs, the cost of both the aerial photograph and ground survey of the selected types together with the laboratory work involved would, as pointed out by him, be much less."

QUESTION 7: How have the establishment of factories, working of mines, quarries, growth of cities and towns, development of railways and similar factors affected forests or land available for agricultural purposes? Do you consider that in view of the rapid growth of urban population and other changes,

towns and villages require to be developed according to definitely laid down principles and plans?

39. Encroachment by industries, mining and quarrying on forests and arable land has not yet taken place on any appreciable scale, excepting certain parts of Chota Nagpur and of the Burdwan division of Bengal. An enquiry conducted in these regions will be of interest. Soil subsidence in some of these areas and deforestation as a result of mining enterprise are noticeable.

40. Interference with natural drainage in many parts of the country has been undoubtedly caused by Railways. This raised the question of coordinating the activities of the communications departments with those of other departments in matters relating to soil conservation. Communications, Revenue and Irrigation Departments have been so far a law each unto itself. This position should without question give way to one of mutual understanding and obligatory co-operation in matters affecting soil conservation.

41. The distillation of the population from villages to towns and cities is known to all. Important questions of town and village planning arise. Apart from these water and wind erosion appears to have affected the related levels of old village sites and the surrounding land and possibly, as a consequence of this, also the drainage. Villages form the sub-units in the plan of soil conservation. It does not appear that attempts in rural reconstruction are based on such thorough investigation and research (of several types) by experts as this vitally important subject requires. They are more a hobby or a stunt of politicians and administrative officers. To be more generous it may be said that they are a product of enthusiasm to do something. Present attempts are mostly likely to do more harm than good.

APPENDIX F. PART I.

Extract from

THE STRUCTURE OF AGRICULTURAL RESEARCH IN GREAT BRITAIN.

*(Report on Agricultural Research in Great Britain
November 1938, Page 15)*

The Agricultural Research Council and Committee—the Development Commission—the Central Departments of Agriculture—the Research Institutes—the Provincial Advisory Centres—Local Authorities—Private Research—the Imperial Bureaux and Institutes—Other Information Bureaux.

The Agricultural Research Council, which is responsible to a Committee of the Privy Council, acts both as an executive body in carrying out certain schemes of research, and as an advisory body in co-ordinating the whole field of State-aided research, and recommending individual schemes to the Development Commission and the two central Departments of Agriculture which are the grant-awarding and administering authorities.

Agricultural research in Great Britain is carried out mainly by specialised research institutes (some of which are autonomous and the rest attached to universities), and only to a relatively small extent by the A.R.C. and the Departments of Agriculture. In addition to the institutes, and independent of them, there are 17 provincial advisory centres, at least one in each of the 16 provinces into which Great Britain is divided for this purpose.

Some state-aided research is also done at agricultural colleges, farm institutes and university departments which are not advisory centres. Finally, and in a key position, for they are almost the only direct link between the research structure and the farming community, come the County Councils in England and Wales, and the agricultural colleges in Scotland.

Allied with the domestic structure are the Imperial Institutes of Entomology and Mycology and the nine Imperial Bureaux for the co-ordination of the results of agricultural research throughout the British Empire.

1. The Agricultural Research Council and Committee.

(a) The Agricultural Research Committee of the Privy Council.

The Committee of the Privy Council for the Organisation and Development of Agricultural Research consists of the Lord President of the Council, who is Chairman, the Secretaries of State for Home Affairs and for Scotland, the Minister of Agriculture and Fisheries and the President of the Board of Education.

(b) The Constitution of the Agricultural Research Council.

The Agricultural Research Council was created by Royal Charter in 1931* to direct and co-ordinate agricultural research in Great Britain under the supervision of the Committee of the Privy Council described above.

The A.R.C.** consists of 15 members, appointed by the Privy Council Committee, of whom four or five must be persons with experience of or interest in agriculture, and the remainder are appointed after consultation with the President of the Royal Society and must have qualifications in one of the basic sciences underlying agriculture.

Six standing committees, mainly composed of members of the Council, cover the whole field of agricultural research.

Soils and Plant Nutrition;
Plant Physiology, Breeding and Disease;
Animal Diseases;
Animal Nutrition and Breeding;
Dairying and Animal Products;
Economics.

There are also fourteen technical committees, mainly composed of co-opted members, dealing with:

Preservation of Grass and other Fodder Crops;
Nutrition in relation to Disease;
Insecticides and Fungicides;
Plant Virus Diseases;

Helminths of Economic Importance (Plants section);
Helminths of Economic Importance (Animals Section);

Diseases of Sheep (diseases not within the purview of other technical committees of the Council);

Contagious Abortion (*Brucella abortus* infection in animals and man);

Fowl Paralysis and similar diseases, and Coccidiosis;

John's disease in cattle and sheep;

Swine Fever, Necrotic Enteritis, and similar diseases of pigs;

Tuberculosis;

Iodine deficiency and Thyroid Disease;

Equine Research.

(c) The Functions of the A.R.C.

The two primary functions of the A.R.C. are (1) to advise the Development Commission and the two central departments of Agriculture in regard to all expenditure on agricultural research, including the award of scholarships, and (2) itself to commission or carry out a limited amount of research work with the staff and funds placed at its disposal.

The present powers and functions of the Council, and its relations with the Department of Agriculture and the Development Commission may be summarised as follows:

(i) The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland must submit the research programmes of all agricultural research institutions applying to them for grants to the A.R.C. for criticism and advice. The relationship between the two departments and the various research institutes, agricultural colleges and university departments remains, however, unchanged by the coming into operation of the A.R.C.

* July 23, 1931, amended by supplemental charter, March 24, 1934.

** This abbreviation will be used throughout this Report for the Council, not for the Committee.

(ii) The A.R.C. may itself carry out agricultural research, and for this purpose may either employ its own staff at research centres of its own, or make grants to outside research institutions. If the Council makes a grant to an institution aided by one of the central Departments, it must first obtain the consent of the Department concerned, and in any case the Council must consult the Departments on all proposals which it initiates itself. The A.R.C. has, in fact, purchased an estate at Compton in the Berkshire Downs to provide certain facilities for large-scale experiments on livestock which do not exist at any other research institution.

(iii) The A.R.C. is the scientific adviser of the Development Commission on agricultural research, and as such is responsible for securing the effective co-ordination of all agricultural research financed from the Development Fund. It also scrutinises the estimates of all schemes of agricultural research chargeable on the Fund, and if the Treasury sanctions less than was budgeted for, advises the Commission on the reallocation of the expenditure sanctioned. In the performance of these functions the A.R.C. is expected to have particular regard to the requirements (1) that any expansion of agricultural research is directed to the most important needs of the industry, (2) that present and future facilities available at research institutes or elsewhere are utilised to the greatest advantage, and (3) that undesirable duplication of research work is avoided.

(iv) Applications for special grants, to be borne on the estimates of one of the central Departments, are also referred to the A.R.C. The A.R.C. is empowered to consult directly with research institutes whenever it is thought desirable.

2. The Development Commission.

Sphere of operations included:

- (a) Aiding and developing agriculture, rural industries and the organisation of co-operation;
- (b) Promotion of forestry;
- (c) Land drainage and reclamation;
- (d) General improvement of rural transport (excluding roads, which were the function of the Road Board);
- (e) Construction and improvement of harbours;
- (f) Construction and improvement of inland navigation;
- (g) Development and improvement of fisheries.

The original powers of the Commissioners have been whittled away by the subsequent creation of the Forestry Commission, the Ministry of Transport and the various catchment boards, and are now practically reduced to examining applications for grants out of the Development Fund in aid of agricultural and fishery research, the development of rural industries and the improvement of fishery harbours.

3. The Central Departments of Agriculture.

(a) The Ministry of Agriculture and Fisheries.

The Ministry of Agriculture and Fisheries is the authority concerned with the administration of agricultural research in England and Wales. Through its Education and Research Division, it exercises a two-fold influence. On the one hand, with the advice of the A.R.C., it allocates grants, to be paid out of the Development Fund, to research institutions and the provincial advisory service, as well as a few grants borne directly on its own vote. On the other hand, the Ministry makes grants, without consulting the A.R.C., to county towards the maintenance

of the local advisory centres, and the services of the advisory officers. For agricultural education, both capital grants and grants in aid of annual expenditure may amount to 60 per cent.

The only research centres directly maintained by the Ministry are its Veterinary Laboratory at Weybridge, Surrey—which also houses the Imperial Bureau of Animal Health—and its Plant Pathological Laboratory at Harpenden, Hertfordshire, which is largely concerned with questions arising out of the administration of the Destructive Insects and Pests Acts.

The Ministry also controls the Royal Botanic Gardens at Kew, Surrey.... and the Experimental Station of the Foot-and-Mouth Disease Committee at Pirbright, Surrey. Seed-testing is done for the Ministry, on a fee basis, by the National Institute of Agricultural Botany at Cambridge, and the Agricultural Botany at Cambridge, and the Agricultural Machinery Testing Committee supervises the testing of agricultural machinery on behalf of the Ministry at the Institute for Research in Agricultural Engineering at Oxford and the National Institute for Research in Dairying at Shinfield. The Royal Technical College at Glasgow carries out tests on grass-drying machines on behalf of the Ministry.

In the sphere of agricultural research the Ministry also arranges for extension lectures by research-workers, and awards scholarships and studentships and overseas travelling grants on the advice of the A.R.C.

In addition... the Ministry engages in special activities in dairying and poultry.

(b) The Department of Agriculture for Scotland.

The functions performed in England and Wales by the Ministry of Agriculture and Fisheries are performed in Scotland by the Department of Agriculture for Scotland, whose political chief is the Secretary of State for Scotland.

4. The Research Institutes.

Agricultural research in Great Britain is mainly carried on in some fifty institutions. These are either institutes devoted purely to research or departments attached to universities or agricultural colleges, which also have educational functions.

(i) Agricultural Economics.

The only research institute in Great Britain devoted solely to the study of agricultural economics is the Agricultural Economics Research Institute at Oxford... It is organised in five sections: agricultural policy, farm management, agricultural marketing, prices and statistics, costs of production, and farm finance.

(ii) Soil Science.

The chief centres of soil research in Great Britain are Rothamsted in England, the Macaulay Institute in Scotland, and University College, Bangor, in Wales.....

The Rothamsted Experimental Station, Harpenden, Hertfordshire—specialises in the study of soils, crop production and plant pathology. Its 13 departments deal with soil physics, soil chemistry, biochemistry, crop physiology, botany, general microbiology, bacteriology, fermentation, mycology, and virus diseases of plants, entomology, insecticides and fungicides, statistics, and field experiments.

The Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen... studies the soil itself, and particularly soil chemistry. The Institute has six sections, dealing with soil surveys, past investigations, geology, and mineralogy, lysimeter (drainage water) studies, soil fertility and forest soils.

Co-ordination in the sphere of soil survey research is provided for by the Soil Surveyors' Conference, which meets annually.

(iii) **Plant Physiology.**

The central institution for the study of plant physiology in Great Britain is the Research Institute in Plant Physiology at the Imperial College of Science and Technology, University of London.... The general work of the Institute is the study of the physiological processes underlying crop production, and there are two main branches, physiology and physiological pathology.

Work on various aspects of plant physiology is also carried out at the Cambridge Animal Nutrition Research Institute, Cheshunt, East Malling, Long Ashton, Jealott's Hill, Wisley, and Bedford College for Women, University of London.

(iv) **Plant Breeding.**

The principal research institutes concerned primarily with plant breeding in Great Britain are situated at Cambridge for England, Corstorphine for Scotland, and Aberystwyth for Wales.

The Plant Breeding Institute, attached to Cambridge University, is mainly concerned with the breeding of cereals and other agricultural crops.

The Welsh Plant Breeding Station, attached to the University College of Wales, Aberystwyth, Cardiganshire, covers the whole subject of the improvement of pastures, and some investigations on arable crops.

The Station of the Scottish Society for Research in Plant Breeding, is situated at East Craigs, Corstorphine, Edinburgh. Its work consists chiefly in the discovery and establishment of new varieties of crop plants suitable to Scottish conditions.

(v) **Horticulture and Fruit Research.**

The John Innes Horticultural Institution, Merton, Surrey, is mainly concerned with pure plant genetics and cytology. It has departments for genetics, cytology, pomology and biochemistry.

The Horticultural Research Station attached to Cambridge University was founded in 1922. The main objects of the Station are: (1) to determine the botanical and commercial characters of the more important varieties of vegetables; (2) to produce and distribute improved varieties of vegetables; (3) to maintain a collection of the varieties produced by the Station to meet appropriate requests for pure stocks; (4) to study genetical problems as an aid to breeding and disease prevention in vegetables; (5) physiological growth defects; and (6) to undertake appropriate advisory work so far as staff resources permit.

The Experimental and Research Station, Cheshunt, Hertfordshire, studies the most important breeding and disease problems of tomatoes, cucumbers, lettuces and other glasshouse products, and is organised in seven sections: chemistry, physiology, entomology, mycology, virus disease, fungicides and insecticides, and advisory work.

The Horticultural Research Station at East Malling, Kent, is organised in nine sections: Biochemistry, plant physiology, mycology and bacteriology, entomology, insecticides and fungicides investigations, pomology, technical, statistics, administration and farm.

The National Fruit and Cider Institute, Long Ashton, Somerset, is organised in six sections: pomology, plant nutrition, plant pathology, fruit products, domestic preservation of fruit and vegetables, and willow culture and utilisation.

(vi) Plant Pathology.

Apart from the Ministry of Agriculture's Plant Pathological Laboratory at Harpenden, Hertfordshire, and the Plant Pathology Service of the Department of Agriculture for Scotland at Corstorphine, Edinburgh, there is no institution in Great Britain devoted solely to plant pathology. There is, nevertheless, considerable provision for the study of the disease of plants at most research institutions dealing with plant problems.

(vii) Animal Breeding.

The Small Animal Breeding Research Institute attached to Cambridge University... The present work of the Institute is mainly on the genetics of rabbits and poultry.

The Institute of Animal Genetics was founded in 1920 as a department of the University of Edinburgh. Its work is organised in four sections: genetics, cytology, physiological genetics, live-stock genetics.

The National Institute of Poultry Husbandry is the only husbandry institute dealing with all aspects of a particular product, in Great Britain.

The Bureau of Animal Population at Oxford founded in 1932 to study the scientific principles affecting wild animal populations, has made several investigations of value to farmers.

(viii) Animal Physiology and Nutrition.

Rowett Research Institute, Bucksburn, Aberdeen, is mainly concerned with the mineral and vitamin requirements of animals, and is organised in four departments: administration bio-chemistry, physiology, experimental farm.

The Animal Nutrition Research Institute attached to Cambridge University..... is organised in five sections: chemistry, physiology, genetics, nutrition, poultry nutrition the last of which works in cooperation with the National Institute of Poultry Husbandry.

(ix) Animal Diseases.

The principal centres of investigations in animal pathology in Great Britain are the Ministry of Agriculture's Laboratory at Weybridge, the Institute of Animal Pathology at Cambridge, the Research Institute in Animal Pathology and the Institute of Agricultural Parasitology in London, and the Moredun Institute in Scotland.

* * *

The A.R.C.'s new field station at Compton, Berkshire, is also intended to be devoted mainly to animal disease.

(x) Dairy Research.

There are two institutions for dairy research in Great Britain one in England and one in Scotland. Research bearing on dairy problems is also in progress at many of the institutions already described, at some of the agricultural Colleges, notably the East and West of Scotland Colleges, at Manchester University and at the London School of Hygiene and Tropical Medicine.

(xi) Preservation and Transport.

All research into the preservation of agricultural products now comes under the Department of Scientific and Industrial Research.

(xii) Agricultural Engineering.

The only research institute in Great Britain devoted to agricultural engineering is the Institute for Research in Agricultural Engineering at Oxford University.

The Agricultural Machinery Testing Committee supervises the testing of machinery on behalf of the Ministry of Agriculture.

(xiii) **Agricultural Meteorology.**

There is no institute specifically for the study of agricultural meteorology.

5. THE PROVINCIAL ADVISORY CENTRES

The whole of Great Britain, except for the County of London, is divided into sixteen provinces, in each of which is an advisory centre or centres at which from three to seven specialist advisory officers are stationed. The centres are all either university departments of agriculture or agricultural colleges.

The principal branches of science for which advisory officers are provided are chemistry, dairy bacteriology, agricultural economics, entomology, mycology and veterinary science, but advisory economists are the only officers to cover all the provinces.

The primary function of the provincial advisory officers is to act as specialist advisers in their respective sciences.

6. LOCAL AUTHORITIES

The Agricultural education organised by local authorities falls into six categories: (1) regular yearly or terminal courses at farm institutes; (2) organised day courses; (3) evening classes; (4) correspondence courses; (5) instruction in agricultural manual processes, such as ploughing, ditching and sheep-shearing; (6) occasional lectures, demonstrations and other meetings.

7. PRIVATE RESEARCH

A considerable amount of valuable research is done outside the official subsidised research structure, at universities, agricultural colleges and farm institutes, and by private firms, societies and individuals.

8. THE IMPERIAL BUREAUX AND INSTITUTES

Allied with the whole structure of agricultural research in Great Britain are the two Imperial Institutes and nine Imperial Bureaux, which provide a coordinating, abstracting and information service for agricultural research workers throughout the Empire, covering the sciences of entomology, mycology, the soil, animal health, nutrition and genetics, plant genetics, fruit production, dairying and parasitology.

9. Other Information Bureaux.

A number of other information bureaux also have an agricultural bearing.

The Boron Agricultural Bureau (Abford House, Wilton Road, London, S.W.1).

The Iodine Educational Bureau (Stone House, Bishopsgate, London, E.C. 2).

The Bureau of Hygiene and Tropical Diseases at the London School of Hygiene and Tropical Medicines.

The Central Agricultural and Scientific Bibliography.

APPENDIX F — PART II.

LIST OF AGRICULTURAL RESEARCH INSTITUTIONS IN GREAT BRITAIN

(From 'List of Agricultural Research Workers in the British Empire, 1937')

STATE INSTITUTIONS.

- Ministry of Agriculture and Fisheries
 - Veterinary Laboratory, New Haw, Weybridge, Surrey.
 - Foot-and-Mouth Disease Experimental Station, Pirbright, Surrey.
 - Plant Pathological Laboratory, Harpenden, Hertfordshire.
 - Royal Botanic Gardens, Kew, Surrey.
- Department of Agriculture for Scotland.
 - Seed-Testing and Plant Registration Station, East Craigs, Corstorphine, Edinburgh.
 - Agricultural Economics Department, Edinburgh.
- Department of Scientific and Industrial Research.
 - Low Temperature Research Station, Cambridge.
 - Ditton Laboratory, East Malling, Kent.

UNIVERSITY INSTITUTIONS.

- London
 - Imperial College of Science and Technology, South Kensington, London S.W. 7
 - Research Institute in Plant Physiology, South Kensington, London S.W. 7
 - Biological Field Station (Stored Products Research) Slough, Buckinghamshire.
 - London School of Hygiene and Tropical Medicine:
 - Department of Helminthology, London, W.C.I.I.
 - Institute of Agricultural Parasitology, Winches Farm, St. Albans, Hertfordshire.
 - South-Eastern Agricultural College, Wye, Kent.
- Cambridge
 - Animal Nutrition Research Institute.
 - Institute of Animal Pathology.
 - Low Temperature Research Station (see D.S.I.R.)
 - Plant Breeding Institute.
 - Horticultural Research Station.
 - Small Animal Breeding Research Institute.
 - School of Agriculture.
- Oxford
 - Agricultural Economics Research Institute.
 - Institute for Research in Agricultural Engineering.
 - School of Rural Economy.
- Bristol
 - Agricultural and Horticultural Research Station, Long Ashton, Somerset.
 - Fruit and Vegetable Preservation Research Station, Chipping Campden, Gloucestershire.
 - Agricultural Advisory Department.
- Liverpool
 - Department of Veterinary Pathology.
- Reading
 - National Institute for Research in Dairying, Shinfield, Berkshire.
 - Faculty of Agriculture and Horticulture.

Wales

- University Colleges of Wales, Aberystwyth, Cardiganshire:
 Welsh Plant Breeding Station.
 Cahn Hill Improvement Scheme.
 Department of Agriculture.
 University College of North Wales, Bangor, Caernarvonshire:
 Department of Agriculture.
 University College of South Wales and Monmouthshire, Cardiff:
 Department of Agriculture.

Durrham

King's College, Newcastle-on-Tyne.

Leeds

Department of Agriculture.

Manchester

Agricultural Advisory Department.

Edinburgh

Department of Agriculture (and East of Scotland College of Agriculture).
 Department of Zoology.
 Institute of Animal Genetics.

PRIVATE INSTITUTIONS.

Royal Veterinary College, Camden Town, N.W. 1:

Research Institute in Animal Pathology.

John Innes Horticultural Institution, Merton, Surrey.

National Institute of Agricultural Botany, Cambridge.

Rothamsted Experimental Station, Harpendon, Hertfordshire.

Experimental and Research Station, Cheshnut, Hertfordshire.

Horticultural Research Station, East Malling, Kent.

Harper Adams Agricultural College, Newport, Salop:

National Institute of Poultry Husbandry.

Midland Agricultural College, Sutton Bonington, Leicestershire.

Seale Hayne Agricultural College, Newton Abbot, Devon.

Rowett Research Institute, Kirkhill, Ayr.

Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Moredun Institute of Animal Diseases Research Association, Gilmerton, Midlothian.

Scottish Society for Research in Plant Breeding, Corstorphine, Edinburgh.

Edinburgh and East of Scotland College of Agriculture, Edinburgh.

West of Scotland Agricultural College, Glasgow.

North of Scotland College of Agriculture, Marischal College, Aberdeen.

*Linen Industry Research Association, King's Lynn, Norfolk.

IMPERIAL BUREAUX

Imperial Institute of Entomology, British Museum (natural History), South Kensington, S.W. 7.

* Northern Ireland.

- Parasite Laboratory, Farnham House, Farnham Royal, Buckinghamshire.
- Imperial Mycological Institute, Kew, Surrey.
- Imperial Bureau of Soil Science (see Rothamsted).
- Imperial Bureau of Animal Health (see Ministry of Agriculture, Veterinary Laboratory).
- Imperial Bureau of Animal Nutrition (see Rowett Institute).
- Imperial Bureau of Plant Genetics (non-herbage) (see Cambridge University, Plant Breeding Institute).
- Imperial Bureau of Plant Genetics (herbage) (see Wales University, Welsh Plant Breeding Institute).
- Imperial Bureau of Fruit Production (see East Malling Research Station).
- Imperial Bureau of Animal Genetics (see Edinburgh University, Institute of animal genetics).
- Imperial Bureau of Agricultural Parasitology (see London University Institute of Agricultural Parasitology).
- Bureau of Hygiene and Tropical Diseases (see London University School of Hygiene and Tropical Medicine.)

APPENDIX G — PART I.

Extract from the report of the Sub-committee of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India held on the 26th and 27th February 1935, to consider subject No. 11 of the Agenda.

"A simple survey be made and the following named data recorded:

1. Climate
2. Altitude
3. Surface features
4. Soil water—maximum and minimum depth of water table
5. Texture—a field test.
6. Colour—black, red, yellow and grey.
7. Depth and succession of soil horizons.
8. Character of underlying rock (where possible).
9. Nature of natural and cropping vegetation.
10. Field estimation of pH to determine whether soil is acid or alkaline.

The soil to be examined at distances not greater than 50 miles apart."

"The Committee also consider that where more detailed examination is required the following named determinations should be made on soil samples collected to a depth of 9 inches:

1. Mechanical analysis.
2. (a) On Acid soils—base saturation and exchange.
(b) On alkaline soils—Lime and water soluble salts and exchangeable bases.

A still further extended examination should include Nitrogen, Phosphoric Acid, Potash, Sesquioxide to Silica ratio, total carbon, loss on ignition."

APPENDIX G — PART II

The following determinations are made by simple rapid methods which are sufficiently accurate for the purposes of the reconnaissance survey. (Some aspects of tropical soils—F. Hardy, Imperial College of Tropical Agriculture, Trinidad, British West Indies.)

- (1) Index of Texture (I.T.), from moisture content at the point of stickiness (P), and content of coarse and fine sand (S) determined by sedimentation (I.T. eq. P-S/S);
- (2) reaction (both normal and exchange) by the quinhydrone electrode;
- (3) content of calcium carbonate by the Collin's Calcimeter;
- (4) organic matter content by wet combustion;
- (5) total nitrogen by the Kjeldahl method;
- (6) Carbon/nitrogen ratio, from (4) and (5), which should be corrected by a suitable factor for organic carbon if absolute values are desired;

(7) nutrient status, by Atkins's electrical conductivity method applied to water extracts of the soil, (a) after 21 hours standing ("available nutrients"), and (b) after 7 days standing ("rate of solution");

(8) available phosphate by truog's method, and

(9) available (exchangeable) potash by the cobaltinitrite volumetric method applied to N₂ acetic acid extracts of the soil.

PART B — SOIL EROSION.

Suggestions for Improvement.

1. A rough survey to locate zones of serious erosion and correlate them with vitally important catchments.
2. (a) Gradually eliminate uneconomic cattle and also ensure that the requisite number of better bred cattle is available to meet requirements.
- (b) Eliminate or control shifting cultivation and the breaking of virgin forest land.
3. Encourage the proper contour ridging, terracing and leveling of fields etc. by means of remission of revenue and by propaganda.
4. Enlarge co-operative activities to include land reclamation, village afforestation and forest management, consolidation, village afforestation and forest management, consolidation of scattered holdings, partition of common holdings, and the marketing of cut grass crops.
5. Extension of afforestation work in the plains for (a) shelter belts, (b) fodder trees, (c) hedgerow timber, (d) fuel supply.
6. The schedule given below summarises the various lines of attack.
7. The best agency for controlling all such work is probably as in the Punjab a conservator's circle under the Forest Department, rather than attempting to create an entirely new department.
8. It is presumed that legislation will be necessary to attain the objectives mentioned above.

Schedule summarising erosion control activities.

Waste Land. (Livestock and Fodder)

1. reduction of surplus live-stock.
2. grading up of flocks and herds.
3. grassland improvement.
4. encourage voluntary and rotational closures.
5. partition of shamilat (common grazing lands) to develop individual ownership.
6. panchayat management of grass lands.
7. replace grazing by grass cutting and stall-feeding of hay.
8. develop grass markets for profitable disposal of surplus cut grass.
9. Use green fodder crops and silage.
10. restrict immigrant flocks where these are a serious factor.

Forest.

1. encourage the village as the unit for forest improvement and protection schemes under co-operative or panchayat organisation.
2. reclamation of rayine lands for grass and forest produce.
3. reclamation of flat lands in torrent beds which are often cultivable after a period under forest conditions.
4. village plantations for fuel and timber.

5. planting of fodder trees.
 6. rotation of lopping fodder trees
 7. Control of nautor grants (breaking virgin land for cultivation).
 8. protection of existing forest.
 9. creation of shelter-belts.
- Ploughlands.**
1. watt bandi and contour terracing to retain rainfall and reduce run-off.
 2. remission of land revenue to encourage watt bandi and terracing.
 3. consolidation of holdings to allow better lay-out of field terracing.
 4. patwaris and district civil staff to be given short courses in watt bandi and field improvement.
 5. co-operative organisation for land improvement projects.
 6. use of live hedge plants to replace dry thorn twigs.
 7. encourage use of compost manure.
 8. find legume or grass crop to sow on fallow (bare fallow land gives a high run-off).
 9. improvement of cultivation methods for soil-wasting crops such as potatoes.
 10. restriction of cultivation on very steep slopes.

PART B: SOIL EROSION AND RECLAMATION

Nature and extent of erosion: Owing to the spectacular damage done to sloping lands by gulying, this has been noted on and observed wherever it occurs but the less spectacular sheet erosion is only now coming under observation. It was previously considered that sheet erosion was confined more or less to sloping lands and that flat lands escaped serious damage. Recent observations by your Planning Committee and other trained observers, however, show that sheet erosion is widespread on practically flat cultivated lands and also on flat uncultivated land where over-grazing is severe.

The various phases of erosion can, therefore, be summarised as follows:—

- A. Sheet erosion is more or less universal (a) on all bare fallow whether on slopes or level ground, (b) on all uncultivated land whose plant cover has been thinned out by grazing, fire or other misuse, (c) on all sloping cultivation no matter what crop is in the ground, (d) on sloping forest and scrub jungle whose natural porosity of soil has been reduced by heavy grazing, clear-felling of trees, or burning.

Run-off measurements taken for scrub jungle in Kangra district and for black cotton soil cultivation at Sholapur in Bombay (see Problem of Soil Erosion in British Empire, Reprint from Royal Society of Arts) both confirm these conclusions, the loss of 133 tons of soil per acre per annum from a well tilled field being a particularly clear indication of losses, the seriousness of which has not previously been appreciated.
- B. Gully Erosion is common (a) wherever a river system has cut down into elevated plateaux of soft or unconsolidated geological strata, so that the feeders and branches can carve out an intricate pattern of gullies as they cut back into the

high ground. (b) It is also common in relatively level country wherever large blocks of cultivation give rise to concentration of field run-off: this enhances the cutting power of the drainage water in channels which are not naturally intended to carry such concentrated flow. (c) Roads, railways and other engineering works frequently divert natural drainage and concentrate it so that serious gullying results. Gully erosion is common in the Siwaliks, Jhelum Salt Range, and the Jumna and Chambal ravines of the U.P.

Gullied land in the U.P., Punjab and N.W.F.P. probably amount to about 5,000 square miles, not only rendered completely useless itself but forming a serious danger to neighbouring good land

- C. **Wind Erosion** is only serious over any wide expanse of unprotected light soil in an arid climate where high winds find no obstruction. It is locally common in plains, areas with a poor or badly distributed rainfall and can be recognised from the characteristic hummocky sandhills with wind ripple markings. It has been observed in many parts of India—e.g., Patiala State, Gurgaon, Karnal, Hissar and Mianwali in the Punjab, and in the drier parts of Madras, Bombay, C.P., U.P., Sind and Rajputana.
- D. **Bank Erosion** occurs to some extent along the channels of all Indian rivers and leads to serious loss of cultivated land when large slabs of riverside land are broken off and swept away.

Causes of Erosion: In Bihar, Orissa, C.P. & parts of U.P. and the Punjab overgrazing is emphasised as the main cause of erosion while in Assam and Bengal shifting cultivation is most blamed. There is, however, a growing realisation in many quarters that the ordinary field cultivation also is a prime cause, and even on the basis of the committee's well-informed reports, it would be dangerous to classify the causes in order of seriousness. Roughly speaking, field cultivation and overgrazing share the blame equally over large territories but local intensive studies show that here and there for obvious reasons such as topography, castes and customs of the people, itinerant grazing, methods of land tennure, favourite crops etc., one or other branch of agriculture must take the major share of the blame. Similarly it is hard to decide between deforestation and overgrazing because one is complementary to the other and the two can seldom be completely separated in the gradual process of deterioration and denudation which is going on over millions of acres of our uncultivated land.

- Effect of Erosion:** The combined effect of the various phases of sheet, gully and bank erosion can be summarised as follows:—
- (a) increasingly severe and sudden floods.
 - (b) longer intervening periods of drought, affecting canal efficiency.
 - (c) failure of underground supplies, affecting water table level, wells and springs.
 - (d) uncertainty of irrigation supplies due to combination of b and c.
 - (e) raising of river beds by sand, deposits, leading to catastrophic changes in river courses and blocking of navigable channels and harbours.

(f) reduced crop yields from eroded fields owing to loss of top soil.

(g) reduced area of cultivation due to gullying and bank erosion.

Remedial Measures so far Employed : Apart from some contour trenching in dry areas and reservations in Bihar, some useful bund building in cultivated land in Bombay and a promising beginning to a big village afforestation scheme in the U.P., the Punjab seems to be the only province which has tackled the problem seriously. The following is a summary of steps actually taken in the various provinces.

ASSAM : The Forest Department is taking steps to control the deforestation of the hills because this has been recognised as a very serious matter. The progress of terracing is slow owing to the heavy expenditure involved. Erosion losses in the hills are due to shifting cultivation and lack of terracing rather than to grazing. Sheet erosion is particularly serious along the Surma and Brahmaputra valley lands.

BENGAL : Gully erosion is noticeable in the rolling uplands of Burdwan division. No exact information is available about the extent of sheet washing but it is admitted that in many places the accumulated top soil has been washed away and the sub-soil exposed. In Lower Bengal bank erosion is serious along all the major rivers, and the loss affects urban areas as well as cultivable ground to an alarming extent. No action has been taken yet. Out of a total of 49 million acres, 6 million are shown as cultivable waste and 9½ million are not available for cultivation, but a good deal of both these classes would lend themselves to village afforestation projects, such as have recently been outlined by the West Bengal Forest Committee Report.

BIHAR : In 1907 the Government of India addressed all local governments on the subject of the relation between forests and the retention of soil moisture and called for suggestions to check destruction of forests and reforest denuded areas. The lamentable condition of the Chotanagpur plateau was taken up and in 1918 a scheme for the reservation or protection of private forests was framed with Government accepting certain responsibilities for the cost of settlement and demarcation. This scheme was applied in only one case. In 1925 a revised Private Forest Bill was prepared but was thrown out by the Legislature. The present position is that Government is prepared to take over suitable areas in Chotanagpur plateau on a 40 year lease and to rent, but will have a half share in whatever profits may eventually accrue. The response to this very liberal and far-sighted proposal has been disappointing but the Conservator of Forests hopes that progress will now be made if government, as it has proposed empowers him to take over the management of such private forests as require attention under a gazette notification of 20th September 1939.

An experiment is being carried out in Bihar to test how far soil moisture conditions and the resultant tree growth can be improved by catching hillside torrent water behind rubble dams and passing it along contour trenches.

ORISSA : Both sheet and gully erosion do immense damage, the main causes being uncontrolled grazing and faulty field cultivation. Gullying follows immediately upon destruction of forests by fire, clearance or heavy fellings. In hilly Government lands steps are being taken to demarcate areas liable to shifting cultivation and fresh rules have recently been drafted.

SIND : The chief erosion loss here is from bank erosion along the Indus, and very little can be done to prevent it owing to the enormous expense involved.

UNITED PROVINCES: This province is fortunate in that its highly erodible Siwalik foothills are reserved forests but in the plains sheet erosion is very widespread and serious in both cultivated and uncultivated lands. Gully erosion is universally serious in many of the plains districts in the neighbourhood of streams and rivers, and the ravined "bad-lands" are said to cover half a million acres in Jalaun, Etawah, Agra, Gwalior and the adjoining states and districts. Out of the provincial total of 60 million acres 5 million are barren ravines, rocky hills or salt impregnated waste and a further 8.7 million is so-called "culturable waste" (though apparently this is an enormous classification and much of it is not cultivable). Apart from conservation of the 2.8 million acres of Government forest and some experimental closures in the Etawah "bad lands", very little has been done either to encourage the ridging of fields or the reduction of the awful incubus of 40 million cattle.

The gravity of the position is fortunately causing increased attention to the problem. Thus in the United Provinces, in addition to the National Planning Committee, a number of other committees and authorities are and have been considering different aspects of it. The Fodder and Grazing Committee have been concerned over the intense overgrazing in all waste land, resulting in reduced fodder production and accelerated erosion. The Usar and Waste Land Reclamation Committee have wide terms of reference,—including prevention of deterioration of waste lands and cultivated lands, and will shortly be making a series of important recommendations. The Inter-Provincial Ganges Flood Committee are concerned with river silting and floods in the Ganges, and its tributaries; their field overlaps provincial and political boundaries and includes the whole Ganges basin. The Forest Department, in cooperation with the Rural Development Department has already started an organisation, which is proving popular with zamindars and tenants alike, and which can be expanded into a new branch of forest activity as future developments indicate, to deal with the creation of village timber, fuel, and fodder plantations on culturable lands and on unculturable lands fit for tree growth. The scheme visualises the possibility in course of time of creating up to one million acres of these village plantations, an afforestation policy which compares in magnitude and importance with any of the major afforestation schemes in the world today. The scheme also provides for technical advice and assistance in reclamation of ravines, the better management of grazing grounds and of waste lands generally to improve natural fuel and fodder production and to check soil erosion and conserve moisture as far as possible. In the plains districts of the U.P. (excluding the Himalayas) there are nearly 20 million acres of waste and uncultivated lands, so the scope of work is enormous, and this scheme anticipates, and will test out on a practical scale, some of the recommendations and proposals that will obviously be made by this Committee. It is inevitable that the activities of these various committees and authorities involve a good deal of overlapping, and some co-ordination appears desirable.

PUNJAB : Attention to the appalling condition of the Siwalik foot-hills was called by forest officers as early as 1870, but it was not until 1902 that a Land Preservation Act was passed. This

an excellent income from cut grass, and run-off conditions have been greatly improved in certain torrents. From 1934 onwards voluntary closures under this act and also under section 38 of the Indian Forest Act have been encouraged by village to village propaganda, and in 1939 co-operative staff were also employed to form reclamation societies, some of which have already done excellent work in making closures, encouraging watt bandi or contour ridging of fields, and reclaiming torrent ruined land.

An Anti-Erosion Circle formed in April 1939 now has ten units under it doing some form of erosion control in Ambala, Gurgaon, Hoshiarpur, Kangra, Gurdaspur, Shahpur, Gujrat, Jhelum, Rawalpindi and Attock. This circle forms part of the Forest Department but actually a good half of the work in progress is in cultivated land. Good cooperation is being obtained from the Co-operative Branch and the Agriculture Department and to a lesser extent from the revenue staff and the Veterinary Department.

Projects now in progress include :—

(a) closure of grazing areas by bringing them voluntarily under closure by means of the Ches Act or Section 38 of the Indian Forest Act. About 80,000 acres of badly gullied Siwalik foothills have been closed in this way since 1934.

(b) village management of waste by means of "Cho" Reclamation Co-operative Societies which accept technical guidance of the forest staff. A special staff of co-operative Inspectors and sub-Inspectors is employed in Hoshiarpur and Ambala for this.

(c) consolidation of holdings and for partition of common land where this is advantageous.

(d) control of pine tapping for resin extraction by Forest Department in village lands to ensure that trees are not killed and ground is not exposed by heavy felling.

(e) active erosion control by means of contour trenching gully plugging, terracing and watt bandi of fields, silt catching, dams, tree plantations, etc.

(f) tree nurseries for growing and distributing suitable trees to villagers for plantation projects, hedgerow planting, fodder trees.

(g) education and propaganda, from village to village, and also amongst local officials. This includes attending local cattle fairs where erosion models are placed on view and leaflets distributed.

N.W.F.P. : Thirty years ago the Hazara Gullies forests which form the main catchment area of the Province were opened to indiscriminate tree lopping. Destruction is now complete and what were previously forest clad mountains with perennial streams are now deep clefts of raw soil and bare rock in gullies torn out by torrent action. The attention of the N.W.F.P. Government was drawn to this state of affairs by the writer in 1937 but nothing has been done. Pressure of population is intense and clearing of strip forest to make way for cultivation continues at an alarming pace.

BOMBAY : The dry areas with less than 40 per cent of rain suffer most. Uncontrolled grazing is the worst factor. The Agriculture Department has made good progress with the introduction of contour ridging of fields in several areas. The Forest

neering on the lines already in use in the Punjab and U.S.A. and has introduced rotational grazing schemes in several areas. Department is undertaking some studies of flood control engineering. The Provincial Rural Development Board of Bombay has suggested: (a) survey to ascertain facts, (b) loans for building check dams and weirs, (c) training men in bund work, (d) research in soil loss and conservation.

MADRAS : It is only in the dry northern districts that erosion is a serious consideration and even in these the presence of black cotton soil reduces the erosion hazard by its extreme sponginess and the facility with which it absorbs rain and prevents heavy run-off.

CENTRAL PROVINCE : The problem here is essentially a grazing one, for the uncultivated waste is in a terrible condition everywhere, whereas the common system of field bunds to catch and store monsoon rain prevents serious sheet washing. This practice is strongly recommended throughout the other wheat-growing areas. The Forest Department has introduced rotational grazing schemes and has demonstrated the value of grass reserves, but the main problem is how to get rid of the awful incubus of millions of useless scraggy livestock whose presence is responsible for the lamentable condition of the grazing lands.

KASHMIR : The lower hills in Poonch adjoining the Punjab border are in an utterly appalling state of gully erosion owing to uncontrolled grazing and bad field cultivation. Many torrents from this area do damage in the lower Punjab lands down-stream. An erosion committee of state officials and non-officials visited Hoshiarpur a year ago and have recommended that active control work on similar lines be taken up.

SIKHA HILL STATES : In the largest of these states, Bashahr, considerable areas of high level fir forest in the main Sutlej valley are being cleared to make way for cultivation. These forests have in the past been held under lease by the Punjab Forest Department but the lease is now being terminated and the forests are being handed back to state control. In view of the vital importance of the Sutlej for canal supplies sound conservation is absolutely essential.

Part B

SOIL RECLAMATION

By J. N. Mukherjee
SUMMARY

Paragraph 1: There are various classes of land which require for their utilisation special types of operations other than the usual methods of soil management and treatment. It is necessary in the first place to provisionally classify these soils according to their more obvious characteristics and to obtain a broad idea of their extent of occurrence. This should form part of the programme of the reconnaissance survey. The major problems of reclamation of a province will be known from this survey. Soils which are similar as regards their broader features show wide variations and the general information regarding the methods of amelioration collected so far cannot be utilised without detailed knowledge about the soils to be reclaimed. A detailed scientific survey will be necessary for dealing with each of the major problems.

Paragraph 2: Examples are given of the diversity of the reclamation problems. All these have their respective group and local characteristics and methods must be devised to suit them.

Paragraph 3: Simultaneous and serious studies from the point of view of soil science are required to deal with problems of soil reclamation. In common with many other problems of soil conservation coordination of investigation and efforts are necessary. Reclamation of land should be one of the subjects coming under the purview of the Land Development Boards.

PART B—SOIL RECLAMATION

BY J. N. MUKHERJEE

Question 2: What is the area or percentage of:

- (a) Culturable waste (including mild usar that can be economically reclaimed)?
- (b) Unculturable waste, including reh or severe usar that cannot be economically reclaimed, and lands that are physically impossible to cultivate, such as arid and desert tracts.
- (c) Water, Waterlogged land, and land liable to regular flooding (river beds, Khadir, etc.)
- (d) Roads, railway and canal land, town and village sites, etc.

1. Some aspects of reclamation of land have already been considered. The question of reclamation in its general aspects is discussed below. There are various classes of land which require for their utilisation special types of operations other than the usual methods of soil management and treatment. Large areas of such lands occur under the head, 'culturable waste other than fallow', 'not available for cultivation' and possibly also

under 'current fallow'. References have already been made to Usar and Reh and the subject of eroded lands has been thoroughly discussed in the preceding pages of this part. Vast stretches of saline and alkaline soils, sand deposits, arid and semi-arid soils, swamps and other types of water logged soils, ravines and soils afflicted by defects not covered by the above are known to exist in the country. It is necessary in the first place to provisionally classify these soils according to their more obvious characteristics and to obtain a broad idea of their extent of occurrence. This should form part of the programme of the reconnaissance survey. It is quite probable that problems of reclamation will arise which have not been so far either so well recognised or are quite new, and more detailed scientific surveys will be necessary. Even where the problems have been more or less known for a long time, for example, in the case of Usar and Reh, such detailed surveys are necessary. It is true that alkaline and saline lands have been for long the subject of investigation in several countries and considerable information regarding successful methods of amelioration is available. But soils which are similar as regards their broader features show wide variations and this general information cannot be utilised without detailed knowledge about the soils to be reclaimed. Besides there are very often local problems to be considered. The importance of these scientific surveys has not often been well recognised even by officers of the agricultural departments. There is still a pronounced tendency to dogmatize about what are called 'practical' aspects of reclamation and other projects. These 'practical' attempts have not infrequently been based on meagre scientific data and it is no wonder that so little is known about such vast areas which can be of practical use. It is time that a rational attitude is taken up and detailed investigations are begun. It will be necessary to recognise the major types of problems of reclamation within a province and deal systematically with each one of them. A few examples are given below to illustrate how varied these problems may be.

2. In the coastal tracts of Bengal extensive areas suffer from the existence of hard clay pans which lie some times only about a foot below the surface. These interfere with root development and present other difficulties. In some places of the Chittagong district soils are going out of cultivation and they are characterised by certain special features. They are called 'Kash' lands. Along the coast of Orissa from the Lake Chilka to the mouth of Mahanadi at False Point there is a broad stretch of sand varying between one to four miles in breadth. Sand dunes are known in Sind on the east coast of Madras and many other parts of the sea board. Extensive tracts are covered by ravines, by lands which formerly formed beds of rivers now dead, by swamps or waterlogged soils, by coastal sands and sandy soils. All these have their respective group and local characteristics and methods must be devised to suit them.

3. Afforestation, irrigation and drainage have their uses in reclamation but they do not constitute the only aspects of its problems. Simultaneous and serious studies from the point of view of soil science are required in most cases. Engineering operations are performed on extensive tracts with due regard to these soil problems and to the system of land utilisation. Problems of reclamation especially in low lying tracts of swamp lands are connected with drainage, water transport and communication as also

with land utilisation, e.g., in some parts of Bengal. Engineers alone cannot visualise all the technical aspects of such problems. It is often much better to leave some lands, e.g., some swamp lands, to nature to reclaim it, if necessary with some artificial help. Vegetation plays an important part in many cases of reclamation and the botanical aspects require special studies by botanists. It is evident that in common with many other problems of soil conservation, co-ordination of investigation and efforts is necessary. Reclamation of land should thus be one of the subjects coming under the purview of the Land Development Boards.

PART C. CONSERVATION OF SOIL MOISTURE AND REGULATION OF WATER SUPPLY

BY J. N. MUKHERJEE

(Incorporating suggestions in a note by Rao Bahadur
V. A. Tamhane).

SUMMARY

Paragraph 1: By regulation of water supply and conservation of soil moisture great improvements of agriculture can be effected. The ideal to attain is the power to command water in sufficient quantities by conserving the excess for use when it is in demand. Large quantities of water still go waste.

Paragraph 2: For agricultural purposes information is necessary on two points, namely (i) the extent and location of land which will profit by irrigation and (ii) the availability of water for irrigation from any possible source. It is necessary to work out estimates of the availability of water and demands on it for a province as a whole as also for physiographic units and to draw up plans in terms of reservoirs and distributory system in order to ensure a sufficient and dependable supply to meet all demands. The needs of drainage and communications by water also require to be reconciled in the formulation of plans. Costs should be as low and projects as simple as possibly consistent with efficiency so that they pay working expenses and cultivators do not find much difficulty in taking the water.

Paragraph 3: More systematic attention requires to be paid to the rehabilitation of existing tanks, ponds and bunds where desirable and to the excavation of new ones.

Paragraph 4: More attention should be paid to the importance of suitable methods of soil management and vegetation cover for the conservation of soil moisture. Methods of 'Dry Farming' or perhaps in some tracts of 'Desert Farming' require to be worked out. More dry farming stations require to be established in many provinces and the soil conditions during the dry period require to be studied in detail. The creation of a grass cover and utilisation as pasture is sometimes of no less importance than afforestation.

Paragraph 5: It will be helpful to take stock of the measures which have been taken in each province for the conservation and regulation of soil moisture and the success they have achieved.

Paragraph 6: An enquiry should be instituted in each province to ascertain the extent, nature and periodicity of damage done by floods to soils and crops and assess their monetary

value. Systematic records should be kept on a scientific basis containing information of all relevant factors. They should be available to the public and scientific workers. The steps which have already been taken to cope with floods and the results of such action should be investigated and a report prepared for the information of the Development Board, one of whose main functions will be to consider measures for the control of floods. Comprehensive schemes will require to be formulated by the Development Board at the Centre.

Paragraph 7: The extent and causes of water logging and remedial measures require detailed study. The reconnaissance survey is likely to give useful information. Schemes of drainage will require to be worked out in connection with the plans of soil conservation.

Paragraph 10: Some adverse effects of irrigation have been experienced in the Bombay Deccan, round about Sind and in the Punjab. Drainage by open trenches or deeper closed drains are being tried by the agricultural and irrigation departments and has met with considerable success.

Paragraph 11: The agricultural department of every province where irrigation is of any importance should have a special section to conduct preliminary soil surveys, to keep watch over the effects of irrigation on the soil and to study associated agricultural problems.

PART C. CONSERVATION OF SOIL MOISTURE AND REGULATION OF WATER SUPPLY

BY J. N. MUKHERJEE

(Incorporating suggestions in a note by
Rao Bahadur V. A. Tamhane)

Question 1: Is the supply of water from natural sources sufficient for agricultural purposes in your Province, or, is there any room for improvement by irrigation or by conservation of soil moisture?

1. The supply of water from natural sources including supplies from rivers shows widest variations in different parts of the country. It is sufficient for the local crops in places like Assam, East Bengal, U.P., etc., while in most other places e.g., the Bombay Deccan, parts of Gujerat, Kathiawad, Sind, etc., the supply of water is insufficient. Conditions vary even within the same province. In Madras, for example, in some parts it is in excess of that required and in deficit in some others. In tracts traversed by the moisture laden monsoon winds the rain fall is sufficient during normal years but its amount and distribution depend on the vagries of the weather. Periods of droughts and floods occur causing great damage to crops. Generally speaking, the rain fall is very much unevenly distributed over the seasons. The ideal to attain is the power to command water in sufficient quantities according to requirements by conserving the excess for use when and where there is a defect of supply of water. The water resources of a country have to meet demands other than those of agriculture and these require to be reconciled. Our agricultural practices, crops and vegetation depend to a large extent on the water supply of the locality. By regulation of water supply and conservation of soil moisture great

Improvements of agriculture can be effected. Extensive irrigation projects have already been carried through and possibilities of further extensions are under consideration of the Irrigation Departments. Apart from rain fall and surface water, underground water or subsoil water is also capable of utilisation. Recent experience in the United Provinces constitutes an important example of what an organised attempt can achieve in the utilisation of subsoil water. Reference has been made elsewhere in this report of the importance of re-afforestation, of planting of trees and of training of rivers for the purposes of obtaining a steady and dependable stream supply, of food control and of conservation of soil moisture. Supply of some of the big rivers is often in excess of present requirements and larger quantities of water go waste whereas in many cases the supply is scanty, unreliable and is drying up. A similar state of affairs holds also for many smaller rivers and streams. In several forests, e.g., in the Ghats, Bihar, Bengal, Assam and Orissa water from a number of perennial streams is allowed to go waste. Simple and cheap designs (such as those said to have been constructed by the Forest Department of Bihar) to utilise such water are necessary. Water power is, however, being increasingly tapped for the generation of electricity.

2. For agricultural purposes information is necessary on two points, namely, (i) the extent and location of land which will profit by irrigation, and (ii) the availability of water for irrigation from any possible source. A definite idea of the latter can only be obtained if broad estimates of the water resources of various types of the province and of the demands on them are arrived at and plans of utilisation are drawn up based on these estimates. This is of course an ideal difficult of achievement. But rough and working estimates should be possible. It is also necessary to work out the availability of water and the demands on it for physiographic units and the cost of projects to ensure a sufficient and dependable supply. Considerable information has been collected by the Irrigation Departments and the Central Board of Irrigation but it does not appear that any systematic attempts have been made to visualise the problem as a whole in terms of reservoirs and systems of distribution for each province. Planning and efforts to deal with it should be commensurate with its difficulties and importance. Schemes of drainage and irrigation which are also of so great import to sanitation and water transport remain to be formulated for vast tracts and to be put into operation. A dependable water supply is one of the greatest needs of Indian agriculture and too much attention cannot be paid to the questions discussed above. Large areas remain to be utilised and many crops considered to be essential for local communities cannot be grown for want of water of proper drainage. Great improvements in national income and health should result from planned action. Projects should, however, be as cheap as is planned consistent with efficiency so that they pay working expenses and cultivators do not have much difficulty in taking the water.

3. Tanks, ponds and bunds have for ages served the purposes of conservation of rain water and have an important place in irrigation and also in plans of soil conservation. More systematic attention requires to be paid to the rehabilitation of the existing tanks, ponds, and bunds where desirable and to the excavation of new ones.

4. The importance of suitable methods of soil management and vegetation cover for the conservation of moisture have been already discussed. In the arid and semi-arid tracts in Sind, Rajputana, etc., these methods of conservation of soil moisture assume first rate importance. Methods of 'Dry Farming' or perhaps in some tracts of 'Desert Farming' require to be worked out. At Sholapur such work is being carried out under the inspiration of the Imperial Council of Agricultural Research. A scheme is also under contemplation for Sind. But here also only a fringe of the subject has been touched. More dry farming stations require to be established in many provinces and the soil conditions during the dry period require to be studied in detail. Afforestation is not an infallible remedy in dry tracts. The creation of a suitable grass cover for pasture is sometimes equally or more important. The type of vegetation, soil management, bunding or putting of 'Tals' have however to be examined and methods require to be worked out with due cognisance of soil, climatic conditions and local needs.

Question 2: What measures have been taken in your Province for the conservation and regulation of soil moisture and with what success? To what extent could this be done by afforestation, arboriculture, suitable methods of cultivation, rotation of crops, etc., especially in rural areas and planting of trees in rural areas?

5. It is necessary to take stock of the measures which have been taken in each province for the conservation and regulation of soil moisture and the success they have achieved. Protection of forests by Inter-Provincial Flood Committee in U.P. and bunding or putting Tals round fields as practiced in Bombay and Madras have met with considerable success in conserving and regulating the soil moisture. Large scale tree planting is likely to help the process. Suitable methods of cultivation such as mulching etc. followed in dry farming methods, rotation of crops, shallow rooted followed by deep rooted crops have been found useful for conservation and utilisation of soil moisture (vide para 5). It does not seem however that this matter has so far received very great consideration.

Question 3: What is the nature and extent of damage done to soils and crops by floods in your Province? What steps have been taken to cope with them and with what result? What are your suggestions for improvements?

6. From the available information it appears that damages done to soils and crops by floods are often very severe in Assam, recent in Trichur, the United Provinces, Bengal, Bihar, and Orissa but not in Madras, Bombay or the Central Provinces. Heavy floods have not occurred in Sind after the opening of the Sukkur Barrage canals. An enquiry should be instituted in each province to ascertain the extent, nature, and periodicity of damage done by floods to soils and crops and assess their monetary value. It does not appear that systematic records are kept on a scientific basis containing information of all relevant factors. They should be available to the public and scientific workers. There cannot be a difference of opinion that fullest records should be kept. "The Inter-Provincial Flood Committee has been taking action to check floods by protection of class 1 forests in U.P." They are considered to have achieved considerable success.

7. Flood can be checked by:

(i) Conservation of Forests; (ii) Terracing hill sides to check erosion and heavy floods; (iii) Federal control or joint action by

neighbouring provinces; (iv) Strong embankments on both sides of rivers and clearing all obstructions from rivers to give them clear passage to the sea; (v) Opening canals from rivers to divert water and utilise it for agricultural purposes.

8. The steps which have already been taken to cope with floods and the results of such action should also be investigated and a report prepared for the information of the Development Board, one of whose main functions will be to consider measures for the control of floods especially in relation to soil conservation. Comprehensive schemes will require to be formulated by the Development Board at the Centre.

Question 4: How far is water-logging a menace to the agriculture of your Province? Is water-logging caused by sudden excessive rainfall, low drainage or is it due to flooding by rivers? How can the existing drainage be improved to prevent water-logging?

9. Water logging has been a serious menace to agriculture e.g., in the Bombay Deccan, places near Sind and occasionally in Surma Valley in Assam. Water logging is common in some parts of Bengal and also in low lying clay areas of C.P. It is not a serious problem in places where adequate drainage exists, e.g., Trichur. The extent and causes of water logging and remedial measures require detailed study. Water logging has resulted in a wide scale from wrong alignment of roads and railways and also of canals. In Assam a special Flood Committee has been appointed which is also investigating this problem. The reconnaissance survey is likely to give useful information. Schemes of drainage will require to be worked out in connection with the plans of soil conservation.

Question 5: Has any adverse effect of irrigation been noticed anywhere in your Province? If so, what is the nature and extent of the damage? Have any remedial measures been taken and with what success? What steps are being taken to keep watch over possible soil deterioration or total loss as a result of irrigation?

10. Except in the Punjab Irrigation Research Laboratory (and also in Sind) the suitability of soils for irrigation and the after-effects of irrigation do not appear to have been made the subject of systematic study. It is considered that irrigation had no adverse effect in some provinces, e.g., Madras. But such statements are very often not based on any scientific investigation. Some "adverse effects of irrigation have been obvious in the Bombay Deccan, round about Sind and in the Punjab, where there has been a general rise of subsoil water table. This has caused the formation of salt efflorescence on the surface of the soils which are harmful to crops. Drainage by open trenches or by deeper closed drains is being tried by the agricultural and irrigation departments and has met with considerable success." Some difficulties arising from seepage from canals in U.P. have been set right.

11. The agricultural department of every province where irrigation is of any importance should have a special section to conduct a preliminary soil survey before any project is put into operation, to keep watch over the effects of irrigation on the soil and to study associated agricultural problems, which are not so few as is often imagined to be.

PART D. SOIL FERTILITY AND CROP PRODUCTION

BY J. N. MUKHERJEE, D.Sc.

(Incorporating suggestions in a note by
Dr. D. L. Sahasrabudhe, D.Sc.)

SUMMARY

Paragraph 1: The maintenance of the productivity of the soil at its optimum level is of the utmost importance in plans of soil conservation. The factors which affect the yield of crops are enumerated.

Paragraph 2: It is definitely necessary that all problems of crop production should be treated as belonging to one subject. A crop Production Committee should be set up under the Land Development Board for the purpose of coordination and planning. The normal work and administration should of course be left to the department of agriculture.

Paragraph 3: The average yields of our major crops are very low when compared with those of countries with more scientific systems of agriculture.

Paragraph 4: There is a case for considering whether a fundamental change in the orientation of our agricultural research is necessary. The probable causes for the low yield are discussed. New varieties must be fully tested as regards their suitability for the soil types and the climatic conditions prevailing in a locality. The optimum conditions of rotation, soil management and of treatment with manures and fertilisers should be worked out with more thoroughness before they are recommended to the ryot. The soil condition, which are now at a level of minimum productivity, probably constitute the most important cause of the low acreage yield of crops. The cost of production of crops on government farms and the economic gain consequent on the application of methods recommended by the department should be worked out by competent accountants working independently of the department. It is necessary at the first instance to collate the results already obtained on manurial treatments and varietal trials. This work should be taken up jointly by the crop production and the soil conservation committees. There is great scope for studying with scientific thoroughness the problems of crop production and for improving the yield.

Paragraph 5-6: Information regarding the damage caused to crops by various factors should be collected by men trained in agriculture and in statistical methods and guided by expert statisticians who will also analyse the data. At the same time estimates of probable increase in the yield as a result of possible improvements should be carried out. The enquiry must be conducted in selected areas most conveniently in the physiographic units. The yields in government farms should be compared with those in ryot's fields. Detailed procedures can only be laid down by the experts under the Development Boards. Planning will certainly benefit from the information proposed to be collected.

Paragraph 7: Greater attention should be devoted to all aspects of soil management and in the same degree as it is now usual in other countries.

Paragraph 8: Organic matter and nitrogen must be added each year in large quantities to almost all our soils. All avail-

able sources of organic matter and of nitrogen should therefore be conserved with the greatest care. Oil seeds and cakes should be exploited inside the country so that residues where suitable may be utilized as manures. Waste of cowdung as fuel must be stopped. Practical methods of composing suitable for the cultivators require to be worked out. Conservancy systems in villages as also in towns should be examined with a view to find out how refuse can be utilised for this purpose. Mixed farming and greater cultivation of trees occupy an important place in the supply of organic matter to the soil.

Paragraph 9: Vast areas of our soils are deficient in phosphorous and the use of phosphatic fertilizers in considerable quantities is indicated. Liming of the soil is used on a very extensive scale in most other countries but very little attention has been given to it in our experimental stations. 'Minor' or 'trace' elements, which occur in very minute quantities and are of great importance to plants and their availability often depend on a number of factors. This subject requires systematic study. Physiological studies have to be correlated with soil studies and there is great scope for a large amount of experimental work. Great improvements of our agricultural practices should be possible of achievement through research.

Paragraph 10: Suitable methods of rotation and proper quantities of green manure and other forms of organic matter and farmyard manure can be relied upon to materially increase the yield.

Paragraph 11: The fertility status of our soils require to be worked out with much greater thoroughness. The reconnaissance survey recommended in part A should take up this question and work out provisional classifications.

Paragraph 12: The whole problem of manurial requirements of our soils requires more thorough and extensive experimental work. Provisional estimates of manurial and fertiliser requirements should be made by the reconnaissance survey.

Paragraph 13: Figures for quantities of fertilisers imported into India for five years and their values are given.

Paragraph 14: The fertilisers consumption in different countries in 1926 is given. The quantities have increased since then. Fertiliser consumption from 1934-35 is given in Appendix H.

Paragraph 15: Methods of intense farming must be resorted to if competition from other countries has to be withstood by the ryot. The consumption of fertilisers per year should be increased enormously. Ten times the present quantities are a low estimate of the requirements if steps suggested in this report are initiated.

Paragraph 16: The use of manures and fertilisers is small compared to the vastness of the cropped area. The use of artificial fertilisers has not achieved much popularity. Artificial fertilisers must be available locally to the ryot manufacturers or distributors should be stopped. The price of the fertilisers should be controlled by the State, which should take an active part in promoting their manufacture in the country and if need be should have a share in the capital or firms manufacturing them. The position regarding individual fertilisers is as follows: (1) Ammonium sulphate: Its consumption has gone up to 100,000 tons and more than three fourths of the quantity is being used by the ryot. A small fraction of the annual requirements of this fertiliser is available at present in India. There is some scope for increasing the output of ammonium sulphate from the concerns now

engaged in manufacturing it and more scope for starting a suitable large size manufacturing plant to meet the present and future demand in India. Serious search should be made for deposits of anhydrite and taken over by the state. It forms a key mineral. The possibilities of increasing its production and of its greater use as a fertiliser should be fully investigated. (ii) **Sodium nitrate:** It is imported into India. The possibilities of manufacture of nitric acid should be fully investigated. It is a key chemical. (iii) **Compound fertilisers:** These are still very little used in India though elsewhere they are in vogue. The possibility of manufacture of these or suitable substitutes from Indian resources should be investigated. (iv) **Superphosphate and Rock Superphosphates.** These are mostly imported from outside. The amounts used are very small compared to our requirements. All available sources of phosphatic fertilisers should be thoroughly investigated. (v) **Bone-meal:** Some attention has been paid to the question of supplying cheap bonemeal to the cultivator either from mills or by developing its production as a cottage industry. There is great scope in this direction as also for developing methods of treatment of bones which ryot might himself use. By far the larger portion of bones go unutilised. (vi) **Soils** are generally not deficient but the need for potash as a balancing fertiliser is well recognised. The prevalent opinion regarding use of potassic fertilisers for our soils is based mostly on chemical analysis or insufficient experimentation. Potassic fertilisers are however used in India for certain special crops such as tobacco. More experiments with mixed fertilisers and manures and greater progress in our agricultural practices will reveal its utility.

Paragraph 17: Liming is very little practised in India. Besides reducing the acidity of the soil, lime is also essential for the success of crop rotation. Care must, however, be taken to avoid excess of liming. It is fairly definite that a consumption of about a million tons of lime per year is a safe estimate.

Paragraph 18: Magnesium is some times required. Indian sources are the dolomite and magnesite deposits.

Paragraph 19: As yet no undesirable effect of the use of fertilizers has been noticed but they have not been used for long nor on a large scale. Attention should be directed to find by manual experiments the most suitable balanced or mixed fertiliser.

Paragraph 20: Every care should be taken to induce substantial tenants and middle class zemindars to take to the system of mixed farming. The introduction of mixed farming is of major importance in relation to measures for the conservation of the soil and for the improvement of soil fertility and human and animal nutrition.

Paragraph 21: Suitable systems of rotation must be worked out by the experimental stations. Introduction of a leguminous crop in the rotation wherever possible should be encouraged and demonstration and propaganda to impress on the cultivators the advantages of a proper rotation of crops and of following where found suitable are necessary.

**PART D. SOIL FERTILITY AND CROP PRODUCTION
BY PROF. J. N. MUKHERJEE, D.Sc.**

(Incorporating suggestions in a note by
Dr. D. L. Sahasrabudhe, D.Sc.)

Question 1: What are, in your opinion, the limiting factors regarding the yield of agricultural produce in the soils of your Province? What percentage increase in yield do you think would be possible if adequate attention were paid to all productive factors?

1. The maintenance of the productivity of the soil at its optimum level is of the utmost importance in plans of soil conservation and occupies a place in them second only to the protection of the soil against destruction. Though crop production is a subject of enquiry of another sub-committee it is considered desirable to discuss it in some detail before taking up the question of soil fertility. The yield of crops depends on or is affected by a large number of factors. The more important of these are:

- (i) climatic conditions;
- (ii) nature of the soil (including its fertility status);
- (iii) water supply;
- (iv) drainage.
- (v) soil management, i.e., tillage and other agricultural operations;
- (vi) treatment with lime, manures and fertilisers;
- (vii) system of rotation;
- (viii) variety of the crop and supply of healthy seeds;
- (ix) control of plant nutrients (soluble salts and fine colloidal matter) by erosion, or, by leaching with water;
- (x) control of weeds.

2. Excepting the climate all these factors are now more or less capable of modification or control. Advancement of science has opened up numerous possibilities and great successes have been achieved. It is definitely necessary that the problems of crop production are treated as belonging to one subject and should come under the sphere of the Land Development Boards for the purposes of coordination and planning. The normal work and administration should of course be left to the departments of agriculture.

3. The average yields of our major crops are found to be very low when compared with those of countries with more scientific systems of agriculture. There cannot be any doubt that this is a major contributory factor of our low national income and poverty. No amount of legislation and modification of tenancy laws can improve the condition of the ryot unless optimum yields are obtained from our soils and the produce utilised in industries. The following figures illustrate the present position: The average yields in lbs. per year per acre of rice, wheat, sugarcane and cotton are given below for the period 1932-36.

	Rice	Wheat	Sugarcane	Cotton
India	.. 1,208	617	26,693	88
Italy	.. 4,481	....	....	....
Japan	.. 5,592	....	....	....
Java	.. 1,323	....	118,611	....
Rumania	.. ....	714	....	....
Australia	.. ....	714	....	123
United Kingdom				

Holland	1,923	.....
Cuba	32,458	.....
Egypt	459	.....
U.S.A.	185	.....

4. While such averages do not justify our drawing sweeping conclusions they do indicate the most general features of the present position. It is apparent that there is a case for considering whether a fundamental change in the orientation of our agricultural research is necessary. This question of low yields was discussed at the last meeting of the Crops and Soils Wing of the Board of Agriculture held in Delhi in December 1939. Mr. Patel made out the point that the average yield does not show any perceptible increase from the improvements in irrigation and the introduction of better plant varieties. ("Out of 4.14 million acres of sugarcane grown in British India 3.07 million were reported to be under improved varieties. About 25 million acres were under improved crops in 1936-37".) This impression may partly result from the manner the averages are drawn up. Apart from the amount of rainfall and its distribution there are other climatic conditions which affect the growth and maturity of plants. The time taken for a crop to mature depends on a number of factors e.g. intensity of sunlight, duration of the day, temperature. Variations in climatic and soil conditions have to be taken into account in judging the averages over so large an area as the whole of India or of a province. The low average is also possibly due in part to the inclusion of the yields from marginal or discarded and deteriorated lands under these crops as a result of the increasing pressure of the population. Another important factor is that the ryot has to grow the crops which are required to meet his needs or which he considers to be profitable for getting ready money without any reference to the optimum conditions of the climate and the soil and the treatments suitable for a particular crop. It is known that under unfavourable conditions the yield of the same variety may fall to 75 per cent or even 50 per cent. It has often been found that improved varieties evolved at our experimental stations when introduced in general cultivation do not show the same increase in yield as is observed in government farms. This has been ascribed to inferior conditions of tillage and it has been suggested that "greater attention should be paid in future to the selection of varieties suitable for the inferior type of soils which constitute the major portion of soils on which crops are grown." This point of view illustrates that it is often taken for granted that the soil cannot be improved. It is a pity that the maximum yields obtained by the best cultivators are seldom recorded and compared with those of the Government Farm in the same locality. The yield in government farms with all their advantages is not always better than that obtained by the better type of cultivators. New varieties must be fully tested as regards their suitability for a soil type and the prevailing climatic conditions. And the optimum conditions of rotation, soil management and of treatment with manures and fertilisers and the probable economic gain should be worked out with more thoroughness before they are recommended to the ryot. It also appears that the production, storage and distribution of healthy seeds of proved quality, are far from being satisfactory. But considering everything it is not unsafe to draw the conclusion that the conditions of the soil, its management and

treatment remain mostly as they were, namely, at a level of minimum productivity. The soil conditions therefore probably constitute the most important cause of the low average of our crop yield. Departmental efforts have mostly been devoted to effect improvements through irrigation and introduction of better plant varieties. Soil management, soil treatment, soil microbiology, conservation of moisture, of organic matter and nitrogen and systems of rotation have not been studied with the same earnestness. The cost of production of crops and the economic gain consequent on the application of methods recommended by the departments should be worked out by competent accountants working independently of the department. On the scientific side, there are many gaps in the design of the programme and studies which require to be filled up. Much useful work has however been done and notable successes have been achieved. Also conditions vary from province to province. It is necessary in the first instance to collate the results already obtained and this should be taken up by the crop production committee working in conjunction with soil conservation committee. Sir John Russel mentions that 'three weaknesses are fairly common. The work is frequently too diffuse. In many cases the work is confined too much to the laboratory and the pot culture house; the field and growing crop should be the centre. Almost always it is restricted to the experiment station: test experiments should be carried out on other soils and at other centres not too far removed, so as to ensure that all factors coming into play are recognised'. It appears that there is great scope for studying with scientific thoroughness the problems of crop production. There is no a priori reason to assume on the basis of scientific data at present available that intensive scientific research based on well conceived and coordinated programmes, in which team work between the experts representing different branches of science is ensured, will fail to achieve for us what has been achieved elsewhere.

5. Information on the following points should be collected and systematically recorded.

(i) Variations of yield of the same crop in the same locality. The variations, including the maximum and minimum yields, are of great importance for the purpose of determining the factors which govern the yield.

(ii) The losses caused by (a) insects and pests, (b) plant disease including deficiency and soil borne diseases, (c) depredation by animals and birds, (d) floods, (e) loss of plant nutrients (soluble salts, colloidal matter and bacteria) by sheet erosion or by leaching by water and (f) weeds.

(iii) The increase in yield, if any, resulting from each of the following factors:

- (a) modifications in soil management.
- (b) introduction of systems of rotation.
- (c) introduction of better seed supply and better seed treatment.
- (e) treatments of soil by lime, manures and fertilizers.
- (f) irrigation or drainage, etc.
- (g) control of erosion and leaching.

6. The information should be collected by men trained in agriculture and in statistical methods and guided by expert statisticians who will also analyse the data. The enquiry must be

conducted in selected areas most conveniently in the physiographic units suggested earlier in this report. The yields in Government farms which are under controlled conditions should be compared with those in the ryots' fields. Detailed procedures can only be laid down by the experts under the Development Boards. Enquiries conducted on the above lines will give a workable idea of (a) the magnitude of the loss under present conditions and the contribution made towards it by different factors, (b) the probable maximum yield under present conditions, (c) the progress which has been achieved by the measures recommended by the departments for improving crop yields and (d) the gaps in our knowledge and the lines of research of major importance. Planning will certainly benefit from this information.

7. Soil management occupies an important place in the conservation of soil and its fertility. Various aspects of soil managements have been discussed in preceding parts of this report. Greater attention should be devoted to all aspects of soil management and in the same degree as it is now usual in other countries.

8. The rapid decomposition of organic matter under our climatic conditions constitutes a major factor which influences crop yields. Organic matter and nitrogen must be added each year in large quantities to almost all of our soils. The available quantity of farmyard manure is not sufficient to meet requirements and only a small portion of what is available is actually added to the soil. Organic matter and nitrogen also seem to constitute the limiting factors in determining the response to artificial fertilisers where their utility is indicated and other conditions are favourable. All available sources of organic matter and of nitrogen should therefore be conserved with the greatest care. Oil seeds and cakes should be exploited inside the country so that residues where suitable may be utilised as manure. Composting has received considerable attention but practical methods suitable for the cultivators still require to be worked out. The use of refuse matter including human excreta offers a large field to which more attention should be paid. Conservancy systems in villages as also in towns should be examined with a view to find out how refuse can be utilised for this purpose. Other sources have been discussed in part A.

9. Coming to the other factors vast areas of our soils are deficient in phosphorus and the use of phosphatic fertilisers in considerable quantities is indicated. Phosphates, lime as also magnesium, are easily leached and our soil under heavy rainfall must have for ages suffered such depletion. The results of leaching are now seen in the acid soils, the deficiencies of phosphates and limes and also perhaps in some places in usar, reh and alkaline soils. Acid soils require large amounts of phosphates as also lime. Both are necessary for healthy microbial activity and for legumes. Liming of the soil is used on a very extensive scale in most other countries but very little attention has been given to it in our experimental stations. As a result of the measures adopted for soil conservation in America, the application of lime is rapidly increasing. From 1.7 million tons in 1935 it rose to 7 million tons in 1937. It is considered by American experts that the amount should be raised to 15 millions tons per year. It is very difficult to understand what scientific argument has prevented extensive liming experiments under our conditions. Of the other nutrients, potash in Indian soils is generally considered

to be sufficient for our crops excepting tobacco; but it appears that this conclusion has not been drawn on the basis of well planned experiments. It has been realised in recent years that certain inorganic elements which occur in very minute quantities are of great importance for plant nutrition, the control of plant diseases and improving the yield. It is not yet known exactly how some of them act. They are known as 'minor' or 'trace' elements. They are also of great importance in the nutrition of animals feeding on the plants. Their availability to plants often depends on a number of complex factors which require systematic study. The deficiency diseases of plants are known to give important indications of soil conditions in relation to plant nutrition. Often physiological studies have to be correlated with soil studies and there is scope for a large amount of experimental work in this field. The interaction of the various soil factors which determine the yield of crops and plant growth are complex in character and the outline given in the preceding paragraphs will convey some idea of the complexity. Agricultural science like any other branch of science is continually attempting to improve its theories and technique with a view to obtain a fuller knowledge of its problems and continuous efforts are required for this purpose. Practice and theory have to go side by side and judging by what has already been achieved there is no reason why great improvements of our agricultural practices should not also be effected by planned research.

10. The tentative estimates of the possible increase in the yield of crops made by our collaborators vary a great deal—from 30 per cent to 100 per cent. They have emphasised the dearth of adequate information. But there is no reason why there should be no substantial increase in crop yield if the more important limiting factors are set right. Suitable methods of rotation and proper quantities of organic green manure and other forms of organic matter and farmyard manure between themselves can be relied upon to materially increase the yield. Suitable systems of rotation not only check erosion losses but also increase the yield, which is not infrequently found to be double that obtained by continued cultivation of the same crop in the same soil.

Question 2 (a). What are the main crops grown in your Province? Does the nutrient status of the soils answer their requirements satisfactorily? If not, what alternative crops and rotations do you suggest which would be more suitable for the existing soil conditions.

1. Information, though perhaps not quite accurate, regarding the main crops grown in a province and the area under each crop is available. But the nutrient or fertility status of our soil requires to be worked out with much greater thoroughness. The available information regarding the fertility status mostly consists of chemical analyses. Even these are often conspicuous by their absence for the major part of the country. Where they exist they are seldom correlated with the soil type or with plant response to treatment. The textural differentiation, prevalent in Mughal times and found in revenue records, and colour form the main basis of our soil classification! The reconnaissance survey recommended in part A should take up this question and work out provisional classification.

Question 2 (b). To what extent, do you think, the fertility of the soils could be maintained and increased by the application of manures and fertilisers? Mention the manurial requirements of the different kinds of soils of your Province and for the different crops separately.

12. General aspects of this subject have been already considered. Approximate and provisional estimates of the manurial requirements of some soils can be made on the basis of the data at present available. The following examples chosen at random would convey some idea: In the United Provinces the nitrogen requirement per acre of sugar cane is about 100 lbs., for wheat and barley about 30 lbs. and for rice about 20 lbs. In C.P. wheat and other rabi crops growing on heavy black cotton soils require 80 to 100 lbs. of ammonium sulphate and 3 to 4 tons of farmyard manure; cotton requires 2½ to 4 tons of cattle dung or 3 to 5 mds. of oil cake and 100 lbs. of ammonium sulphate; groundnut requires in addition to the organic manures 70 lbs. of potassium sulphate; and rice growing on sandy loams requires green manuring or 3 tons of cattle dung and 20 lbs. phosphoric acid. In Orissa it has been found that by growing green manures like Dhaincha, Sann hemp and manuring with oil cakes of mustard, polang and groundnut about 30 per cent to 50 per cent increase in yield might be obtained. Application of ammonium sulphate together with organic matter shows a considerable increase in the yield of rice. As already stated the whole problem requires more thorough attention and extensive experimental work. Provisional estimates of manurial and fertiliser requirements should be made by the reconnaissance survey. Several fertilisers in use in other countries do not seem to have been tried to any extent in the manurial experiments. (See Appendix HO.)

13. The following table shows the quantities of fertilisers imported into India for five years and their values.

Manure.	Quantity imported in tons					Value in rupees.				
	1933-34	1934-35	1935-36	1936-37	1937-38	1933-35	1934-35	1935-36	1936-37	1937-38
A. Nitrogenous										
Nitrate of soda	2217	3510	2714	2470	3208	2,53,751	2,76,512	2,70,803	2,36,739	2,18,91
Sulphate of ammonia.	29800	40875	46385	61238	53218	29,04,312	39,92,527	45,70,860	58,43,656	56,10,3
Others.	890	708	488	550	509	96,955	74,820	43,723	47,407	58,9
B. Potassic										
Mucera of potash.	3112	3037	3376	2064	2928	3,95,575	4,02,151	3,24,599	2,09,084	2,86,7
Others.	717	1798	1999	890	1604	92,369	1,08,488	1,21,100	74,783	1,79,9
C. Phosphatic										
Superphosphates	3000	4750	6483	6009	7405	2,17,112	3,47,155	4,67,064	3,99,713	3,67,9
Ammonium										
Phosphate.	3804	2503	5529	4122	3167	5,64,299	11,34,007	7,93,936	6,14,566	3,16,74
Other Phosphates.	2109	1116	3951	3162	3779	2,32,243	77,118	3,22,449	3,22,129	4,06,28
D. Fish Manures.										
	1007	1143	1479	2016	1783	80,885	92,746	1,12,046	1,73,313	58,23
E. Other Manures.										
	2809	1134	700	712	1726	4,24,452	1,09,922	67,122	84,309	1,63,82
Total (excluding										
oil cakes)	49546	66481	72210	83653	78425	52,41,966	67,05,504	71,14,302	80,07,722	79,66,8
Oil cakes.	9	6	5	56	29	427	739	206	4120	1008

14. The following table shows the fertiliser consumption* in different countries in 1926. The quantities have increased considerably since then. (See Appendix H).

	Nitrogen	Phos. Acid.	Potash	Total
Netherlands	.. 16.08	68.20	84.14	168.43
Germany	.. 2.68	13.95	41.37	64.99
Belgium	.. 6.19	20.72	3.91	30.37
Chile	.. 24.52	1.60	0.08	26.14
France	.. 2.00	14.77	5.90	22.68
Great Britain	.. 3.26	15.58	0.14	18.99
Japan	.. 2.77	14.75	0.01	17.54
Denmark	.. 1.55	12.74	0.32	14.62
Norway	.. 3.77	4.67	3.35	11.79
Italy	.. 0.88	9.58	0.17	10.58
United States	.. 1.01	3.20	0.91	5.13
Canada	.. 0.07	0.01	0.07	0.15
Australia	.. 0.10	3.32	0.10	3.34

15. The extremely low consumption of fertilisers in India will be apparent if one remembers that 301 million acres constitute the area at present sown in India and that the quantities given in the table in paragraph 13 include the fertilisers used in tea and coffee gardens and in the cotton and sugarcane plantations belonging to progressive corporation, most of these being heavily manured. Methods of intense farming must be resorted to if competition from other countries has to be withstood by the ryot. One can easily visualise the colossal quantities of fertilisers which will be required in addition to green manures, farmyard manures and other forms of organic matter. There is no reason why the consumption of fertiliser per year should not increase by at least ten times, and 1 million ton of lime per year should not find use in our soils with profit as a result of more definite knowledge during the next ten years.

Question 3. Mention localities known to you in which manures and fertilisers are being increasingly used in recent years. What has been the percentage increase in the yield of crops as a result of their use which cannot be traced to irrigation and other causes? Has their use produced any undesirable after-effect? If so, give details.

16. Manures and fertilisers are now being increasingly used in areas where sugarcane is grown in the plantations and to some extent in rice fields. However, it would appear from paragraph 15 that their use is small compared to the vastness of the cropped area. The use of artificial fertilisers has not achieved much popularity. The causes of this unpopularity are: (i) the poverty and ignorance of the cultivators, (ii) the recent prolonged depression of prices in agricultural produce, (iii) uncertainty of seasonal conditions, (iv) the very small margin of profit even in good years, (v) difficulties of obtaining supplies, and the last but not least (vi) the advantages of fertilisers have not been definitely demonstrated by the experimental stations and there is an impression amongst some of our agricultural chemists that they are not of much value for our lands. Artificial fertilisers

*In pounds for each acre of cropped land.

must be available locally to the ryot and at the lowest possible price. Care should be taken to see that local manufacturers or distributors do not profiteer. The price of fertilisers should be controlled by the State, which should take an active part in promoting their manufacture in the country and if need be, should have a share in the capital of firms manufacturing them. The position regarding individual fertilisers is discussed below:

(i) **Ammonium sulphate**:—Artificial fertilisers worth about a crore of rupees a year are now imported into India, of which by far the heaviest item is ammonium sulphate. According to Hendry (The Indian Farming, Vol. I P. 18, 1940) its consumption has gone up to 100,000 tons and more than three-fourths of this quantity is being used by the ryot. A small fraction of the annual requirement of this fertilisers is available at present in India consisting chiefly of about 20,000 tons of ammonium sulphate produced every year by the Sulphate of Ammonia Federation in Bengal and Bihar. In Mysore a plant has very recently been installed for production of synthetic ammonia. There is some scope for increasing the output of ammonium sulphate from the present concerns and more for starting a suitable large size manufacturing plant to meet the present and future demand in India. The difficulties lie in the matter of supply of sulphur. Assam coal may be utilised. Serious search should be made for deposits of anhydrite and taken over by the State. It forms a key mineral. The possibilities of increasing its production and of its greater use as a fertiliser should be fully investigated. Ammonium sulphate has a tendency to make the soil acid and this aspect requires to be watched with care.

(ii) **Sodium Nitrate** is another artificial fertilizer which is imported into India. A large quantity of Indian salt-petre (Potassium nitrate) is exported from India. The latter contains potassium in addition to nitrogen. While the possibilities of greater exploitation and production should be investigated its production does not appear to be capable of large expansion. The possibilities of manufacture of nitric acid should be fully investigated. It is a 'key' chemical.

(iii) **Compound fertilizers**. These are still very little used in India though elsewhere they are in vogue. Among them are amophos containing 11 per cent—16 per cent nitrogen and 48 per cent—20 per cent phosphoric acid ($P^2 O^5$) and nicifos containing 14 per cent — 18 per cent nitrogen and 41 per cent to 18 per cent phosphoric acid ($P^2 O^5$). They have an advantage in weight. The demand for these is expected to increase. The possibility of the manufacture of these or suitable substitutes from Indian resources should be investigated.

(iv) **Superphosphates and Rock Superphosphates**. These are imported in quantities from outside. As yet the amounts used are very small compared to our requirements. All available sources of phosphatic fertilizers must be thoroughly investigated. Natural phosphates are found in Madras and Bihar. These, as have been recorded by the Royal Commission on Agriculture in India, do not offer much possibility of economic use. The matter should however be freshly examined.

(v) **Bonemeal**. Its importance as a phosphatic fertilizer is firmly realised. Only a small fraction of the bones is exported in various forms, while the major portion remains unutilized. Bones which are used in the form of bonemeal as manure forms but a very small fraction of the amount available and are obtained chiefly from bonemills, a number of which exist chiefly in

Bombay, Madras, Bengal and the United Provinces. They manufacture either bonemeal or crushed bones. Bonemeal available from bonemills is rather costly to cultivators and attention has been paid to the question of supplying cheap bone-meal to the cultivator by developing its production as a cottage industry. There is great scope in this direction as also for developing methods of treatment of bones which the ryot might himself use. Bones contain besides lime and phosphate a certain amount of nitrogenous organic matter. We can ill afford to allow so large quantities of bones to remain unutilised.

(vi) Indian soils are generally not considered to be deficient in potash mostly on the basis of ordinary chemical analyses or insufficient experimentation. Soils all the world over generally speaking contain potash in fair amounts. But all the same potassic fertilisers have been found useful and economic in many cases and the total quantities applied to the field in the more advanced countries are quite large. Potassic fertilizers are however used in India for certain special crops such as tobacco. More experiments with mixed fertilisers and manures and greater progress in our agricultural practices will reveal its utility, specially in combination with nitrogenous and phosphatic fertilizers. It has in a sense a balancing effect in such conditions. All sources of potassic fertilisers should be investigated. The United States is gradually making itself free from outside supply of potash and its use has greatly increased as a result of the measures adopted for soil conservation.

17. Liming is very little practised in India. The need of liming in acid soils has been already referred to. Besides reducing the acidity of the soil, lime also helps in the proper utilisation and effectiveness of other manures. It is also essential for the success of crop rotations. Speaking roughly on an average about 2 tons of lime are required as lime stone per acre or about 1 ton in case hydrated lime is applied. Lime is generally applied once in ten to twelve years. Care must be taken to avoid excess of liming. It is fairly definite that liming will be found useful and a consumption of about a million tons of lime per year is a safe estimate.

18. Magnesium is sometimes required. Indian sources are the dolomite and magnesite deposits e.g., in Mysore.

19. From the data available at present it appears that as yet no undesirable effect of the use of fertilizers has been noticed. This is probably due to the fact that the application of fertilisers and manures has not been heavy or extensive and has not continued for a sufficient length of time. Attention should be directed to find by manual experiments the most suitable balanced or mixed fertilizers.

Question 4. What is the extent of mixed farming in your province? Do you advocate it? If so, how would you improve the present position?

20. The system of mixed farming is not prevalent on a wide scale in India and there is great scope for improvement. Contributory causes are, the very small size of the average holding and its subdivision. Mixed farms opened in some parts of the country have been fairly successful. In order to increase the soil fertility, to utilize the time of the ryot to the fullest possible extent, and generally to better his condition he should be

encouraged to take up certain allied branches of farming such as dairying, stock raising and poultry. It has been advocated that every care should be taken to induce the substantial tenants and middle class zamindars to take to the system of mixed farming. The introduction of mixed farming is of major importance in relation to measures for the conservation of the soil and for the improvement of soil fertility and human and animal nutrition.

Question 5. Is fallowing and rotation of crops practised in your Province? If so, what has been its effect on soil productivity? Do you advocate them?

21. It appears that fallowing is not practised with a view to improve the soil. Generally speaking the ryot does not seem to understand the advantages of fallowing or systems of rotation of crops. The cultivators are inclined to exploit their land to the fullest possible limit in their anxiety to get a quick return. Insufficient attention to rotations has led and will lead to a great decrease in soil fertility. The rotations of crops now practised are not always of the desired type. Suitable systems of rotation must be worked out by the Experimental Stations. Introduction of a leguminous crop in the rotation wherever possible should be encouraged and demonstration and propaganda to impress on the cultivators the advantages of a proper rotation of crops and of fallowing where found suitable are necessary.

Appendix "H"

Fertiliser consumption in 1000 metric tons in different countries in 1935 (International Year Book of Agricultural Statistics, Rome 1937. pp. 966-973)

Countries.	Area of arable land in 1000 hectares** in 1935	Nitrate of Soda	Sulfate of Ammonia	Nitrate of Ammonia	Nitrate of Lime	Calcium Cyanamide	Super-Phosphate of Lime	Natural Phosphates	Potash Fertilisers.	Basic slag	Sulphate of Copper.
Netherlands	931	46.1a	1.9b	1.3b	21.4*b	13.6a	183.9a	--	442.2a	423.3a	3.3a
Germany	19396	71.4*a	558.0*a	1009.5*a	--	551.9*a	1130.9*a	--	775.4*a	2350.0*a	--
Belgium	1084	53.8b	144.0a	--	1.7b	14.0b	136.0*a	--	243.5a	--	--
Canada	23120	3.9b	11.4	--	0.3b	1.5a	50.9b	--	3.9	5.6b	2.9*
France	21386	178.8b	280.0b	--	92.0b	35.0b	1070.0b	18.0a	152.1b	545.0a	102.0a
Great Britain	5329	36.1a	158.6a	--	4.7a	2.9a	377.0b	7.2	192.8a	235.7a	--
Japan	6009	36.9a	212.6a	--	--	155.6a	1151.0a	--	84.1a	--	--
Denmark	2663	45.7a	38.7b	--	95.5a	2.2a	352.0a	--	73.8a	0.5b	--
Norway**	824	--	0.1*	--	31.3a	4.0a	65.9a	--	15.3a	2.6b	--
United States	137333	--	395.8b	--	21.7a	101.8a	747.7a	33.9a	361.6a	--	10.0
Australia	11922	4.1a	31.0a	--	0.4a	0.4a	224.0a	--	19.9a	--	0.3

* for 1934

** 1 hectare 2.47 acres.

(a) Consumption increasing.

(b) Consumption decreasing.

PART E: FOREST**(Summary of Recommendations)**

(1) Forestry should be judged by the long run financial results rather than the immediate surplus (para 15).

(2) Forests must be preserved as a National heritage (para 15).

(3) The men and money necessary for silvicultural research should be provided.

(4) In provinces where there is no organised working plans branch, the possibility of creating one should be examined. While the intensity of management should not be in advance of the stage of progress of the forest, it is essential that the level of working plans be kept up to the state of progress of the forest, and this is unlikely to happen without a properly organised branch (para 15).

(5) While the general position is eminently satisfactory in Government forests it is unsatisfactory in most private forests. The whole question of the management of private forests should be investigated and adequate management should be insisted upon (para 17).

(6) Methods to prevent erosion must vary with the problem and the problem must be examined locally. Measures recommended are

Control of grazing.

Control of fire.

Contour trenching, gully plugging etc.

Generally better land management.

(paras 19-21)

(7) There is great scope for an increase of forest area in most provinces. Most provinces have less than 20 per cent of their area under forest. This figure of 20 per cent may be considered as normal. Where it is below this, steps should be taken to bring it up to this. Even where the percentage is correct, the distribution is often faulty.

The following methods are suggested and have actually been adopted in certain provinces:—

(a) A proper classification of "Waste" land to be made to find what is available for forests. It should be classified as

(i) cultural waste.

(ii) uncultural waste.

(para 26)

(b) Cultural lands should be afforested (para 26).

(c) Uncultural lands will usually produce far more fodder than they do produce if the grazing is controlled (up to about 5 times the uncontrolled Production) (para 26).

(d) Cultural lands belonging to Government should be afforested under the Forest Department—taungya is usually the easiest method. Cultural Government land will include waste land, roadsides, canal banks, etc. etc. (para 28).

(e) Owners of other culturable waste land should be encouraged to afforest it. Government's part should be to give expert advice, free tree seeds etc. (para 28).

(f) Owners should be encouraged to manage mango baghs properly. They often produce far less than they might (para 28).

- (g) The proper management of hedge row trees should be encouraged. (para 28).

PART E.

FORESTS

General. As certain questions under Part E overlap questions in other parts of the "Soil Conservation and Afforestation" questionnaire (e.g. E. 3 and 4 overlap B1 and would perhaps fall more suitably under part E), no attempt has been made to write this out in a form for publication. This is an attempt to give the information available from the answers (and other sources) in such a way that the final compiler can work with this summary in the main, and will only need to turn to the original answers to amplify any doubtful detail.

2. No replies on this part of the questionnaire have been received from the Punjab, Bengal, Assam, Madras or any Indian State except Baroda. Considering this means a lack of information this question loses much of its value.

Question 1.

Mention the different types of forests found in your Province and give their total area. What proportion of the total forest area is owned by the State and private owners respectively?

3. The chief types of forest with their general distribution but without the area occupied by each are given below:

Tropical wet evergreen forest. Rainfall over 100 inches. Western Ghats of Bombay and Madras, a strip southwest from Upper Assam through Cachar and southwards through the Chittagong Hill tracts and along the Arakan coast. Evergreen, Dipterocarps, etc.

Tropical Semi-evergreen forest. Usually adjoins the tropical evergreen forming a transition between it and the Moist Deciduous. Locally in the Western Ghats, widespread in Assam and the lower slopes of the Eastern Himalayas. Dipterocarps and deciduous species in the canopy.

Tropical Moist-deciduous forest. Rainfall 60 in.—80 in. and four to six months dry season. The most characteristic forest of India, sometimes called Monsoon forest a strip along the foot of the Himalayas, a strip along the east of the Western Ghats and a large block round Chota Nagpur.

The northern half includes the valuable moist sal forests and the southern half the valuable moist teak forests.

Open savannah forest occurs scattered throughout.

Tropical dry deciduous forest. Rainfall 40 in.—50 in. and about 6 months dry season. Occurs in a wide irregular strip from the foot of the Himalayas to Cape Comorin bounded on the north by the Himalayas, on the North-West by the Sind Desert, on the South-West by the Western Ghats and on the east by the wetter Bengal forests. Sal and teak are typical but are not found everywhere and are much inferior to that found in the tropical moist deciduous forest.

Tropical thorn forest. Rainfall 10 in.—30 in. A big strip in the Indus basin in South Punjab and Rajputana and Sind, and large areas in the Upper Gangetic plain and the Deccan Plateau Acacias, Prosopis etc.

Tropical dry evergreen forest. A small area on the Carnatic coast. Small-leaved thorny species.

Sub-tropical wet hill forests. Lower slopes of the Himalayas in Bengal and Assam and locally in Khasis, Mahabeleshwar and Nilgiri Hills.

Sub-tropical pine forests. The chir pine forests between 3000' and 6000' in the Central and Western Himalayas and other pines in the Khasia hills.

Sub-tropical dry evergreen forests. Only a small patch in the north-west corner on the higher reaches on the Indus and its tributaries. Thorny Species.

Wet temperate forests. Eastern Himalayas between 6,000 feet and 9500 ft. and the tops of the hills in South India. Evergreens, *Castanopsis* *Betula* etc.

Moist temperate forests. Inner ranges of the Central and Western Himalayas with rainfall below 40 in. and between 5000 ft. and 10000 ft. Conifers and Oaks, Deodar, Blue Pine, Spruce, Fir and *Tsuga*.

Dry Temperate forests. The inner ranges of the Himalayas. Deodar Pine Juniper and most broad-leaved European genera.

Alpine forests. In the Himalayas over 10000 ft. High level fir, birch, rhododendron etc.

4. The irrigated riverain forests of Sind perhaps deserve special mention. They lie in the alluvial plain of Indus from the Punjab frontier to within 30 miles of the Delta. They cover some 1155 square miles and consist mostly of babul (*Acacia, aranica*), kandi (*Prosopis spicigera*), Ive (*Tamarix spp.*) and populous *euphratica*.

5. It would have been interesting if figures of area had been submitted of the principal species as was done by the United Provinces which classified its 8,064 square miles of Government forest as

Sal	..	..	..	..	1697 sq. miles.
Chir	..	..	..	..	1093 " "
Deodar, Spruce and Fir					91 " "
Oak (Class II of Kumaun and Chakrata)					146 " "
Oak (Class I of Kumaun)	..	..	..	..	1900 " "
Hill Miscellaneous					1048 " "
Plains miscellaneous and grass					1717 " "
Bundelkhand miscellaneous and grass lands					308 " "
Canal plantations and afforestations	..				64 " "
					<hr/>
					TOTAL 8064 " "
					<hr/>

It is possible these areas may have been given in the answers to A 1, which I have not seen. Whether they are or not, an attempt will be made to collect these figures before the final report is issued.

6. Another classification which might be made is given below, and at the same time, it answers the second part of the question about ownership. The figures are extremely rough and those for Assam and Baluchistan are not given in detail. Taking them for what they are worth and excluding Assam and Baluchistan, it will be seen that of the total, 63 per cent is owned by the State and 37 per cent is privately owned.

Question 2.

Do you consider that the methods adopted by the Forest Department and private owners for the maintenance of forests

need revision? If so, indicate the directions in which such revision is desirable.

7. The replies are unanimous about the general mismanagement and often ultimate destruction of practically all private forests.

8. Opinion is almost equally unanimous that the State forests are scientifically managed in so far as policy, knowledge and funds permit. Most provinces manage their forests under properly drawn up and sanctioned working plans, which are kept up to date by periodical revisions; several have a definite working plans branch, though it is perhaps to be regretted that the special working plans branch has recently been abolished in the Central Provinces, and all, by one means or another, aim at keeping in touch with the latest forest research developments in India and endeavour to apply them in practice through their working plans.

9. For the proper needs of a country 20 per cent is usually reckoned the correct amount of forest. Less than 3 per cent of Bihar is under forest managed by government, under 7 per cent in the United Provinces.

Excluding small places like Coorg and the Andamans, only Assam has more than 20 per cent, while Bombay and the Central Provinces have 17 per cent and 20 per cent respectively. Madras is the next best with 15 per cent and the average of the whole of India is only 12 per cent. Apart from the small percentage the forests are often badly distributed. Thus, in the United Provinces, of the total of over 8,000 square miles shown in para 6, some 80 per cent is in the Himalayas or just at the foot of them, and even of the 20 per cent which might be considered to be in the plains, all except 5 per cent is within 30 or 40 miles of the hills and that 5 per cent on the extreme southern border of the Province.

10. There is no doubt that much improvement is possible before Indian forests produce what they should produce. The past history of the State forests has followed the same broad lines everywhere though in some provinces the general destruction had gone further than in others, as shown by the figures in para 9.

When the forest departments in the various provinces were created, they took over ruined areas which they have been opening up and protecting for the last 70 years. But it has been a 70 years fight often against prejudice to appreciate the value of their forests, so at first they offered opposition. India has only repeated the history of most other countries.

11. The immense increase in productivity from 1869 to the present day may be gauged by the fact that the average yearly net revenue at that time was just over Rs. 12 lakhs, while now-a-days it is over Rs. 75 lakhs. In addition to this, it is estimated that some 70 lakhs of rupees worth produce are given away free or at reduced rates and incidentally grazing is provided for some 1 and 1½ crores of animals.

12. There is still, however, a very long way to go. Taking only Government forest as merchantable, dedicated for timber production and accessible (which is the only figure that can be taken) and assuming that the free produce is revenue (as it is), even so the average surplus is only 9 annas per acre per annum. Of course, large areas even of the area here included is and always will be forest only in name and large areas are of such inferior material that they are hardly exploitable, but there is,

at any rate, one forest in India giving a surplus of over 10 rupees per acre per annum, so that, making every allowance, it is certain that there are still immense possibilities for increase.

13. But forestry is a slow business. It takes anything from 40 to 150 years or more to grow a forest, and an understocked forest often has to wither again and lose all increment to date or be kept perhaps for 50 years, give a low yield and then start again. Experiments seldom take less than 5 years to complete, often take 10 to 15 years, and still be incomplete after 30 years e.g. experiments to produce and grow sal seedlings naturally from mother trees at the will of the forester.

14. In government forests, therefore, the only recommendations to make are not to judge the success of forestry by immediate surplus but rather to take the long run financial result to provide men and money for silvicultural research, remembering that results must be slow in appearing, to remember that forests are a national heritage and are not merely preserves of those living nearer their borders, to insist that as a national heritage they must be managed under properly drawn up and properly sanctioned working plans, and above all to remember that in most civilised countries forest policy is entirely divorced from party politics.

15. The recommendations to improve the management of private forests are unanimous in principle though they differ somewhat in detail. No private owner should be allowed to destroy his forest if such destruction endangers the general security and well-being of the community at large. In fact, over large areas private forests have already been destroyed and, unless something is soon done, the rest will go. It takes an hour to cut down a tree but a century to grow one. Under chapter V of the Indian Forest Act XVI of 1927, the State has legal powers to compel an owner to manage his forests properly but little use has been made of these powers.

This power is being implemented by legislative action in several provinces, e.g., The Punjab, United Provinces, Bihar and Bengal.

16. It is recommended that each province investigate the whole question of private forests and, if necessary, make use of existing legislation or enact legislation to ensure better management of private forests which are at present a danger to the community in general.

Question 3.

What are your views regarding the adoption of a long term policy of afforestation of the areas denuded of forests in your province, mentioning particularly the schemes of this nature already in operation.

17. Answers to this have varied according to the way the question has been taken. There is a general agreement that watersheds, headwaters of rivers, ravine country etc. should be properly managed to prevent run off.

But more generally the answers have been made from the general standpoint of the amount of existing forests. Thus the Central Provinces consider they have enough area of forest and advocate preservation of existing forests—both State and private, while Bihar and the United Provinces discuss, in addition, the increase of the total area by afforestation. As so many of the

solutions offered under Question 5, I propose to give a combined answer under that question.

Question 4.

To what extent is afforestation, control of grazing or formation of grass reserves likely to prevent erosion of steep hill sides in these areas?

18. As might be expected the answers are unanimous that all or any of the above methods will help in preventing erosion of steep hill sides, but the extent to which it can be done will vary from place to place and each actual problem must be studied on the spot.

In many places control of grazing would be sufficient to ease or any of the above methods will help in preventing much of the erosion. It would allow a heavier crop of grass to grow wherever the soil was still sufficiently fertile and the effective rainfall adequate, it would encourage the existing scrub and tree growth (Etawah ravines), and such control is strongly advocated by the Bihar, Orissa, the United Provinces and the Central Provinces.

19. Where things have gone further, other methods must be adopted. These may be contour trenching, gully plugging and subsequent afforestation (Punjab and formerly Etawah in the United Provinces) or the Italian "Gradoni system".

20. Possibly the only final solution to this grazing problem is continued propaganda. Fewer and better cattle, more stall feeding, more cultivated fodder crops and green leaf fodder, the substitution of grass cutting for grazing, periodic, rotational and deferred grazing, and control of grazing incidence are all important, but it is a long and difficult task to change the habits of the peasants.

It is a fact in the United Provinces that the finest cattle are found in districts like Meerut where there are a minimum of grazing grounds and the worst cattle in districts like Jhansi where the grazing grounds are at a maximum.

Question 5.

Is there scope for planting village forests to supply both fuel fodder and grazing for the villagers? How and by what agency should such areas be managed?

21. Reference should be made to question 3. If "denuded of forests" in that question, means what most replies have taken it to mean, namely, uncultivated lands which are not now forest but which were or could be forest, then the whole question of their afforestation is bound up with this question of village forests. Village forests would be merely one of the agencies for creating and managing forests on the existing waste or other land.

22. Even where figures are available they are likely to be of little use because the classification was not originally made for the same object as the National Planning Committee has in view.

For example, in the United Provinces there are rather more than 100 sq. miles classified as "Fruit orchards". These presumably include mango baghs and might, therefore, be omitted from any calculation of area available for afforestation. But, in fact, the vast majority of the mango baghs are mismanaged and long past their prime and, with proper management, could materially contribute to the economy of the province.

Again, in the United Provinces, there are nearly 3,000 sq. miles occupied by sites, roads and buildings and the whole of this might be omitted from any area available for afforestation. Yet, in fact, the proper management of roadside trees could also help quite considerably in the economy of the province.

Conversely, again in the United Provinces, over 13,000 sq. miles are shown as "cultural waste" and this figure is almost certainly too high.

23. Outstanding points connected with the lack of forests within easy distance of the most populous districts are the enormous waste of the only source of cheap manure by burning cowdung, called attention to by Dr. Voelcher as long ago as 1893, and again dealt with by the Royal Commission on Agriculture in 1928; the low standard of village dwellings largely because there is no cheap wood available and the high price of forest produce.

It is no use trying to transport the forest material to the plains. Fuel can never be carried cheaply enough to compete with cowdung. The only solution to this problem is to grow forests in the plains near the village.

24. Apart from actual forest produce, bare land is an identical source of erosion. This may not always attain the obvious form of gully and ravine formation, but a little observation on any journey in the plains will betray the presence of erosion by the stilt-like roots of so many trees. This insidious sheet erosion whether caused by water or wind, reduces fertility far more than is realised. In the course of comparatively few years it can remove fantastic figures in tons per acre of fertile soil, permitting floods, silting rivers and generally lowering the fertility of the land.

This question of bare lands and overgrazing, consequent loss of fertility followed by erosion, and the resultant floods and silting up of rivers is perhaps the greatest real problem facing India to-day. India has no wish to let erosion cause its downfall as it caused "the downfall of former civilisations and empires whose ruined cities now lie amid barren wastes that once were the world's most fertile lands". The Yellow River in China transports an annual load of 2500 million tons of soil and I wonder what the Ganges carries away.

25. The remedy for all this is better management of all uncultivated land, mango baghs, private forests and road sides and possibly even setting aside a small proportion of existing cultivation for village plantations. These lands are either

- (a) Culturable
- (b) Unculturable.

Culturable lands should be afforested, usually by taungya, while unculturable lands in the plains can still often produce far more fodder than in their present overgrazed state, and even the worst usar with controlled grazing can produce some 12 maunds more than with uncontrolled grazing.

26. What should be the agency for this? The agency must vary considerably with the land and the problem, and, in fact, the agency is often the crux of the problem. The most suitable agency is the owner.

27. On culturable land where government is the owner e.g. for Government waste land, government roadsides etc. Government should do the work usually through its Forest Department. Tenants should be encouraged to create plantations on a small part of their holding, Zamindars should do the same on old baghs

or on part of their "sir" land. Here Government's part should be propaganda, expert advice, free tree seeds or plants etc.

Where common land exists the village community should be encouraged to do the work.

On culturable land the cheapest and best methods of raising the plantations is usually taungya.

28. On culturable land the agency should also be the owner, but here the principal work is to control grazing and therefore the co-operation of the village community is essential.

Government might also take action under Section 38 of the Indian Forest Act XVI of 1927, for demonstration.

District or village authorities might also be set up with legal powers under a special Act

29. A good deal is being done already in parts of India. The problem is very urgent in the United Provinces and there the Usar Committee are dealing with waste lands in general; the Inter-provincial Flood Committee (Bengal, Bihar and the United Provinces) are investigating the general question of Ganges floods and erosion, the Forest Development Officer is giving advice on plantations to Zamindars, the Forest Department have taken over the roadside avenues in the Cawnpore district as an experiment and have made a small working plan for them, and the Forest Department manage a number of Canal plantations under the Irrigation Department.

The work in that province will expand considerably and a vast amount will be in the form of village forests and better management of mango baghs where Government will give expert advice and help.

PART F.
FOREST PRODUCE
BY
Mr. L. R. SABHARWAL, I.F.S.
Summary of recommendations

1. Improvement in the growing stock.

Much has been accomplished already but there is still room for considerable improvement. It is therefore necessary, if we want to progress further, that more funds should be allotted to silvicultural research than it has been the case hitherto.

2. Paper industry.

The production of Indian mills in the past has been confined to writing and printing papers only. The consumption of newsprints in 1935-36 was 34,328 tons; this type of paper is not produced in India at present. The consumption of packing and wrapping papers, including Kraft papers, was 77,857 tons in 1935-36; the whole of this tonnage is imported from abroad. As against 28,175 tons of strawboards imported in 1935-36 only about 4,000 tons were produced in India. The value of annual cheap classes of papers and board alone comes to about 3 crores of rupees.

A well organised plan and intensive research are needed to exploit the natural resources and render the country self-sufficient with regard to her requirements of a commodity like paper, of vital importance.

The development of this industry depends to a large extent on the possibility of producing mechanical pulp on a commercial scale.

3. Plywood and veneers.

India is lamentably backward in these industries. In more advanced countries, tremendous strides have been made within the last few years in these spheres. The total value of plywood tea chests imported into India in 1935-36 was nearly Rs. 53,00,000.

The possibilities of establishing plywood and veneer factories in India should be explored.

4. Textile machinery parts, tool-handles, matches, pencils, etc.

The value of foreign woods and manufactured wood articles (excluding teak, sandal, and cabinet wares) in 1935-36 was Rs. 18,37,785 and Rs. 25,60,442 respectively.

India can supply substitutes for several foreign imported woods, but not for all. The important factors are (1) seasoning and (2) selection of fault-free material which is up to the standard of the imported woods.

5. Preservative treatment and seasoning of timbers.

In the past, Indian woods have suffered on account of these not being durable and able to stand up to the ravages of termites and fungi. Wood preservation in other countries has made great advances in recent years, and is now looked upon in those countries as one of the greatest assets of timber exploitation.

Once the perishable woods, of which there are hundreds in India, can be made durable by treating them with a suitable preservative the Indian woods can be exploited more intensively for constructional purposes as well as for railway sleepers.

6. Improved methods of extraction and exploitation.

There are large tracts of forest in India which are not served with suitable communications, and which are not therefore as valuable as they might have been. The necessity for more and better roads and the improvement of waterways for floatable produce is emphasized. The introduction of charcoal and wood as motor fuel in internal combustion engines for generating cheap power is recommended.

7. Development of minor forest products.

The revenue to Government in 1937-38 from royalty from this source was Rs. 79 lakhs. This source of revenue could be increased if more attention was paid to the development of minor forest products.

8. Development of Forest Cottage industries.

It has been recommended that the possibilities of starting forest cottage industries may be explored in suitable localities.

9. Lac.

The increased use of shellac depends upon the development of the following industries:—

Gramophone records, Electrical insulating materials, Protective and decorative finishes, Plastic moulding etc., etc.

10. Capacity of forests to furnish employment.

The census returns of 1931 show that directly or indirectly the forests offer employment to about 2,000,000 people in British India alone.

11. Causes which have hindered the development of forest wealth of India have been examined and remedies suggested. The Forest Research Institute at Dehra Dun has been carrying on research for many years in the process of growing trees and making profitable use of timber and other produce of forests and it has produced abundant results of acknowledged economic value. The report emphasizes the necessity for co-operation between this Institute and Industry so that the forest resources may be fully developed.

12. Suggestions for reducing the imports of teak have been made.

PART F.

FOREST PRODUCE.

BY

MR. L. R. SABHARWAL, I.F.S.

1. What are the most important forest products in your Province? What industries, (e.g. paper pulp, artificial silk, cellulose products, plywood and veneers, distillation products, resin, tanning extracts, etc.) and occupations are based on them? What scope is there for their further development, or for new industries, to increase production and reduce unemployment? What causes have hindered the development of such industries up to now?

This is a very large subject and in order to give a description of hundreds of forest products which are found in India, to describe the existing forest industries and to make suggestions for the new ones which might be started will fill a large volume. This note therefore is only a very brief account of some of the new lines of utilisation. It would not have been possible to deal with this subject without consulting valuable literature issued from the Forest Research Institute, Dehra Dun, on the subject and which has been made use of freely and extensively.

(a) The most important forest products are—

- (i) Timber,
 - (ii) Pit-props,
 - (iii) Wooden poles for electric transmission.
 - (iv) Bamboos,
 - (v) Baib or sabai grass,
 - (vi) Pine (*Pinus longifolia*) resin,
 - (vii) Katha from (*Acacia catechu*),
 - (viii) Lac,
 - (ix) Myrabolans (*Terminalia chebula*),
 - (x) Sonari bark (*Cassia fistula*), Tanning.
 - (xi) Babul bark (*Acacia arabica*),
- and (xii) a large number of other products which go under the name of "minor forest produce" and dealt with in the report further on.

Trade in forest products makes a large contribution to the wealth of the country. The increase of revenue from the forests was continuous until the world economic crisis began in 1930. Revenue in the Forest Department has increased from 125 lakhs in 1899-1900 to 1903-04 to 383 lakhs in 1924-25 to 1928-29. Since then it has fallen and now stands at about 301 lakhs (1937-38). These figures take no account of large quantities of forest produce provided free of charge or at concession rate to the villagers; such supplies including timber, firewood, grass, grazing, bamboos, etc., etc. are often irreplaceable necessities of life in the vicinities of the forests. Some conception of their local importance is afforded by the fact that the estimated value of free grazing and timbers and other forest produce removed free of charge was about 84 lakhs of rupees. Forests provide grazing for over 6,000,000 cattle—free of charge. Very little forest is closed to grazing and in times of scarcity, supplies of fodder from the forest are invaluable.

Revenue.

Year	Major forest produce	Minor forest produce	Miscellaneous	Expenditure.	Surplus
	Rs.	Rs.	Rs.	Rs.	Rs.
1927-28	28344447	3337957	7219064	2,68,46,796	1,20,54,672
1928-29	28851343	3809264	7048395	2,66,36,498	1,30,72,502
1929-30	29634411	3863936	7457910	2,85,26,918	1,24,29,339
1930-31	22977499	2760658	5879852	2,76,44,565	39,73,444
1931-32	18713804	3904002	5593952	2,34,22,614	47,89,144
1932-33	19060823	3624341	5482997	2,19,32,167	62,35,994
1933-34	17012325	3462519	5806315	2,11,02,391	51,78,768
1934-35	18040254	3493490	5697631	2,09,75,966	62,55,409
1935-36	19739976	2877303	5894624	2,10,79,231	74,32,672
1936-37	19725626	2759699	5875401	2,24,56,176	59,04,550

N.B. Actually different forest areas show wide differences.

- (b) The following important industries and occupations are based on the above products:—
- (a) Timber
- (i) Building industry,
 - (ii) Railway and tramway sleepers,
 - (iii) Highway bridges,
 - (iv) Matches,
 - (v) Packing cases—Plywood & Veneers,
 - (vi) Transport vehicles (bullock carts, horse carts of various kinds and railway carriages),
 - (vii) Furniture,
 - (viii) Boats and dugouts,
 - (ix) Agricultural implements,
 - (x) Tool handles, toys, textile machinery parts such as bobbins, shuttles, etc.,
 - (xi) Wood distillation (No information available),
 - (xii) Sandalwood carving,
 - (xiii) Bamboo pulp for paper making, etc., etc.
- (c) The possibilities of developing and increasing the forest resources of India are examined below:—
- (1) Improvements in the growing stock,
 - (2) Wood pulp manufacture (Paper Industry),
 - (3) Plywood and veneers,
 - (4) Tool handles and textile machinery parts etc.,
 - (5) Preservative treatment and seasoning of timbers,
 - (5) (a) Railway sleepers,
 - (6) Wood and charcoal gas,
 - (7) Improved methods of extraction and exploitation,
 - (8) Development of minor forest products,
 - (8) (a) Pine Resin
 - (9) Development of Forest Cottage Industries,
 - (10) Lac,
 - (11) Tanning,
 - (12) Artificial silk industry.

(1) Improvement in the Growing stock.

The productivity of the forests is generally low in many cases compared with what the land might be producing. We could hardly expect anything better from the forests which had been heavily worked and were semi-ruined when the Forest Department took them over. But with careful tending many of them have now been converted into vigorous crops and the yield in some cases has gone up by 10 per cent—20 per cent and even more. Much however still remains to be done. It is therefore necessary, if we want to progress further that the required knowledge be acquired through properly organised silvicultural research.

We claim that silvicultural research is one of the most paying investments that can be made. It is only from the knowledge gained thereby that the Forest Department can judge whether the total legitimate production is being realised and if it is not how to attain it. It must however be appreciated that these returns on a small expenditure on research, will not be obtained in a year. The full value of returns will not be felt for several years. It is however our duty to posterity to ensure that the forests as a whole are brought to a status of maximum productivity as quickly as possible, when the expenditure on research will be re-paid hundred-fold.

(2) Paper Industry

In view of the enormous wealth of the country which can be utilised for paper making and of the 'Protection' extended to the industry by Government since 1925, the dependence of the country to such a large extent on foreign imports would appear to be anomalous. Paper is indispensable at all times. It is, therefore, of national importance that this country should, as far as possible, be self-sufficient with regard to her requirements of paper.

The paper industry may be dealt with under the following heads :

- | | |
|---|-------------------------------------|
| (i) Writing and printing papers, | (iv) Strawboards, cardboards, etc., |
| (ii) Cheap printing papers including newsprints, | (v) Insulation boards. |
| (iii) Packing and wrapping papers, including kraft, | |

Statement showing Imports and the Quantities of various kinds of Paper etc. made in India.

Item No.	Description of Papers and Boards.	Imports		Made in India.		Total Consumption.	
		Tons 1925-26	Tons 1935-36	Tons 1925-26	Tons 1935-36	Tons 1925-26	Tons 1935-36
1.	Writings & Printings including budami, envelopes, etc.						
	a) Protected	8,637	12,095				
	b) Not protected (mostly printing papers)	10,490	11,654				
		19,127	23,749	25,205	43,530	44,300	67,279
2	Newsprints	13,672	34,328	-	-	13,672	54,308
3	Kraft	--	9,544	-	-	-	9,544
4	Packings & Wrappings	8,805	110,730	Included in item No. 6.		8,805	10,730
5	Old Newspapers	28,268	57,583	-	-	28,268	57,583
6	Other kinds	2,382	3,846	3,018	2,181	5,400	6,027
7	Paper manufacture.	1,442	2,019	-	-	1,442	2,019
8	Straw-boards	10,935	15,090	-	4,000	10,935	19,090
9	Card Boards, Mill-boards, Paste-boards, etc.	2,358	9,085	-	-	2,358	9,085
10	Manufacture of Boards.	528	671	-	-	528	671
	Total:-	87,415	166,645	28,221	49,711	115,636	216,356

An examination of the table brings out the following interesting facts.

(a) That the production of Indian Mills in the past has been confined mainly to writing and printing papers. In 1935-36 these mills supplied almost 65 per cent of the country's requirements of these papers.

(b) That the annual consumption of newsprints (papers for printing newspapers) increased from 13,672 tons in 1925-26 to 34,328 tons in 1935-36, i.e. by nearly 251 per cent. This type of paper is produced in India only in very small quantities.

(c) That the total yearly consumption of packing and wrapping papers, including kraft papers, increased from 37,073 tons in 1925-26 to 77,857 tons in 1935-36, i.e. by about 210 per cent. The whole of the above tonnage is imported from abroad and about $\frac{2}{3}$ of it consists of printed unused newspapers.

(d) That the annual consumption of straw-boards, card-boards, etc., increased from 13,191 tons in 1925-26 to 28,175 tons in 1935-36, i.e. by about 221 per cent. The share of the Indian production of these in 1935-36 was about 4,000 tons, or only about 14 per cent of the total.

(e) That while the Indian production in 1935-36 was 176 per cent of that in 1925-26, it was only 23 per cent of the total consumption in 1935-36, as compared with 24.4 per cent in 1925-26.

(i) Writing and Printing Papers.

It will be seen from the table that the production of these papers by the Indian mills increased in one decade from 25,203 tons in 1925-26 to 43,530 tons in 1935-36. Prior to 1925, the industry depended mainly on sabai or bhabar grass (*Ischoemum angustifolium*) as its staple raw material. The available quantities of this grass were not adequate to permit expansion of the industry on an economic basis. In bamboo the industry has found a material, sustained supplies of which are available in abundance in different parts of the country and from which a large variety of writing and printing papers can be produced at an economic cost. The use of bamboo has enabled the industry, with the aid of 'protection' granted by Government, to expand and capture almost the entire increase, in the last decade, in the demand of writing and printing papers, which would otherwise have been met by foreign imports. It is true that over 12,000 tons of writing and printing papers, consisting of superior quality and special papers, e.g. banks, bonds, art, litho, etc. are still imported into the country. These papers could be made from bamboo and other available raw materials, but as the quantity of each individual variety is too small, its manufacture cannot be taken up profitably by an Indian mill, particularly as the distribution of such manufactures over the vast area of India would be uneconomic. Until, therefore, the demand for the individual papers increases considerably, their manufacture in this country is likely to remain uneconomic. Excepting these papers, therefore, India is now in a position to meet not only her present requirements of writing and printing papers but also to supply the greatly increased demands of the future.

(ii) Cheap Printing papers including newsprints.

The consumption of these papers increased from about 24,000 tons in 1925-26 to about 46,000 tons in 1935-36, i.e. by about 190 per cent. With the advent of the Reforms and the spread of education among the masses the consumption of these papers is bound to increase at a much higher rate in the coming years. It

has not yet been possible to manufacture these papers at competitive prices in this country, as in their production a large proportion (70 per cent—80 per cent) of cheap mechanical pulp (i.e. pulp made by mechanical processes of grinding without the use of any chemicals) are required and the production of this kind of pulp from indigenous materials has not hitherto been attempted. Cheap mechanical pulp should be made available to the paper-maker in this country in order to enable him to capture the large and growing market for these papers.

(iii) **Packing and Wrapping papers including kraft papers.**

The use of kraft papers (strong brown paper used for packing purposes, often glazed on one side and rough on the other) on a large scale has only developed in India within the last few years. As the use of this paper is likely to grow considerably in the near future, its manufacture in the country offers bright prospects.

A remarkable feature regarding the other cheaper varieties of wrapping and packing papers is the enormous consumption of imported old newspapers. In 1935-36, while the import of ordinary wrapping papers was 10,730 tons, that of old newspapers was 57,583 tons or more than double of what it was in 1925-26. These old newspapers are, as is well known, largely used for wrapping foodstuffs, fruits, provisions, etc., in bazaars. Such a use is admittedly very unhygienic and detrimental to public health. The price at which the old newspapers are dumped into the country is so low that it is impossible to manufacture any paper, even from the cheapest material available, to compete with them. In the interests of public health and of the development of a large and new industry it is obviously necessary that the present undesirable use of old newspapers should be discontinued. The only effective measures which can be taken to bring this about are—

Firstly, the production of very cheap wrapping papers in the country. For this purpose it is indispensable that cheap pulp, both chemical and mechanical should be available to the paper maker. Secondly, it will be necessary to educate public opinion against the use of old newspapers for wrapping up foodstuffs, and lastly it may be found advisable to put a heavy protective duty on the imports of old newspapers, once the possibility of producing cheap wrapping papers in India is fully established.

Experiments at Dehra Dun have established the possibility of manufacturing good class of packing and wrapping papers from Ulla grass (*Anthiatria Gigantea*). About 45,000 tons of this grass is available in the forests of the United Provinces which is ample for a good size mill.

(iv) **Straw-boards, card-boards etc.**

As the demand for these products is increasing there is scope for their manufacture. It is believed a company has recently been floated for the purpose of manufacturing straw-boards in Sind from Sar grass (*Sacchrum arundinaceum*). The company has, it seems, secured a 10 years' monopoly of removing grass from Government forests.

(v) **Insulating boards.**

No statistics are available about the consumption of these boards, but there is ample evidence to show that large quantities are used and the demand is daily increasing. Investigations have shown that bagasse can be utilised for the production of these

boards. There seems to be ample scope for the manufacture of these boards in this country.

To sum up, during the last ten years the consumption of papers and boards in India has increased on the average by about 10,000 tons per annum. With the industrial and economic development of the country and the widespread diffusion of literacy among the masses, the demand for papers, particularly of the cheaper variety, is bound to increase more rapidly in the future. The present per capita consumption of paper in this country is hardly 1½ lbs. as compared with 150 lbs. in the United States of America, and is the lowest of all countries in the world, except perhaps China. There is thus an enormous scope for the growth and development of the paper industry in India. A well-organised plan, enterprise, and sustained and intensive research are needed to exploit the natural resources and render the country self-sufficient with regard to her requirements of a commodity of vital importance for national development and for the progress of civilisation. The development of the paper industry depends to a large extent on the possibility of producing mechanical pulp on a commercial scale when the production of cheap types of paper and boards will become a good proposition, and India would become independent of the large and growing imports of these classes of paper, which today amount to more than 1,600,000 tons per annum, the value of which comes to about 3 crores of rupees. The position has slightly improved during the last two years but there is still a great scope for the expansion of the paper industry in India.

So far mechanical pulp has not been produced in this country from indigenous materials. Some work has been done but more intensive research is required.

(3) PLYWOOD AND VENEERS

India is lamentably backward in plywood, veneer, and allied industries. In more advanced countries, tremendous strides have been made within the last few years in these spheres. In France for example, the cutting of luxury veneers is a large and profitable business, while in such countries as Finland, Poland, Japan, and America, the plywood trade forms one of the chief industries of these countries. In India, the position is the exact reverse. There is no general commercial plywood factory in India nor is there any real veneer industry. There are two plywood factories in Assam manufacturing 3-plywood boards almost exclusively for the tea box trade, but they are fully occupied in their own line of business and are limited even in their own sphere of activity. Their total output is about 3,50,000 boxes. Now, India imports very large quantities of plywood and also to a more limited extent, veneers. According to some accurately compiled export and import figures for 1930, India was, next to the United Kingdom, the second largest importer of plywood in the world. In 1929, the imports were 31,791 tons and in 1930 they were 35,127 tons. More recent figures are not available but from information received, the imports of plywood and laminated boards have been greatly on the increase during the last few years. The total value of plywood tea chests imported into India during 1935-36 was nearly Rs. 53,00,000. These are very large figures and the question naturally arises as to why plywood industry in India is not more advanced. At first sight the manufacture of plywood appears to be a simple business, but on examination in more

detail it is found to be more complicated. In the first place, there is very keen foreign competition, and foreign plywood is being sold in India at prices with which it is difficult to compete, but in order to compete successfully, cheap and abundant supplies of suitable woods are necessary. Unfortunately, when a species is abundant and cheap in India, it is more likely than not to be unsuitable for plywood work, and if there is a suitable species in abundance it is often impossible to produce it at an economic price, that is to say at a price that is favourable for the manufacture and at the same time profitable to the grower. The profits on plywood manufacture are usually small. They must be in order to compete in the scramble for business in a highly organised trade. It is therefore, necessary for a factory to have a large output in order to pay its way, since a large turn-over with a small profit is the best method of competing with foreign competition. A small out-turn with a large profit is not feasible unless the manufactured product is of much better quality than the imported equivalents. It is estimated that even a small commercial plywood mill would require at least 4,000 to 5,000 tons of timber a year, if it is to be a financial success. That is a lot of wood, and Forest officers will at once recognise the difficulty of producing that amount of suitable timber (preferably of one species) from an Indian forest. It is of course possible to combine 2 or more species together provided they are similar and suitable, but even then the problem is not easy of solution. It may be possible to run a smaller type of plywood factory profitably in India, and there are indications that this may be tried in the near future, but it is a matter which will need very careful consideration and extreme efficiency and good organisation on the part of the owners.

The second part of this item concerns veneers, and this is a far more hopeful subject for India. In Europe, and America there is a good trade in what are known as luxury veneers. These are usually matched sheets of figured and ornamental woods which are used for sticking on to the face of plywood, laminated wood, or solid boards, so as to produce the effect of a solid panel of handsome wood. These luxury veneers are very valuable, and are sold at high prices. Sometimes, a firm deals only in the production of these veneers, and sells them to manufacturers of plywood and laminated boards and to furniture manufacturers. In other cases, the plywood and laminated board manufacturers cut their own luxury veneers in addition to manufacturing commercial plywood. Such veneers are usually cut on a slicing machine. Sometimes they are rotary cut on a veneer lathe, but all woods will not react to this process. Occasionally they are sawn, but this procedure is usually only adopted when a slicing machine is not available.

India possesses some extremely ornamental woods. There is however no royal road to immediate success in the exploitation of a timber to make its name and popularity. The timber may be intrinsically good but just the same efforts are necessary to popularise it as are required with any other article; expenditure and advertisement are therefore necessary.

A few examples of the ornamental woods suitable for cutting them into veneers may be given:—

Padauk (*Pterocarpus dalbergioides*), Laurel (*Terminalia tomentosa*), Silver-grey (*Terminalia bialata*), Kokko (*Albizia lebbek*), Gurjun (*Dipterocarpus* species), Haldu (*Adina cordifo-*

lia), Sissoo (*Dalbergia sissoo*), Chickrassy (*Chukrasia tabularis*), Walnut (*Juglans regia*), etc. etc.

Veneers prepared from these woods would undoubtedly command a good market and good price, not only in India but also abroad. There are many dealers in other countries who would be prepared to buy veneers of which the figures and appearances are known, while they are not prepared to purchase logs of unknown and doubtful quality on the chance of their containing figured wood.

The establishment of a Veneer Board Factory in North India and another in South India may be possible. There are indications that a plywood factory in Bombay Presidency and a veneer factory in Calcutta may shortly be established.

Laminated construction—Timber in the past has been used mostly either in rectangular or circular (natural) cross section for structural purposes. As a result of the great progress that has been made during recent years in research on glues and laminated construction, it is now possible to obtain practically any economical cross-section that is required. The advantage of such materials lies in the fact that they are strong, and, in the case of panels, steady. For example, modern doors are now all made in one piece and are often faced with a decorative veneer. The cores of such boards are not difficult to make, and they can be made of inferior woods in small strips and sizes. If such cores are faced with good veneers, they are a very good business proposition. If face veneers, can be purchased in India, the manufacture of laminated boards should not be beyond the scope of our wood workers, as the machinery required for making cores is not complicated or expensive.

(4) TEXTILE MACHINERY PARTS, TOOL-HANDLES, MATCHES, PENCILS, ETC.

The position of these industries is fully explained in a memorandum prepared some time ago by the Utilisation Officer of the Forest Research Institute, Dehra Dun, on Indian substitutes for foreign imported timbers. Extracts from this memorandum are given below:—

The following consolidated figures of foreign woods imported into India are available and are tabulated for information:—

Year	Deal and pinewood	Other kinds of wood (excluding teak sandal & firewood).	Manufactured wood article (excluding cabinet wares).
	Tons.	Rs.	Rs.
1933-34	8,347	21,50,704	14,65,593
1934-35	12,815	18,37,785	25,60,442
1935-36	11,131	17,55,148	22,95,873

The question which is naturally of most interest to India is whether any Indian woods are suitable and available as substitutes for these foreign imported woods.

This question can best be answered by a detailed examination of the uses to which they are put.

Woods for box shooks, planking etc. In addition to the Japanese deal woods, the other deal woods brought into India are to a large extent, in the form of packing cases of machinery and stores. These cases are broken up and re-conditioned for making

new packing cases in India. This kind of trade is one with which it is very difficult to compete, as the imported packing cases come into the country virtually free of cost, and the wood can be reconditioned and sold at very low prices. There are firms in India which carry on quite a good trade in this line.

As regards Indian substitutes, there are plenty of soft, whitish woods in India suitable for this type of work. It is merely a question as to whether they can compete in price. Some of these woods are, however, available only in limited quantities and measures should be considered to increase their supply. A few suggestions are Semul (*Bombax malabaricum*), Kanju (*Holoptelea integrifolia*), Kadam (*Anthocephalus cadamba*), Baing (*Tetrameles nudiflora*), Kuthan (*Hymenodictyon excelsum*), Dhup (*Canarium* sp.), Spruce (*Picea* spp.), Fir (*Abies* spp.) and similar timbers. Organisation and modern woodworking machinery run on economic lines are essential (even on a small scale) if success is to be assured. Kiln-seasoning is also a great help in dealing with these perishable box woods.

Shuttles—Foreign imports of persimmon and cornel are now mostly used. Well seasoned *Mesua ferrea* has been suggested as a possible substitute as this species (imported from Ceylon) was considered satisfactory. It is now under trial in a Bombay shuttle factory. Seasoning and selection are very necessary.

Bobbins, Pirns, etc.—These are mostly made of foreign beech and birch at present, and Japanese competition has made it very difficult for a bobbin factory to function on a profitable basis in India at the present time. Haldu (*Adina cordifolia*) is being used for the purpose by the bobbin factory at Bareilly, and is found suitable but requires careful selection and seasoning. *Mitragyna* (*Stephegyne*) species would probably be very suitable if properly seasoned.

Sley Boards—These are the boards used for throwing and guiding the shuttle on a loom. Daroo wood (*Urandra Corniculata*) beech, and imported pine are apparently largely used for the purpose, and a stock of daroo wood is specially held by at least three Indian firms, in Bombay and Navsari (B.B. & C.I. Riv) against demand. There is no reason so far as we know, why Indian woods should not be more extensively used for the purpose. Teak, sissoo, deodar and kail have been used and found satisfactory. A fairly hard 'steady' wood is required. Timbers like babul (*Acacia arabica*), cutch (*Acacia catechu*), hopea (*Hopea parviflora*), rosewood (*Dalbergia latifolia*), padauk (*Pterocarpus dalbergioides*) or irul (*Xylia xylocarpa*) would probably be very suitable, if properly seasoned.

Rollers—There are several different types of rollers used in the textile machinery. Some are of a specialised nature with fine longitudinal grooving. For this type, very close-grained and hard timbers of small size like box-wood are required. The Indian timbers passed as possibilities by the Linen Industry Research Association, Lambeg, Ireland, were *Parrotia jacquemontiana* Sageraes *listeri*, and *Gardenia*—species. It may be noted that timbers for this purpose must include the heart-centre and should not be larger than 4 inches in diameter. This restricts the choice considerably, and only small shrubby types of close-grained woods can be considered.

For other larger types of rollers, several varieties of foreign woods are used, ranging from beech wood to pine. Such rollers are often of a laminated form of construction. India could supply suitable woods for this purpose, but seasoning in the round

is a difficult problem which might rule out many woods for solid rollers. Very steady timbers like gamhar (*Cmelina arborea*), rosewood (*Dalbergia latifolia*) and padauk (*Pterocarpus dalbergioides*) would be suitable.

Picker Arms—The imported timbers used for picker arms are hickory and ash. Indian woods found suitable are dhman (*Crewia tiliæfolia*), sandan (*Ougeinia dalbergioides*) and *Anogeissus* species. Other Indian woods could no doubt be used for this purpose.

Protection Boards: These are plain boards used as cloth shields or guards on looms. Any good steady wood would be suitable for the purpose. Beech, pine and teak are apparently mostly used for this work at present.

In conclusion, it may again be emphasised that seasoning and selection are the two most important factors in regard to these woods for special parts of textile machinery.

Tool Handles—Ash and hickory are the two main imported woods used. Burma has already made a start against these imports by introducing yon (*Anogeissus acuminata*) on to the Indian market and the demand for yon handles now exceeds the supply, mainly on account of the limited capacity of the Ahlone tool handle plant. Supplies of yon are plentiful and there is a factory or two in India to continue the good work started by Burma. Other woods considered suitable (apart from such timbers as *Olea* and *Sageraea*, of which supplies are hardly commercial) are *Parrotia jaccuemontisna* (already used in good quantities by the Ishopore Rifle Factory), *Anogeissus latifolia*, *Heritiera minor*, *Schleichera trijuga*, *Grewia tiliæfolia* and *Cynometra polyandra*, all of which are equal to and in some cases superior to Ash from a strength point of view, and *Dalbergia sissoo*, *Dispyros* species, *Lagerstroemis parviflora*, *Lagerstroemia moeacrocarna*, and *Terminalia tomentosa*, if well seasoned. There is definite scope for small tool handle and picker arm factories in India. (A tool handle factory has recently been established in Bihar. It also manufactures bobbins.)

Woods for constructional and general purposes—Quite a lot of foreign timber is imported into India and sold as general construction and building timber. The reason why such timbers are preferred to indigenous woods is that they usually come into India in good parcels of clean sawn stock and more often than not they are seasoned. Sometimes, as in the case of Oregon Piner and Sitka spruce, it is on account of the long clean squares available. On other occasions, it is because they are already treated with a preservative. We have frequently been informed by Port Commissioners that they have been offered creosoted oregon pine for piles, and have stated that they would prefer to use a treated Indian wood if such was available. Unfortunately treated woods have not been available in India in the past, but with the advent of several treating plants within the past year or so, the situation has now improved in this respect. India should be able to produce all her requirements of constructional and building timbers, whether treated or untreated, and there is no excuse for the imports of lauan (a soft *Shorea* from the Philippines), maiyang from Siam, and karri and jarrah from Australia. As a matter of fact the imports of these woods are considerably less than they used to be, the Railways, for example, having completely stopped importing foreign wooden sleepers.

Woods for bearing, etc.—*Lignum vitæ* has long been considered the best wood for bearings of turbines and for other pur-

poses where extreme hardness is required. Some years ago a small experiment with *Xylia dolabriformis* for the bearings of some turbines near Roorkee was inaugurated from the Forest Research Institute in collaboration with an Executive Engineer of the U.P. Hydroelectric Department. The results were most gratifying. The *Xylia* bearings lasted for exactly the same time as the *Lignum vitae* bearings on the large installations, and did equally well on smaller turbines. It is safe to say therefore that *Xylia dolabriformis* at any rate could be used as a substitute for *Lignum vitae*. Other Indian woods such as *Heritiera* spp. might also prove equally satisfactory.

Woods for matches—This subject is too well known to need much discussion. Imported aspen wood is admitted to be in a class by itself for match splints, but several Indian woods are very suitable for boxes, and a few (*simul*, *dhun*, *genwa*, *papita*, *bakota*, etc.) are accepted by factories as suitable for making splints, although admitted not to be up to the standard of aspen for this purpose. Kashmir poplar is probably the best indigenous splint wood used in India at present, but its use is restricted by its habitat to one or two factories in Northern India. The imports of aspen have gone down considerably in recent years, and Indian match factories (and apparently the public) are finding Indian woods perfectly suitable for boxes and to a large extent also for splints although it must be admitted that Indian wood splints are not up to the fine quality of aspen splints.

It may also be mentioned that Indian match factories, at or near ports, are using large quantities of imported Japanese woods (*Shina-no-ki*, *hakuyo*, etc.) for splints in addition to Indian woods.

Woods for pencil making—The imported pencil cedar from East Africa is in a class by itself for pencil-making. The only Indian wood approaching it (out of over 100 species tested) is the Himalayan juniper (*Juniperus macropoda*) which has been tried practically and found eminently suitable for the purpose. Unfortunately supplies of this wood are very limited and the difficulties of extracting the wood from the inaccessible heights where it grows makes it hardly a commercial proposition. Other timbers tried are *kuthan* (*Hymenodictyon excelsum*), *malabar neem* (*Melia composita*), *cypress* (*Cubressus torulosa*), *thitmin* (*Podocarpus neriifolia*), *Kail* (*Pinus excelsa*) and the *hill town* (*Cedrela serrate*), but these are very secondary in quality compared to the true pencil cedar. The latter is imported from East Africa at 1 shilling per 48 pieces 7" x 2½" x ¼", and at this price, pencil factories in India prefer to use the imported wood for all except their cheapest and lowest grade pencils, but most Indian factories are finding it very difficult to compete with imported Japanese pencils which sell at extremely low prices in India.

It is suggested that the starting of plantations of *Juniperus procera* or *Juniperus virginiana* in suitable localities might help to ease the situation, and the idea is put forward for the consideration of any Province likely to be interested. Most junipers seem to grow extremely well in Dehra Dun, for example, and it may be found that they would succeed in other localities. As a species they seem to be very adaptable.

To sum up, India can supply substitutes for several foreign imported woods, but not for all. The important factors are (1) seasoning and (2) selection of fault-free material which is up to the standard of the imported woods. To achieve these two necessities, the education of the middleman or supplier is neces-

sary, and the co-operation of Forest Utilisation Officers and industrial departments and organisations is the best means of attaining this end. Such officers must know exactly what the manufacturing industries require and they must aim at doing their best to see that they are supplied with their requirements. To supply unsuitable and unseasoned material, unselected and full of faults, does more harm than good, and is the main reason why imported timbers are in a great many instances, at present preferred to indigenous woods.

Indian woods for sports goods—Tests on mulberry wood from Punjab irrigated plantations showed that this species was better than imported ash for sports goods and especially for hockey sticks. The demand for Indian mulberry has developed so much lately that the Chamber of Commerce had recently to request the Punjab Government to increase the extent of mulberry plantations.

(5) Preservative treatment and seasoning of timbers.

In the past, Indian woods have suffered in competition with other materials like concrete and metal on account of their not being durable and able to stand up to the ravages of termites, and fungi. Weight for weight timber is, in almost all cases, as strong as steel, and considerably stronger than concrete. Volume for volume, concrete weighs $2\frac{1}{2}$ to 4 times as much as wood, and as wood is easy to fashion and easy to alter or reapiir, it is, for many types of structure, a good proposition from the engineering point of view, PROVIDED IT CAN BE MADE DURABLE.

Wood preservation in other countries and especially in America where termites abound, has made great advances in recent years, and is now looked upon in those countries as one of the greatest assets of timber exploitation. Unfortunately India is very backward in the matter of wood preservation, and it is only recently, as the result of considerable propaganda on the part of the Forest Research Institute, that timber sellers and timber users have begun to realise the advantages of rendering wood immune for a long period to the ravages of wood destroying agencies.

India possesses some hundreds of potential commercial woods but only very few of these are naturally durable, and the market for the rest is restricted and limited. Once the perishable woods can be made durable, the position is vastly improved, and even the most despised woods are raised in status to good commercial possibilities. Wood preservation is therefore a very important plank in the platform of a more extensive exploitation of Indian woods. It at once opens up many avenues of utilisation which were formerly closed to wood. To cite a few examples, the possibility of using treated wood for electric transmission poles, highway bridges, piles roof trusses, floorings and cheap house construction, is at once apparent.

Wood preservation is not a subject to rush into blindly. Like all businesses, its possibilities and limitations should be clearly understood before a start is made. Many costly and foolish mistakes have been made in the past owing entirely to a limited understanding of the subject.

All-weather rural roads are an important part of any rural reconstruction programme. For four or five months in the year a considerable length of rural roads lies useless and villages served by these roads are cut off from the urban areas. It is the absence or lack of efficient and economic type of highway bridges

which particularly cause these difficulties. Poles of many species treated with an efficient preservative, would provide excellent material for building durable bridges in most parts of India at considerably less expense than with steel, masonry or concrete.

(5) (a) **Railway sleepers.**

This item ranks very high in importance.

The relative position of the Broad and Metre gauge sleepers during each of the last five years can be seen from the following figures:—

Class I Indian Railways.		Wood, Cast Iron Steel Other kinds.			
Broad Gauge 5' 6"		%	%	%	%
1933-34	.....	44.3	38.6	16.6	0.5
1934-35	.....	43.6	39.3	16.8	0.3
1935-36	.....	42.8	39.8	17.2	0.2
1936-37	.....	42.7	39.7	17.4	0.2
1937-38	.....	42.2	40.1	17.5	0.2
Difference between the last two years		-5	+4	+1	-
Metre Gauge 3' 3½"		%	%	%	%
1933-34	.....	71.8	6.0	22.1	0.1
1934-35	.....	71.6	5.9	22.4	0.1
1935-36	.....	71.7	5.8	22.4	0.1
1936-37	.....	71.3	5.8	22.8	0.1
1937-38	.....	70.6	5.6	23.7	0.1
Difference between the last two years		-7	-2	+9	-

It will be seen that more than 55 per cent of the broad gauge sleepers are of steel or cast iron. It may be remarked that there is almost complete absence of metal sleepers in the railways of the United Kingdom and the United States of America. It is true that conditions in those countries are different and the wooden sleeper there lasts much longer than it would in India. This difficulty can only be solved by the discovery of a really effective wood preservative so that the life of timber sleepers may be prolonged by treating them with such a preservative. It will then be possible for wooden sleepers to compete with metal sleepers. Many experiments are in progress on this subject but no final results are yet available. The Railways and the Forest Department must co-operate in this work so that the use of metal sleepers may be reduced as far as possible. There has been a good deal of discussion on this subject and it is not proposed to go into the details here. Suffice it to say that a timber sleeper is generally preferred for many reasons and the railways must use it provided its life can be prolonged as far as possible. The opinion has been expressed that in the past the life of the wooden sleepers had been assessed lower than it really was, and much below the full possibility with efficient treatment. This suggestion should be examined and if confirmed, the use of wooden sleepers can then be extended at once.

6. **Wood and Charcoal for the production of gas for Internal Combustion Engines**

This subject is discussed under Transport—Part G. It will suffice to mention here that if the future of wood and charcoal

gas consumption increases in India, it would mean an additional and profitable new source of revenue for the Forest Department; for then we would be able to dispose of large quantities of wood which is at present left in the forest and for which no economic use can be found at present.

7. Improved methods of extraction and exploitation.

The three primary means of extracting timber and forest produce are railways, roads and rivers. Roads play an important part in making available the produce of forests, but their radius of action is restricted. There are enormous tracts of forest in India at the present time which are not served with suitable communications, and which are not therefore as valuable as they might have been. The communications as at present are quite inadequate to develop the forests to their full extent.

This subject is again referred to in part G—Transport where the position is reviewed more fully.

8. Development of minor forest products.

Apart from timber, which is the major produce, forests yield a large number of other materials, commonly designated as minor forest products. These include flowers, fruits, leaves, barks, roots, herbs, resins, grasses, flosses, fibres, gums and a host of other products. The revenue to Government in 1937-38 from royalty from this source was Rs. 79 lakhs. This source of revenue could be substantially increased if more attention was paid to the development of minor forest products.

Medicinal Plants

In spite of the fact that India abounds in medicinal plants, some of which are pharmacopoeial, enormous quantities (worth Rs. 267 lakhs in 1937-38) are imported every year. Only a small proportion of the indigenous drugs are manufactured into finished products; the rest are exported as crude drugs which on extraction and standardisation are imported back into the country as medicinal preparations. This procedure to say the least, is most uneconomic since most of the drugs could be extracted and made into medicinal preparations in the country, with only a little effort in chemical and pharmacological standardization. With proper organisation and research it should not be difficult to establish the industry on a firm footing in India.

This brief reference to minor forest products will suffice here. Almost verbatim extracts from various publications dealing with minor forest produce have been compiled by Mr. K. P. Sagreiya and are given at the end of this part of the report.

8 (a) Pine (*Pinus Longifolia*) resin

Resin is separated into resin and turpentine by steam distillation at Jallo in the Punjab and at Bareilly, in the United Provinces. "India's annual consumption now amounts roughly to 150,000 maunds of resin and over 2 lakhs gallons of turpentine, but more than half of the latter is a cheap, inferior mineral substitute, imported chiefly from Burma. Most of the resin and all the genuine turpentine are manufactured by the United Provinces and the Punjab, which are indeed, the only bulk producers of these essential commodities in the Empire. Both the resin and turpentine are of the highest grade and compete with the standardized American articles."

The area of Chir (pine) forest which is now being tapped in the United Provinces alone forms only about 10th of the total Chir forests. The transport difficulties are however great. The

farthest limit of the area which is now being tapped is 80 miles by road and railway and some 20 miles by footpath. This is considered to be the economic limit. The rest of the Chir forest is beyond this limit. The only way to extend the work of tapping is to make more roads and to devise some way of floating resin as we float our timber.

(9) Development of Forest Cottage Industries

Wood working offers possibilities of a new rural industry and the villagers may have in it a suitable occupation when they have not much work in the fields. The possibilities consist in the manufacture of what is called "Small dimension stock" by practically unskilled labour in rural areas, for which no greater capital investment is required than is necessary for the purchase of a few locally made tools.

The question however requires careful consideration before any scheme for this purpose is launched.

(10) Lac

This is a very large subject in itself and detailed information can only be available from the Director, Lac Research Institute, Namkum, Ranchi.

The following statement gives the export figures for 1920-21 to 1937-38, classified according to the grades of lac.

Exports of Lac and Shellac from India 1920-21 to 1937-38 (Financial year 1st April to 31st March)

From 'Annual Statement of Sea Borne Trade of British India, etc.'

Year	Shellac.		Button-lac.		Seed-lac.		Stick-lac.		Other kinds.		Total.
	Qnts.	£	Qnts.	£	Qnts.	£	Qnts.	£	Qnts.	£	
1920-21	260,259	91	10,918	4	687	...	627	...	16,445	5	308,937
1921-22	379,944	87	10,784	2	1,884	...	822	...	41,560	10	434,934
1922-23	363,377	81	18,387	4	4,754	...	2,897	...	66,616	14	476,011
1923-24	397,147	83	16,863	3	19,100	4	1,800	...	50,761	10	485,671
1924-25	337,800	76	21,612	5	35,129	8	6,494	2	36,582	9	427,019
1925-26	416,590	77	21,678	4	37,424	7	22,765	4	41,449	8	539,384
1926-27	424,926	72	20,626	4	89,389	15	7,220	1	69,850	8	592,030
1927-28	404,367	74	18,042	3	94,694	10	9,138	2	57,351	11	545,584
1928-29	530,746	71	24,714	4	92,420	12	26,514	4	69,009	9	743,403
1929-30	496,252	74	24,175	4	68,033	10	6,361	1	72,093	11	648,914
1930-31	366,419	67	25,678	4	106,888	19	4,626	1	46,072	9	547,151
1931-32	297,012	64	18,164	4	104,657	22	12,841	3	31,050	7	463,724
1932-33	261,753	62	17,432	4	120,622	29	4,204	1	14,109	4	418,300
1933-34	529,075	72	19,100	3	152,214	21	6,872	1	23,727	3	730,888
1934-35	451,937	72	15,722	4	88,635	15	5,061	1	44,627	8	586,008
1935-36	284,332	58	29,373	4	125,042	26	7,870	2	40,564	8	487,581
1936-37	496,940	60	26,213	4	261,622	31	4,647	...	37,380	8	633,944
1937-38	409,225	62	24,012	4	197,484	28	808	...	43,441	6	644,671

It is difficult to estimate the total quantity of lac produced in India because the cultivation of lac is spread over a very large area; the number of trees cultivated varies from year to year, and yields depend on the host of species, quality of brood used, season and locality. Assuming that the consumption of lac in India for industrial applications is small and constant, and that stocks of manufactured and unmanufactured lac in India are more or less on the same level every year, the annual export figures would give an idea of the production in India. The total exports increased from 43,740 cwt. in 1863-69 to 146,395 in 1898-99 and 308,937 cwt. in 1920-21. During 1936-37 the total was 833,954 cwt. There has been thus an irregular but definite increase in the exports during the last 70 years, in spite of the enormous development of the synthetic resin industry. It would appear, therefore, that although shellac is not taking its legitimate place in new industries, its time-honoured uses do not seem to have been superseded.

The increased use of shellac depends upon the development of the following industries :—

- (1) Gramophone records.
- (2) Electrical insulating materials.
- (3) Protective and Decorative Finishes.
- (4) The Hat Industry.
- (5) Sealing-wax manufacture.
- (6) Grinding wheels.
- (7) Plastic moulding.

It might be remarked that lac being collected and marketed in the first instance by the ignorant classes, very little trouble is taken to market it in the form required by the manufacturer. It is frequently very dirty and is adulterated with various substances. This is one of the main causes for the development of synthetic resins. In order that shellac may retain its place it is necessary that it should be up to specifications required by the industries using shellac.

The value of shellac produced annually is over Rs. 7½ crores so that its importance to India is obvious.

Cultivation of lac is really a cottage industry.

(11) Tanning Materials

The main tanstuffs found in India are:—

(1) Myrabolans. This is the most important tanstuff in India and large quantities of it are exported to Europe, the value of which exceeds Rs. 4,000,000 per annum. The quantities of fruits produced by the trees vary enormously in different years, and the available supply in one year may be several times the corresponding supply in the following or preceding year. By far the greater part of the myrabolan crop comes from privately-owned forests, and practically nothing is done in India generally to increase the supply.

(2) Babul bark (*Acacia arabica*): The present production of babul bark in the Government forests is much less than the demand. For instance the present demand for Cawnpore alone is 3,00,000 maunds while the production is 8,000 maunds per annum and it appears that considerable difficulties are being experienced by the tanneries in meeting their requirements. The industry could be developed by raising plantations on a large scale on suitable waste lands.

(3) *Cassia fistula*: This is not so common as the myrabolan and babul bark are.

(12) Artificial Silk

There are possibilities of manufacturing alpha cellulose and staple fibre for artificial silk and other textile fabrics but so far very little or no work has been done in this line.

(4) Capacity of forests to furnish employment.

It is most fortunate that the forest work fits in very well with the slack periods in agriculture and a large number of villagers when free from their fields go to the forest for work. The census returns of 1931 show that directly or indirectly the forests offer employment to about 2,000,000 people in British India alone. To many these figures will come as a surprise. They, however, show what a great part forests play in the economy of an agricultural country like India.

Unemployment might be reduced by the development of new industries as indicated above and by bringing under systematic management considerable areas of private forests and waste lands in India.

The forest industry could be greatly developed in these areas by introducing schemes of management and replenishing the depleted stocks.

(5) Causes which have hindered the development of forest wealth of India may be examined under the following heads:—

- (1) Lack of co-operation between the Forest Department and Industry.
 - (2) General prejudice against the use of timber for structural and other purposes.
 - (3) Lack of adequate transport facilities including high freight charged by the railways for forest produce.
 - (4) Lack of knowledge of the qualities of timbers available and the general absence of facilities for seasoning and preserving timbers.
 - (5) Lack of information regarding quantities of forest products (timber and other forest produce) available in our forests.
- (1) Lack of co-operation between the Forest Department and Industry.

There is no doubt that the forests of India represent capital resources of great value but the industry in India does not appear to be taking full advantage of these resources.

The Forest Research Institute at Dehra Dun has been carrying on research for many years in the processes of growing trees and making profitable use of timber and other produce of forests and it has produced abundant results of acknowledged economic value.

At present a triennial programme of research is drawn up for each Branch of the Forest Research Institute and is based on suggestions made by the Institute supplemented by the Forest Officers in each province. It is however felt that more could be done by ensuring a close liaison between forests and industry by the establishment of a permanent link and that such liaison is not only eminently desirable in the interest of India as a whole but would also result in practical returns of real financial value. The Government of India have in order to achieve this end proposed to constitute a Central Advisory Board on Forest Utilization.

The functions of such a Board would be to advise the Forest Research Institute on the selection of particular problems for investigation, on the initiation of such investigations and on the best means of making practical and beneficial use of their results. The personnel of this Board will consist of both industrial and scientific representatives. The Provincial Governments will also be represented on this Board.

It is suggested that Provincial Advisory Board, on Forest Utilization should also be constituted. The appointment of such Boards would no doubt prove a more effective means of tapping as wide a source as possible for suggestions to make the activities of the Forest Research Institute industrially more useful than a Central Advisory Board with a comparatively restricted touch with provincial industrial enterprise.

The Utilization Branch of the Forest Research Institute is always glad to advise on all matters connected with the utilization of forest products and allied subjects. It has got experts on wood technology, seasoning, timber testing, wood preservation, woodworking, and paper pulp. It will require a large volume to record all the work which the Forest Research Institute has done in developing the forest wealth of India and those who are interested in the subject must therefore refer to the literature issued by that Institute from time to time. A recent publication called the "Forest Research and Indian Industry" issued by the Institute summarises this information.

- (2) General prejudice against the use of timber for structural and other purposes.

At present there is considerable prejudice against timber; timber engineering is hardly taught in any of the engineering schools and colleges.

It seems therefore necessary in order to secure increased attention from engineers in India towards the possibilities of timber as a structural material, that the subject of timber engineering and wood preservation should be included in Engineering Colleges' curricula and that the Engineers and students should be encouraged to visit the Forest Research Institute so that they should have a better understanding of the latest developments relating to timber utilization and treated wood structures.

- (3) Lack of adequate transport facilities including high freights generally charged by the Railways.

The provision of adequate transport facilities is essential for the development of forest resources. This question is discussed under part G—Transport.

- (4) Lack of knowledge of the quantities of timbers and the absence of facilities of seasoning and preserving these timbers.

There are over 2,500 species of trees in the forests, not to mention a large number of woody shrubs. Of these species only a few can be sold to their available limit and the supplies of many are in excess of demand while very little is known about the balance. It is therefore clear that intensive research is necessary in order to ascertain the properties of the huge number of species of trees. The Forest Research Institute is attempting to do it. It has already done so to a certain extent but the task is both huge and difficult. India, as has been shown elsewhere, imports large quantities of timbers for the manufacturing of textile machinery parts and other articles and the

task of the Forest Research Institute is to find out Indian woods as substitutes for the foreign imported woods. The co-operation of all the parties concerned in the exploitation and utilization of Indian timbers is therefore necessary to enable the Institute to accomplish this task.

- (5) Lack of information regarding quantities of forest products (timber and other forest products) available in our forests.

There is no doubt that in the past one of the main hindrances to the development of our forest resources has been that we had very little information regarding the quantities available in the forest. It sometimes happens that when we want an industry to buy certain timber or other forest produce we are asked to furnish the information regarding the quantities available and further whether we are in a position to guarantee the continuous supplies of the particular forest product. Very often we cannot give any definite information on either of these points. The result is that we cannot put our produce on the market. It is therefore essential that we must know not only what we have but also the quantities of marketable timbers and other forest produce. The position is better now but our knowledge on the subject is still far from complete. An industrial survey of forest products is therefore indicated. Such a survey requires staff and the appointment of Utilization Officers in all the provinces. Most of the Provinces have now got Utilization Officers but they do not appear to have an adequate staff. These officers have collected considerable data but unless their staff is also strengthened they cannot accomplish very much.

Question 2. To what extent can imports of teak be reduced or eliminated altogether by the development and increased exploitation of Indian forests?

Unfortunately, there has been the habit in the past of classifying the wood of India into two categories, namely, teak and jungle-woods. One might as well have said teak and "rubbish" for that was the impression given. This idea is not so current now but it has done considerable harm and checked the development of many of our excellent timbers. There are very few timbers possessed by the continent of America, yet a descriptive name is attached to each wood by the Americans and the greatest possible care is devoted to make it an attractive term. It is therefore strange that some of the wonderful timbers of India have in the past been given the pernicious title of jungle-woods.

Teak is used for various purposes and the recent investigations carried out at the Forest Research Institute, Dehra Dun, have shown that there are many such purposes for which one or the other Indian timbers can be found as a substitute.

By far the most important factor connected with timber utilisation in India is the proper seasoning of the woods used. This all important matter has, unfortunately, been sadly neglected in India, with the result that many excellent timbers have been condemned as liable to crack, warp, swell, or shrink, while Burma teak is upheld as a pattern. The truth of the matter is that the teak had probably been standing "girdled", i.e. as a dead tree, for two or three years in the forest, before it was felled, and had then taken two or more years to be floated down to Rangoon. There it was sold, and eventually found its way to Calcutta, where it was converted and afterwards stacked for

six months or so, with the result that the wood, when actually used, was in a more or less seasoned state. Other species are not girdled, and are usually extracted from the forest in one year, so that, when converted, they are still quite green, and consequently crack excessively when exposed unprotected to the hot Indian sun. Teak would behave in much the same manner if similarly treated, and, as a matter of fact, green teak is no better, in this respect, than many of the lesser known woods. It is, however, a fact that the shrinkage of teak is less than the shrinkage of other timbers, and as a result, the "working" or "moving" of teak is slight. This is one of the chief reasons for its popularity. Shrinkage varies with weight, and weight for weight, teak heads the list of Indian woods in this respect. In addition, the natural oil in teak wood retards the absorption of moisture, and as a result, when teak is exposed to fluctuating weather conditions, it takes longer to respond to these conditions than other woods. Again, teak and most well-known Indian woods, except sal, are easy to air-season, whereas other timbers are not always so amenable. This drawback has militated against the latter becoming popular amongst Indian timber users. The blame, however, does not always lie with the wood, but, more often than not, it is the timber merchant himself who has not given the wood a fair chance. The first thing therefore, before using any timber is to thoroughly season it. Many woods which are less durable in their natural state and which are available in large quantities can be made more durable by treating them with a suitable wood preservative and can replace teak in building and other structural works to some extent. It is not proposed to go into the various methods of seasoning timbers. They are described in considerable detail in the literature issued by the Forest Research Institute, Dehra Dun.

There is a common belief that teak is the best wood for making furniture, for panelling and in other structural works, where decorative effect is required. That this is not so can only be realised after visiting the places where other ornamental Indian woods have been used. Take for instance laurel wood (*Terminalia tomentosa*). There are some very beautiful rooms in London and Dehra Dun panelled and partly furnished in this wood. The panelling of the whole of the Legislative Assembly building at New Delhi has been done in timbers other than teak. All these have been greatly admired. Silver-grey is another beautiful wood which would provide panels for railway carriage decoration much more attractive in appearance than many woods which are at present used for panels. Rosewood (*Dalbergia latifolia*), Sissoo (*Dalbergia sissoo*), Haldu (*Adina cordifolia*), Koko (*Albizia lebbek*) etc., etc. are examples of other woods which can take the place of teak for many purposes.

There has been a lack of enterprise in popularising these beautiful woods and also the absence of co-operation between the Forest Department and industry. The formation of Central and Provincial Boards on Forest Utilisation mentioned earlier in this report will ensure necessary co-operation. Further, it should be the duty of all the Provincial Forest Departments in co-operation with the Forest Research Institute, Dehra Dun, to have show-rooms in all the big trading centres and in the museums for the exhibition of varied uses of timber. It means that success cannot be ensured without Government help because there are a number of difficulties which cannot be overcome by

private enterprise. It may be remarked that copies of almost all the Forest Research Institute publications are sent to the engineers, various chambers of commerce and others interested in wood but they are seldom read by them for want of time. Show-rooms as proposed will be the best medium for advertising our timbers.

Question 3. What is the total quantity of wood and charcoal consumed in your Province either as domestic fuel or in industrial undertakings?

Figures for wood and charcoal consumed as domestic fuel or fuel in domestic undertaking are not available.

The following figures show the removal of fuel in cubic feet from the State forests—

1933-34	..	229,961,087
1934-35	..	306,755,360
1935-36	..	272,735,127
1936-37	..	271,344,721
1937-38	..	214,224,619

Firewood is not removed from State forests only, but considerable quantities are also taken from Private forests. It is impossible to give even an approximate figure for firewood removed from Private forests—as there is no data to give this information.

The Mysore Forest Department supplies 4,20,000 bags (about 14,000 tons) of charcoal and about 50,000 tons of firewood to the Mysore Iron and Steel Works at Bhadravati. These works are unfavourably situated as regards coal supplies and ports and the only way of smelting the rich iron ores in their vicinity is by the use of charcoal as fuel.

Shellac, steel and other industries together probably consume 5,00,000 maunds of charcoal annually. This again is an extremely rough figure.

Question 4. From what sources is the charcoal obtained? What proportion of the charcoal is produced in by-product recovery ovens and how are the by-products utilised?

Charcoal is produced from most tree species. It is generally obtained by stacking the firewood billets in a paraboloid shape covering the stack with a thick layer of grass and earth and setting fire to it through a shaft provided at the bottom. The local burners produce an inferior quality of charcoal by the open fire process.

As far as information goes there do not appear to be any by-product ovens in British India.

Question 5. Are there any large scale industries in your Province which use charcoal as the principal fuel? Is there further scope for the development of such industries?

Very little information is available on this subject and it appears that charcoal as a principal fuel is used:

- (i) The Mysore Iron and Steel Works use charcoal as the fuel for smelting the rich ore in their neighbourhood. (See reply under 3).
- (ii) In the manufacturing of shellac.
- (iii) For the purpose of covering non-ferrous metals while they are melted and for placing on sink heads of steel castings.
- (iv) In the manufacture of brassware etc.

**Extracts from publications dealing with other
Forest Produce compiled by
Mr. K. P. Sagreiya.**

Question 6. Outturn of Forest Produce (other than timber, firewood, and charcoal).

Minor Forest Products include all kinds of forest produce other than timber and firewood. They comprise all animal, vegetable, and mineral products found in forest areas and in consequence, vary very considerably in kind as well as in value.

The forests of India are so rich in minor products of all kinds that it is possible to refer only to those which are or are likely to be of commercial value. A classification together with a brief description of the more important products will be found in Troup's Indian Forest Utilization (1913)*, while much useful detail regarding them is contained in Watt's Commercial Products of India (1908). Among the more prominent classes are comprised bamboos, grass, (including grazing), leaves for fodder, litter and manure, fibres and flosses, oil seeds, tans and dyes, oils, gums, resins, rubber, drugs, and species, edible products of various kinds, animal products such as lac, honey, and wax, silk, hides, horns and ivory and mineral products. Some of the principal items are considered later.

Figures of outturn are not readily available. The value during 1937-38 was as given in the subjoined Statement I (vide statement XIII of the Annual Report of Statistics relating to Forest Administration in British India for the year 1937-38.)

Statement I.

	Reserved forests.	Ave- rage Per sq. mile.	Protected forests.	Ave- rage per sq. mile.	Unclassed forests	Ave rage per sq. mile.	Total.	Ave- rage per sq. mile.
	Rs.		Rs		Rs.		Rs.	
Bengal	4,14,826	65	2,995	3	78,197	23	4,96,018	46
U. P.	16,75,069	321	95	—	2,910	7	16,78,074	272
Punjab	5,09,016	336	11,00,100	343	3,11,073	676	19,20,189	370
Bihar	8,18,422	62	1,17,903	184	—	—	1,99,745	102
Assam	1,60,474	25	—	—	3,27,459	22	4,87,933	23
Orissa	75,706	54	1,43,039	243	—	—	2,18,745	1099
C. P. & Berar	21,12,019	109	—	—	—	—	21,12,019	180
Coorg	38,390	75	—	—	2,114	7	41,094	49
N. W. F. P.	70,366	265	—	—	1,458	52	71,824	244
Ajmer	46,749	329	—	—	—	—	46,749	329
Baluchistan	1,15,442	339	—	—	316	1	1,15,758	1142
Andamans	82	—	—	—	7,323	11	7,405	33
Madras	11,77,989	78	218	1	4,35,071	133	16,13,278	887
Bombay	24,99,490	205	2,42,312	312	—	—	27,41,802	211
Sind	1,21,895	1122	—	—	—	—	1,21,895	1056
Total	90,99,945	125	16,06,662	232	11,65,921	49	1,18,72,528	115

* An Elementary Manual of Indian Forest Utilization by Trotter, Forest Economist, F.R.I. Dehra Dun, in Press.

The value of removals from the reserved forest by various agencies was as given in Statement II.

Statement II.

(1) By Government.

Province	Bamboos	Grazing & Fodder Grass	Other Minor Produce
	Rs.	Rs.	Rs.
Bengal	3,126	—	8,318
U. P.	704	673	3,47,582
Punjab	27,796	—	2,66,919
Bihar	873	—	3,585
Orissa	1,121	—	88
Assam	22	—	8,270
C. P. & Berar	48,138	832	45,136
Coorg	22	—	100
N. W. F. P.	—	—	57,432
Ajmer	—	81	672
Baluchistan	—	—	45,134
Andamans	—	—	—
Madras	21,257	246	27,653
Bombay	33	—	1,670
Sind	—	—	299
Total	97,092	1,832	8,12,858

(2) By Purchasers.

Province	Bamboos	Grazing & Fodder Grass	Other Minor Produce
	Rs.	Rs.	Rs.
Bengal	1,67,906	38,463	2,34,347
U. P.	1,08,910	1,59,001	4,90,272
Punjab	2,566	1,46,673	12,350
Bihar	30,966	3,964	42,611
Orissa	41,367	20,594	26,699
Assam	75,592	35,249	2,18,128
C. P. & Berar	2,71,089	13,34,059	2,02,513
Coorg	1,236	936	32,322
N. W. F. P.	—	6,222	600
Ajmer	559	10,721	2,255
Baluchistan	—	5,900	11,077
Andamans	—	—	682
Madras	6,71,671	6,13,494	5,25,920
Bombay	98,327	4,29,714	1,08,578
Sind	—	84,932	16,677
Total	11,70,226	28,89,922	19,55,031

(3) By free guarantee

Province	Bamboos	Grazing & Fodder Grass	Other Minor Produce
	Rs.	Rs.	Rs.
Bengal	1,249	38,503	4,106
U. P.	1,041	32,566	785
Punjab	5	78,179	6
Bihar	18	50	56
Orissa	1,290	—	194
Assam	3,268	39,048	1,05,953
C. P. & Berar	12,289	1,80,904	14,284
N. W. F. P.	—	1,412	—
Ajmer	—	2,177	—
Baluchistan	—	608	—
Andamans	1,318	—	4,349
Madras	453	10,925	2,666
Bombay	684	55	49,737
Sind	—	12,660	—
Total	21,812	4,01,086	1,84,295

(4) By right holders.

Province	Bamboos	Grazing & Fodder Grass	Other Minor Produce
	Rs.	Rs.	Rs.
Bengal	—	—	—
U. P.	7,125	4,73,797	55,618
Punjab	126	13,69,066	22,503
Bihar	2,773	1,09,289	5,560
Orissa	9,160	1,15,347	2,885
Assam	554	1,389	460
C. P. & Berar	—	375	2,400
Coorg	—	123	—
N. W. F. P.	—	6,158	—
Ajmer	—	30,284	—
Baluchistan	—	53,026	13
Andamans	415	—	604
Madras	1	8,075	917
Bombay	75,354	16,01,125	3,76,525
Sind	—	7,327	—
Total	95,508	37,75,381	4,67,485

Statement III.

The estimated value of produce given away free and at reduced rates was as under:—

Province	Bamboos	Grazing & Fodder Grass	Other Minor Produce
	Rs.	Rs.	Rs.
Bengal	568	8,750	1,602
U. P.	7,000	5,06,363	57,000
Punjab	131	14,47,245	22,509
Bihar	2,791	1,10,366	5,616
Orissa	10,450	1,89,678	3,079
Assam	3,822	42,806	1,06,413
C. P. & Berar	12,289	13,31,543	16,684
Coorg	193	4,122	2,159
N. W. F. P.	—	7,470	100
Ajmer	—	30,019	—
Baluchistan	—	53,073	13
Andamans	1,733	—	4,953
Madras	454	46,955	26,481
Bombay	76,038	16,01,180	4,26,262
Sind	—	19,987	—
Total	1,15,469	53,99,557	6,72,871

FIBRES

Stem-fibres are obtained by retting from the best tissue of many woody species, some of which yield long strong fibres suitable for twisting into ropes, whereas others yield silky fibres which are fine enough for textile purposes.

There are only a few stem or bast fibres which have any great commercial value, the majority being of local value only. From a financial point of view, therefore, fibres are unimportant, but from an economic point of view, they are very often indispensable, and the Forest Department especially is largely dependent on them, for making ropes for drag-lines and rafting. The villagers also use them extensively for their bullock harness and ropes.

The majority of plants yielding useful fibres belong to the Families Sterculiaceae, Tiliaceae, Leguminosae, Asclepiadaceae and Uriticaceae. The more important of these are:—

STERCULIACEAE:—*Sterculia villosa* is common throughout India and Burma. Yields a coarse, strong fibre. Utilised extensively in Madras, Burma and Bengal, for making elephant harness, drag-ropes, and in tying rafts, and used throughout India for making bags and ropes for all purposes.

STERCULIA URENS, STERCULIA FOETIDA and STERCULIA COLORATA are all yielders of rope fibres but they are not so sought after as the former.

HELICTERES ISORA is a shrub found in the drier forests of India and Burma. Yields a strong light brown fibre finer than that from *Sterculias*. The bast, however, is more difficult to separate from the bark, and, therefore, requires longer soaking in water and more careful retting, before it can be used for rope-making. It is used for tying up rice-bundles in South India, for sewing up "gunny" bags and for cattle harness.

TILIACEAE.

GREWIA TILIAEFOLIA, **GREWIA VESTITA**, **G. LAEVI-GATA**, and **G. OPPOSITIFOLIA** all yield coarse strong yellow-brown fibres which are used in rope-making and for domestic purposes.

LEGUMINOSAE.

HARDWICKIA BINATA is a fairly common tree in Madras, Bombay and the Central Provinces. The fibre (yepi) is obtained from the branches. It is of a red-brown colour, fairly strong, but has an untidy appearance due to the short lengths in which it strips off. Used chiefly for cordage and rope-making. The tree is often pollarded to produce young shoots which yield a superior fibre to that produced by the stem.

SPATHOLOBUS ROXBURGHII, **BAUHINIA VAHLII** and **CALYOPTERIS FLORIBUNDA**: Fibre-producing climbers commonly found in most Indian Forests. They are usually looked upon as enemies, owing to the damage they do to healthy trees by climbing all over them, but they have the redeeming feature of yielding valuable strong rope-fibres which are used extensively for tying up faggots, and other forest work.

SPATHOLOBUS ROXBURGHII fibre is also used commonly in Malabar for tying up rice-bundles.

Amongst other fibre-yielding trees belonging to the order leguminosae are **Ougeinia dalbergioides**, **Acacia leucophloea**, **Bauhinia racemosa**, **Butea frondosa**, **Millettia auriculata** and **Dalbergia sissoo**.

ASCLEPIADACEAE.

Calatropis gigantea and **C. procera** are two common shrubs yielding valuable fibres. Generally found in dry tracts and in sandy river-beds in Sind, Rajputana, and Central Provinces. The fibres are fine, white and silky, very strong, and durable under water. Used extensively for making fishing nets, fishing lines, bow-strings and twine.

Marsdenia tenacissima. A plant found in the Sub-Himalayan tracts and in Chittagong and Upper Burma. Yields a very strong fibre which is used for bow-strings and cordage.

URTICACEAE.

Ficus cunia, **F. Religiosa** and **F. bengalensis** are common trees yielding short strong fibres which are suitable for ropes. The last two are somewhat inferior to **Ficus cunia**.

Boehmeria nivea. Yields the well known rhee or ramie fibre which is a fine white fibre used in commercial rope manufacture.

Trema orientalis.—A shrub or small tree found in most forests of India. Yields a long light-brown fibre which strips off the tree in thin narrow bands which are easily separated after drying and used for making ropes, twine, and coarse cloth.

Other fibre-yielding trees of the order Urticaceae are the **Boehmerias** and **Antiaris toxicaris**, which produce a net-like fibre, stripping off in large sizes so that, by sewing up one end and side a complete bag is obtained ready for use. **Broussonatia papyrifera** and **Streblus asper** also belong to this order and produce white fibres which are used for local paper-making.

Fibre-producing species amongst other orders are not very numerous. **Careya arborea**, yields a fibre in broad bands used for cordage, tying carts and rafters, and in Burma, for putting under elephant saddles. **Cordia myxa** and **Cordia Rothii** both yield bast fibres, used in rope-making, and **Kydia calycina** produces a good strong fibre, commonly used for making elephant drag-ropes.

Amongst others, of local importance only, are *Thespesia populnea*, *Morniga pterygosperma*, *Alibizzia odoratissima*, *Erythrina suberosa*, *Odinia Wodier*, *Cerbera odollam*, *Miliusa Velutina*, *Berrya ammonilla*, and *Urena* spp.

The most important of the fibre-producing leaves are those of *Caryota urens*, the sago palm, which yields the well known "kital fibre" of commerce. This palm is found in the moist forests of Assam, Bengal, Orissa, Madras, and Burma. The fibre is of considerable value, being strong and of fair length. It is used in short lengths as bristles for brushes and is a useful rope-making fibre. It is also used by fishermen in preparing their nets and fishing lines. It is not exported from India to any great extent but a considerable quantity is exported from Malay.

Pandanus spp. produce a useful strong fibre for cordage, fishing nets, fishing lines and sacking, and the aerial root fibres of these species are split by beating and are cut into short lengths for brush bristles. The best known is probably *Pandanus odora* tissimus, a common shrub in the tidal forests of the Sunderbans and Burma. It is also found in the Andamans and on the West Coast.

Agave rigida, *A. lurida*, *A. vivipara*, *A. americana*, and *A. sisalana* are the well known aloe plants of India. All yield fibres of varying utility, *Agave sisalana* producing the "sisal" fibre of commerce.

FLOSSES.

There are several forest trees and plants in India which produce silky flosses in their fruits. These flosses are known commercially as 'tree cottons' or 'kapoks'. They are usually too short to be used for spinning or weaving, but are used extensively for upholstery work and for stuffing pillows, mattresses, and razais. The true "kapok" or white silk cotton tree is *Eriodendron anfractuosum*, a moderate-sized tree found in the West and South of India and in Burma but it is probably not indigenous. It is often found planted round villages and temples. The floss produced by the fruits of this tree is of very good quality, being more elastic and not so liable to "bunch", when used in upholstery, as other flosses found in India. It is, however, only used locally to a small extent and is not exported in any large quantities from India, although it fetches a far higher price than other kapoks.

The kapok which takes precedence in India is that of the semal or *Bombax malabaricum*. The pod of this tree yields a silky cotton, not very long but soft and strong. The semal tree being common in most parts of India, its floss now holds first place in the kapok markets and is exported in large quantities from this country; the price ranging from Rs. 12 to Rs. 16 per maund in local markets. The pods should be collected green, as the floss loses much of its resilience after the pods have opened.

There are many other floss producing plants of local importance only, including *Cochlospermum gossypium*, *Calotropis gigantea*, *Cryptolepis buchanani*, *Salix daphnoides*, *Populus ciliata* and *Beaumontia grandiflora*.

GRASSES.

(Other than Oil Grasses).

The utilization of grass is, from a forest point of view, one of the most important questions connected with forest work in India.

When one realises that the value of grass and grazing amount to the enormous total of nearly 58 lakhs of rupees, it will be

understood that the above remark is not exaggerated. This question of grazing and fodder grass is discussed later. Here grass used for purposes other than cattle food is discussed.

In the first place, there are no grasses in India which supply really fine textile fibres, but there are several which are very suitable for cordage and matting. The two most important in this respect are *Ischoemum angustifolium* and *Saccharum Munia*.

Ischoemum angustifolium is the common bhaber baib or sabai grass found on the bare slopes and forest 'blanks' of the Sub-Himalayan areas. It is also common in Bihar and Orissa, Bengal, Central India, and the West of the Punjab and extends even into Afghanistan. Its chief use is for paper-making and in this respect it holds first place in India at present. It is usually bundled and pressed in situ and loaded in this form on to the railway, to be conveyed direct to the pulp mill. The Bhaber grass areas of India are already beginning to fail to meet the increasing demands of the paper-mills, and this grass is now being collected from distant places and of late plantations have been successfully raised. Bhaber grass is also used for making rough ropes and mats, the long-fibred grass being preferred.

Saccharum munja, known as munj grass, is found almost throughout India, along river-beds and other low lying places of the plains and lower hills. It is a reed-like grass with a straw-coloured, long, straight stem. It is extensively used in the manufacture of ropes, baskets, screens, and the well known "Delhi matting". Munj matting is fairly proof against white ants but they have been known to attack it when it gets old. Munj is also used for thatching in some parts of India, and, to a lesser extent, as a textile fibre and in the manufacture of paper. Ekra grass, a variety of munj found in Bengal and Assam, is used extensively in those provinces for making "ekra mud walls" which are built up with mud plastered over this grass.

Another important grass is *Vetiveria Zizanioides* which produces the "khus" of commerce. It is found throughout the plains and lower hills of India and Burma, on moist heavy soils, and along the margins of streams and lakes. "Khus" is the term applied to the long fibrous roots of this grass, which are used throughout India for making the well known khus* "tatties" or aromatic scented mats, which are hung over doorways and kept wet, to cool the air of the room in hot weather. These roots are exported in fairly large quantities from Madras ports. The stems of this grass are used to a limited extent for paper-making and commonly for the manufacture of fans, ornamental baskets, etc. The young grass is much used for fodder and is also extensively employed for thatching purposes.

Other thatching grasses, used throughout India, and bringing in a continually increasing revenue to the Forest Department, are *Andropogon contortus* (spear-grass), *Imperata cylindrica*, *Saccharum narenga* and *Erianthus ravennae*.

The only other grasses of any importance are *Typha elephantina* (elephant grass) used for ropes, baskets and matting, *Syperus Tegetum* (korai), a sedge, found in most parts of India and used for mat-making, and *Phragmites* spp., found in marshes and swamps of North India and used for chair and basket. When split open it is woven into mats.

*Wrongly referred to as "Khus Khus" tatties by the Anglo-Indians. Khas Khas is the seed of poppy.

CANES

Few forest plants are more useful to the inhabitants of moist tropical regions than the species of *Calamus*, the canes and rattans. As substitutes for ropes, they are invaluable, and in the districts where they abound, canes 300 to 400 ft. in length are frequently employed as the bearing ropes of suspension-bridges. They are exported to Europe in fairly large quantities for basket-making and wicker-work.

The more important canes of India include the following:

Calamus acanthospathus: A common and extensive climber of North East India.

Calamus gurubs: A slender cane which is still fairly common in Burma and North East India.

Calamus latifolius: By far the strongest cane which finds its way on to the Indian market. It is plentiful in Burma, East Bengal and Assam, and may be regarded as the true "rattan" of East India, so much favoured for walking sticks.

Calamus tenuis: A very long climbing cane found all along the Sub-Himalayan tracts from Dehra Dun to Assam and also in Burma. It is the common cane of North India and is used for basket-work, mats, screens and furniture.

Calamus viminalis: A thin strong cane which makes excellent walking sticks. It is the chief "rattan" of Burma, spreading over into China and the Malay Peninsula.

There are several other canes of more or less local importance, the Andaman Islands being especially rich in *Calamus* species.

BAMBOOS

Bamboo is among the most useful indigenous products of India and of great importance to the majority of the population—in the first place to the rural population for a surprisingly wide range of purposes, secondly to the urban population for a variety of more specialised purposes for which it is the cheapest and most convenient material, and more recently, for a purely industrial purpose, viz., paper making. Bamboo is usually a natural forest product, though in some localities, particularly in Bengal, it must rank as a cultivated crop and in many places has undoubtedly been almost or quite exterminated as a wild plant by excessive exploitation.

The really important species of bamboo are perhaps half a dozen in number, and among these *Dendrocalamus strictus* is the most wide-spread and most valued.

According to the Returns of Statistics relating to Forest Administration in British India bamboos bring in a revenue of nearly 15 lakhs of rupees per annum. This is by no means the maximum output. Large areas are not tapped owing to their remoteness and in addition to the cash realised the local population is allowed the use of this product either free of charge or at nominal payments.

Dendrocalamus strictus is found in deciduous forests throughout the greater part of India except in North and East Bengal and Assam. It is common in the drier types of mixed forests throughout Burma. It is found typically on hilly country ascending to 3,500 feet, and occurs gregariously. It sometimes occurs more or less pure with almost no tree growth, but more usually forms an under-story or a mixture with deciduous trees. It is abundant in many parts of the Siwalik tract and outer Himalayas from the Punjab to Nepal, occurring most plentifully bet-

ween the Ganges and Ramganga rivers. It is also common in most of the hilly parts of the Indian Peninsula, viz., the hills of the Eastern and Western Ghats and of Central and Southern India, except in very moist regions. In Burma it is the typical bamboo of the drier types of upper mixed deciduous forests, with or without teak, and also extends into dry Dipterocarp forest. Its range reaches to Singapore and Java but it is not found in Ceylon.

In view of the importance of this commodity a co-operative investigation is being carried out by the Forest Research Institutes in several provinces and States to find out the best method of working bamboo clumps to obtain the maximum sustained yield.

DISTILLATION AND EXTRACTION PRODUCTS (INCLUDING OIL GRASSES)

GRASS OILS

There are in India five well known commercially recognised aromatic oils which are distilled from forest grasses. These are rusa grass, lemon grass, citronella grass, ginger grass, and vetiver grass.

Rusa grass oil is the product of *Cymbopogon maratini* which occurs locally in the Central Provinces, Bombay and Hyderabad. Two important varieties are to be found—a sporadic variety bearing the vernacular name of “motia” and a gregarious variety of less value known as “sofia”.

The distillation of the oil is generally carried out by the contractors leasing the grass areas, or by villagers who are experts at their work although using the crudest of apparatus. Efforts have been made lately to improve the stills used for the production of this oil but without success.

Rusa oil is largely exported to Europe and the United States, where it is chiefly used for mixing with rose oil for the production of “otto of roses”, in which there is a very large trade in European countries. It is also used in soap-making, for scenting hair oils and pomades, and as a tonic and febrifuge, but is frequently found adulterated with cheaper oils such as turpentine or linseed.

Lemon grass oil has a strong scent of lemons. It is used chiefly in the manufacture of scents and in perfuming soaps. There is a large export trade in this oil and the demand is increasing every year. It is also used extensively, in India, for cooking and flavouring. Its medicinal properties are doubtful but it is popular as an anti-mosquito agent when rubbed on the face and hands.

The other three grass oils, namely, citronella, ginger grass oil, and vetiver oil, are of minor importance compared with rusa oil and lemon grass oil.

WOOD OILS

Wood oils are generally produced by the distillation of wood chips with water, and must not be confused with the natural exudation products of woody plants.

From a commercial point of view, the most important and best known of these oils is sandalwood oil, obtained from *Santalum album*.

The chief sandal-producing areas are in Mysore and to a lesser degree in parts of Madras, Bombay, and Coorg.

Another important, interesting wood oil of increasing importance is “agar” oil, distilled from the dark brown resinous

portions of the wood of *Aquilaria Agallocha*. This tree occurs only on the East side of India, in Assam, Bhutan, the Khasia Hills, and parts of Bengal and Burma. Little is known regarding the occurrence of the brown patches of wood which appear in some trees but not in others. The oil is a valuable perfume "retainer", and is much prized by European perfumers for mixing with their best grade scents.

Agar wood itself, sometimes known as "eagle-wood", is in great demand in China, where it is used for burning as incense, and there is a large export trade in this commodity with that country.

Other wood oils, of more or less local importance, obtained usually by extraction in water or by a crude form of destructive distillation, include "cedar-wood oil", obtained from *Cedrus Deodara* a black tar-like oil, used in skin diseases, for fly-bites, and rheumatism; "teak oil" from *Tectona grandis*, used in Burma for skin diseases; and the oils obtained from *Pinus longifolia* and *Pinus excelsa*.

Tars: In addition to the volatile oils here mentioned, tars of varying utility can also be obtained from the above species, and in fact from most woody species, by destructive distillation, but so far there seems to be little demand in India, for these destructive distillation products. It is possible that wood tar creosote will be used in India for the preservation of sleepers, although at present only coal tar creosote is used for this purpose.

LEAF OILS

Among distillation products obtained from leaves may be mentioned the oil and crystals obtained from *Cinnamomum camphora*, the true camphor tree. The world's supply of camphor chiefly comes from Formosa, Japan, and China, and this species is only found cultivated on a small scale in South India and Burma. Eucalyptus oil from *Eucalyptus globulus* is obtained by distillation of the leaves of this species, and this industry is now being conducted on a fairly extensive scale in the Nilgiris mountains in South India.

Other distillation products of minor importance are "cinnamon oil" from the leaves of *Cinnamomum zeylanicum* used for flavouring sweets and confectionary, and the Ngai or "blumea" camphor from *Blumea balsimifera*.

MISCELLANEOUS DISTILLATION AND EXTRACTION PRODUCTS

Two of the most important minor products of India are the well known "cutch" and "katha", obtained from the heartwood of *Acacia catechu*, a common tree found in most deciduous forests of India and Burma. A third article of commerce is also obtained from this tree, in the shape of a white powder which appears as a deposit in the wood and is known as "kheersal".

Cutch is an important commercial product, largely exported and used as a dyeing and preserving agent. It is extensively employed for dyeing canvas, for boat sails, etc., a reddish-brown colour, and for dyeing and preserving fishing nets. It is also used in medicine as an astringent, but is not satisfactory as a tanning agent.

Katha is prepared in the first stages, in the same way as cutch, but the reboiled liquid is poured into moulds dug in fine sand which absorbs the tannic acid, and leaves a residue of catechin to crystallize out into the katha of commerce. Katha is,

therefore, similar to cutch but with most of the tannic acid extracted, and is used throughout for eating with "pan". It is not exported but the Indian demand for this commodity is enormous.

Kheersal, the white crystalline deposit found in the wood of *Acacia catechu*, is much valued as Hindu medicine and fetches a high price.

The only other product that need be considered in this note is the well-known "mahua liquor", obtained from the flower corollas of *Bassia latifolia*, a common tree in most parts of India. The collection of flowers is usually allowed free to privileged and right holders who sell them to the Government distilleries. To facilitate collection, the villagers burn the ground under the trees, and forest fires are not infrequently started in this way. The liquor is obtained by allowing the flowers to ferment under the water and distilling the resulting liquid. Mahua liquor is an intoxicating beverage which might be termed the whisky of native India. The flowers also are used, either fresh or dry, as an article of food.

OIL SEEDS

There are a very large number of forest trees which bear seeds yielding oils of varying commercial importance. Some of these oils have already established good markets for themselves, but the majority are of local importance only, although a few deserve better attention, due to their richness and quality. Owing, however, to the scattered nature of most Indian trees, and the consequent high cost of collection of the seeds on a large scale, forest oil-seeds can seldom compete with oil seeds produced as field crops, such as linseed, sesamum, mustard, and rape. They are used, nevertheless, for multitudinous purposes, of which the chief are cooking, lighting and the adulteration of more expensive oils.

Bassia latifolia: This well known tree produces the "mahua butter" of commerce. This butter is used extensively in India for adulterating ghee, for cooking purposes, and soap-making. The oil is also used by hill tribes for burning.

Bassia butyracea: It is a large tree extending along the Sub-Himalayan tracts from the Ganges to Bhutan. The seeds yield an oil known as "phulwa oil," which is obtained by beating the seeds to the consistency of cream and squeezing out the liquid portion through a cloth, by placing weights on it. It is used for the same purposes as the oil of *Bassia latifolia*; and the seeds of both trees are exported to Europe for use in the making of oil-cakes.

Schleichera trijuga:— A large tree found in the deciduous forests of India and Burma. It produces seeds yielding the "kusum oil" of commerce. It is a bright yellow oil used for cooking and lighting purposes. It has also been found suitable for soap-making, and is reputed to be the original "Macassar oil" possessing properties for cleaning and promoting the growth of hair.

Taraktogenos kurzii:— This tree is found only in Sylhet, Chittagong, and Burma, and is important as the producer of "charlmugra oil" which is expressed from the kernels of the seeds. Chaulmugra oil has long been used in India for leprosy and skin diseases and it is now a drug of some importance in European markets.

Pongamia galbra:—A large tree of Central and South India, produces seeds yielding a yellow-brown oil of local importance. It is used in medicine as an antiseptic and for lighting purposes.

Mesua ferrea:—The ironwood tree which is found in Burma and

Assam, and also on the East and West Coasts of India, possesses a rich oil-yielding seed. The oil has a fine red-brown colour and is slightly scented. It is used for burning and applying to sores, and might be found very suitable for confectionary.

Shorea robusta:— Yields the well-known "sal butter," from the cotyledons of its seeds. It is used for cooking and lighting and adulteration of ghee.

Garcinia indica:— The seeds yield "kokam butter," sometimes known as "mangosteen oil." It is found in Indian bazars in the shape of egg-shaped solid lumps and is used in the preparation of ointments and as a nutritive medicine.

Other oil seeds of varying importance are obtained from *Mimusops elengi*, *Juglans regia*, *Arasinuchha indica*, *Celastrus Paniculata* and *Prunus spp.*

In addition to the above, some tree seeds produce a "wax" which is useful for burning purposes. Amongst these are *Sapium sebiferum*, which is found extensively planted and runs wild in North India. The seeds of this tree are coated with a white wax, used in China for the manufacture of candles and soap and for dressing cloth. This wax is not, however, utilised to any great extent in India, as the cost of collection is prohibitive.

Another wax-producing seed is that of *Rhus succedanea* a small tree of the Himalayas. The seeds are crushed, boiled, and mixed with the oil of *Melia azedarach* fruits, producing a wax which is made up into candles which are sold under the name of "Japan wax."

DYES.

(a) Wood Dyes.

Since the introduction of aniline dyes, the value of formerly important vegetable dyes, obtained from forest trees and plants, has been greatly reduced. There are, however, a considerable number of these dyes, and although most of them are now of local interest only, there are still a few which retain their former importance.

Probably the best known of these is "santaline" dye, the product of *Pterocarpus santalinus*, the red sanders tree of Madras. The wood of this tree yields a bright red dye used as a colouring agent in pharmacy, for dyeing leather and staining wood, and when dissolved in alcohol it dyes cloth into a most beautiful salmon pink colour.

The wood of the jack tree, *Artocarpus integrifolia*, as also that of *Artocarpus lakoocha*, if ground to powder and boiled in water, yields a bright yellow dye, used for colouring cloth and especially for dyeing the robes of Buddhist monks in Burma.

Caesalpinia sappan wood yields a valuable red dye, known commercially as "brazilin."

These are the more important wood dyes used in India at the present time but the use of cutch extract from *Acacia catechu* must not be overlooked. This extract is by far the most valuable dye-agent that India possesses and has been fully described under distillation products. It has the valuable property of being a tan extract as well as a dye-agent and its great value arises from its preservative qualities, when used for tanning and dyeing canvas, leather or cloth.

(b) Bark Dyes.

Many barks yield brown and black dyes, but as the same barks are often used for tanning purposes, the dye contained in

them is, more often than not, considered a defect rather than an asset.

(c) Flower Dyes.

More important, generally speaking, than wood, bark and root dyes, are the natural dyes obtained from the flowers of many forest trees. The right of collecting these flowers is usually given to contractors or to merchants who employ regular collectors from the neighbouring villages. The number of species in the forests of India yielding flower dyes is very large and probably runs into many hundreds but of these only a few are of real revenue producing value, the remainder being of local interest only.

One of the best known flower dyes is that obtained from the red fruit glands of *Mallotus philippinensis*, and known commercially as "kamala powder." The tree is a small one and fairly common throughout India and Burma. The dye is extensively used for dyeing silk a bright orange or flame colour, and mixed with other ingredients, the colour can be toned from pale yellow to dark red. The dye was formerly exported in fair quantities to Europe but, since the introduction of aniline dyes, the export trade has weakened considerably.

Another well known dye is the "arnotto dye" of commerce obtained from the pulp surrounding the seeds of *Bixa orellana*, an American tree now extensively cultivated in South India. The dye gives a beautiful pink colour to silk and cloth. It is exported to Europe where it is employed, amongst other uses, for colouring cheese and butter.

Another popular flower dye is that obtained from the well known tree "Flame of the Forest," *Butea frondosa*. The dried flowers yield a bright yellow dye which is extensively used for colouring native saris, but when used by itself, the dye is not very permanent and has been supplanted to a large extent by the more permanent aniline dyes.

Amongst other flower dyes may be mentioned those of *Ochrocarpus longifolius* and *Woodfordia floribunda* yielding a red dye used for colouring silk; *Wrightia tinctoria*, whose seeds produce a blue colouring agent similar to indigo, and the flowers of *Cedrela toona*, *Nyctanthes-Arbor-tristis*, and *Michelia champaca*, all of which yield yellow dyes, used for colouring silks and cloth.

(d) Root Dyes.

Here again, there are numerous forest trees and plants whose roots yield dyes of varying quality, but the majority are unimportant from a forest point of view and are only used locally by villagers who are unable to procure anything better.

The most commonly used are those obtained from the roots of *Berberis aristata*, *Morinda tinctoria*, *Simplocos* spp. *Datisca cannabina* and *Punica granatum*, all of which yield dyes of yellow and red shades.

TANS.

The name "tannin" is given to organic substances which have the property of combining with albumen and gelatine, to form an insoluble compound which will resist decay. Raw animal hides, treated with tannin, are converted into the decay-resisting material known as leather. India is a country enormously rich in potential tan-stuffs, and investigations carried out during the last war served to bring a number of these more prominently into the daylight.

(a) Bark tans.

Forest trees with barks yielding useful tanning material are very numerous.

The most important bark now used by tanners, especially in Northern India, is that of *Acacia arabica*, the babul tree. It is a common tree found in forests, on waste areas, and on cultivated land. The chief areas producing babul bark in commercial quantities are the Central Provinces, Sind and Bombay. In the United Provinces it is a common tree, but is usually found scattered over waste and cultivated lands. Babul trees are generally sold standing to contractors, who strip the bark, dry it, and despatch it in bundles, to the tanning factories. The most important centre of consumption is Cawnpore, and most of the babul bark of India finds its way to the leather factories situated in that district. It is chiefly used for tanning sole leather. It contains up to 20% tannin. Used alone, it gives an ugly red leather but as a rule it is employed mixed with myrabolans which improve the colour. The chief claim of this bark is its cheapness and abundance. It is, however, bulky and the percentage of tannin it contains is small, so that it is likely to remain a tanning material of great local value, but one that stands a poor chance of being exported in any large quantities.

Cassia auriculata (Turward or Avaram) is pre-eminently the most important tanstuff employed anywhere in the peninsula to the south of a line on the map drawn eastwards through Bombay. It is very largely used in the tanning of "crust" leathers, and most of the hides exported to England during the war were submitted to the half-tanning or crust-leather process with "Turward," before export. "Turward" contains a Catechol tan which yields a pale coloured leather. This leather has a tendency to redden on long exposure to sun. The distribution of "Turward" is wide, but such was the demand for leathers tanned by it during the war, that the supply available was not equal to the demand. The average percentage of tannin in "Turward" bark is about 18 to 20, and of soluble non-tannins about 10. At the close of the tanning process with "Turward," the hides are invariably treated with a brew of myrabolans, this process lightening the colour of the leather.

Woodfordia floribunda (Dhawai): A sample of this bark from Gonda gave 26.65 per cent tannin to 11.47 per cent soluble non-tannins. Of samples collected near Maihar, the heaviest part of the bark showed 27.24 per cent of tannin to 11.22 per cent soluble non-tannins, whilst the lighter bark from the upper portion of the bush showed 20.04 per cent tannin to 9.11 per cent soluble non-tannins. All of these analyses indicate that this bark is capable of yielding some 30 per cent of its weight on an extract containing over 60 per cent tannin. The bark has been used quite extensively at the Esociet Tannin Research Factory in the tanning of crust leathers. The tannin penetrates rapidly and the leather tanned with it has a very fine pale cream colour.

Shorea robusta (sal): The bark of this tree has not in the past been well reported on as a tanstuff, owing to the harshness of tan and more particularly to the strong colour imparted to the leather. It has, however, been employed to a certain extent to eke out the bark of babul. Analysis of the mature bark showed 10.95 per cent of tannin to 7.74 per cent of soluble non-tannin. A powder "concentrate" prepared from this properly collected "sal" bark by crushing and sieving to remove the fibrous portion, showed 24 per cent of tannin to 13.25 per cent of soluble non-

tannins. It is probable that properly prepared "sal" bark will yield an extract similar in class to Quebracho, but less rich in tannin.

Lannea grandis: This tree being of a very wide distribution, the bark might be used in local tanneries. It would probably produce pink leathers. Samples of twig-bark showed 12 per cent tannin, whilst the mature bark from the bole of the tree showed 10.25 per cent tannin. Tannin and soluble non-tannins are present in about equal proportions; the calculated theoretical maximum possible percentage of tannin in "crystals" prepared from the twig-bark only comes to 45 per cent.

Cassia fistula is another tree producing a bark known as "sunari" which is also extensively used for tanning but is not considered so good as 'turward' bark. The tree has a wide distribution, being found all over India, Burma and Ceylon, and is commonly known as the "Indian Laburnum."

Terminalia arjuna bark can be used in mixtures in the production of light leather, but it is pre-eminently suited to the tannage of sole and heavy leather. The rate of penetration is increased by a preliminary treatment with a mucilage of the fruit of *Zizyphus Xylopyra*.

The only other barks of outstanding importance which give tanning agents of commercial value are those of the mangroves.

The term "mangrove" is generally applied to all species capable of growth and development in a water-logged semi-salt soil, earth medium.

Generally speaking the stem bark of the mangroves is richer in tannin than the bark of the twigs and small branches. Conversely, less chlorides are usually found in the bark and wood of the base of the tree than in the upper portions. There are exceptions to this, and in certain instances where the twig-bark is richer in tannin than the bark of the boles, this particular twig-bark is also poorer in chlorides.

Heritiera minor (sundri). With approximately 10 per cent tannin to 5.5 per cent soluble non-tannins, this bark cannot be considered rich. It is however present in the Sundarbans in enormous quantities and therefore should be mentioned.

Caapa Moluccensis (Pussur):— The bole bark of this species gives a yield of "crystals." The bark is, however, coated with an outer scale largely consisting of hard, waxy matter, and this is much richer, although the yield is somewhat less. The yield amounts to 25 per cent of "crystals" with 5 per cent moisture— theoretically capable of a percentage of tannin of 81.66. It is most unusual to find an outer-scale bark at all rich in tannin and the phenomenon in this case may perhaps be attributed to the preservative character of the particular tannin as well as to the protective nature of the waxy or resinous material present. It need hardly be pointed out that this waxy outer scale bark should be included when "Pussur" bark is collected for commercial purposes. It is valuable as a dye of the cutch class, giving somewhat bluer shades of brown on the fibres than pure cutch.

Rhizophora mucronata (Goraun). This is often spoken of as the "common mangrove," though it is relatively less common in the Sunderbans than in most other mangrove areas of the world. Usually, it gives a leather of a very ugly brick-red colour greatly objected to, but by prompt drying after collection the product obtained imparts much colour to the leather, and is proportionately richer in tannin. Collected samples showed some 35 per cent of tannin to 14.09 per cent of soluble non-tannins. This

corresponds to a yield of "crystals" with 5 per cent moisture, of about 46.5 per cent with a calculated theoretical maximum possible percentage of tannin of 67.73.

Ceriops Roxburgiana (Goran): Next to Sundri "Goran" is perhaps the commonest tree in the Sunderbans. Its bark is a well-known product on the Calcutta market, where it (as brought in by the natives adhering to the tree and removed after arrival) analyses out as a rule at some 24 per cent tannin.

Kandelia Rheedii (Goria). This tree is common enough along the various creeks in the Sunderbans to merit some mention here. Its twig and small branch bark is richer than the bark of larger stems, but with only 15.36 per cent tannin to 9.24 per cent soluble non-tannin, it cannot be considered very rich.

Bruguiera gymnorrhiza (Kankra). This is not as common a species in the Sunderbans as in many other mangrove areas. As in the case of "Pussur" the outer scale bark (cortex) is useful, and would be employable as a dye-stuff. The main layer of bark, i.e. excluding the outer scale bark, theoretically should yield 45 per cent of "crystals" and the calculated theoretical maximum percentage of tannin works out at 62.94 per cent.

Lumnitzera racemosa (Kirpa). The mature bark of this tree indicated 28.59 per cent in yield of "crystals" with 60 per cent tannin. It is however a rare species in the Sunderbans.

Analyses of various kinds of hill oaks and chestnut trees of India have given very promising results. The *Valonia* (acorn cups) of *Quercus pachyphylla* of the Darjeeling district has, at Maihar, made leather which is passed by the Committee of Control of the Research Tannery as of very good quantity "as sole leather judged by Indian standards." A sample of bark of *Quercus fenestrata* from Darjeeling district showed 15.85 per cent tannin to 8.44 per cent non-tannins, and gave a remarkable pale oak infusion.

A very great variety of other trees yield tan barks of varying local importance, amongst which may be mentioned *Shorea robusta*, *Acacia leucophloea*, *Terminalia tomentosa*, *Tamarix articulata*, *Lagerstroemia* spp.

(b) Fruit tans.

Of equal importance with bark tans, and yielding a greater revenue to the Forest Department, are certain tree fruits, which are used for tanning purposes and for preparing tan extracts.

By far the most important of these is the fruit of *Terminalia chebula*, known commercially as the 'chebolic' myrabolan. The tree occurs in Madras, Bombay, the Central Provinces, Bengal, Northern India, and Burma, and very large quantities of myrabolans are exported to Europe from the first three mentioned Provinces. By themselves they do not tan leather of good texture, but they give excellent results when mixed with the deeply coloured barks, and are in great demand all over the world. The fruits themselves are exported in a dried state, either whole or crushed, but the cost of this form of export is great and home tanners have always been suspicious of this latter form of raw material, on account of the danger of adulteration. There are several different grades of myrabolans used in commerce, and prices vary according to quality and the source of supply. No. 1 Jubbulpores and No. 1-Bhimlis are prized as of high grade in the European market. These are relatively small, close-ribbed nuts,—or, more correctly speaking, fruits, but the dried fruit is very generally spoken of as a nut and resembles one in appearance.

The pods of babul tree dried, crushed and then sieved to remove the seeds and fibre are employed in the Sudan to produce a raw tanstuff named "Sant Grains," which contain 50 per cent tannin and has found favour in the European market.

Another tree producing tan-pods is *Caesalpinia coriaria*, which yields the "divi-divi" pods of commerce. The tree is a small one and is not indigenous but is extensively cultivated in the forests of Bombay and Madras.

Another tan-fruit of note is that of *Zizyphus xylopyra*. It is a small tree found in most parts of India and its fruits are used to give a black colour to leather. When crushed fruit is mixed with water, a sort of thick mucilage rapidly results. Experiments carried out at the Esociet Tannin Research Factory have shown that if hides be passed through a series of pits containing this mucilage, in increasing strengths, they become penetrated very rapidly, the gummy matter seeming to open up the hide for the reception of tannin.

The fruit of *Sonnertia apetala* (Keora) gave, on the small laboratory scale, a pale coloured strong supple leather quite free from "crack", but the tannage was slow, and the dry leather constituted only some 50 per cent of the wet weight of pelt.

Caesalpinia digyna pods have been reported to give a tan product containing 50 per cent to 60 per cent tannin if shelled when green and dried in the sun after the seeds have been removed.

(c) Leaf tans.

Leaves are not extensively used for tanning purposes and from a forest point of view they are unimportant as tan agents and only used in a small way by local tanners as decolourising agents. The best known are the leaves of *Anogeissus latifolia*, *Phyllanthus emblica*, *Lawsonia alba* and *Rhus continus*. The leaves of *Hopea odorata*, a common Burma tree, yield a sumac of exceptional value but these have not yet been exploited.

Anogeissus latifolia: The young leaves of this plant are very rich in tannin, samples having been analysed upto 54 per cent. The mature leaves, on the other hand, may contain as little as 12 per cent tannin. The "sumac" resulting from the leaves (prepared by prompt drying and crushing) has been reported satisfactorily to fulfill the various purposes for which Sicilian "Sumac" is applied, while when prepared from red leaves it is of double the tannin strength of the European true "Sumac" (*Rhus coriaria*).

The leaves of "Sundri" (*Heritiera minor*), "Goran" (*Cerriops Rixburghiana*), "Kankra" (*Bruguiera gymnorhize*), and the "Golpatta" (*Nipa fruticans*), all gave, on the laboratory scale, soft, supple, pale-coloured "crust," leathers. The leather produced by *Nipa fruticans* was almost white. Attention is called to these leaf tans both for their own merits in the production of supple leather, and also on account of the good influence they are likely to have, when mixed with red barks, both in mitigating the harshness and in improving the colour of the leather.

(d) Wood tans.

Carapa obovata (Dhundul): Analyses indicated a yield of "crystals" with 5 per cent moisture of 7.36 per cent with a theoretical maximum possible percentage of tannin of 58.2.

Carapa moluccensis (Pussur). The branch wood indicated a yield in "crystals" with 5 per cent moisture of 10.85 per cent, with a calculated theoretical maximum possible percentage of

tannin of 61.98. The bole wood showed 11.83 per cent of "crystals," with 67.01 per cent of tannin. This is a good yield for a wood

Cutch is the name given to the solid extract prepared from the heartwood of *Acacia catechu*, "khair"; though at times this name is also applied to lighter coloured tan extracts, such as Borneo cutch. The chief use of cutch in the United Kingdom is for dyeing fishing nets. Cutch—largely the Borneo variety—is also extensively employed in Japan both for fishing nets and sail-cloth. Cutch imparts a deep reddish-brown colour to the material and acts on the fibre as a preservative. Most forms of cutch made from *Acacia catechu* contain a fair percentage of catechin, a white crystalline substance which is insoluble in cold water. This insoluble catechin is also deposited on the fibre, and slowly oxidises into tannic acid and other products by the action of the sea water. Hitherto but little serious effort has been made to organise the industry on strict scientific lines for the reason that the prices obtained for it by the original manufacturers do not justify extra capital being sunk in elaborate machinery similar to that required for the preparation of tan extracts.

Leaf-galls found on several Indian trees are also used locally for tanning purposes. The best known are the galls of *Tamarix* spp., *Garuga pinnata*, *Prosopis spicigera* and the *Terminals*.

At present large quantities of tanning material and hides are exported outside the country, and similarly a considerable quantity of finished leather imported. Research in the utilisation of indigenous raw materials, and the processes, should aim at not only producing locally all the leather of all qualities required in the country but also at producing tannin extracts and finished leather for export. Export of raw hides and tanning agents is a serious drain of the country's resources.

PART G. TRANSPORT.

Summary.

Communications

Out of the total area of 1,25,010 sq. miles of State forests, 54,335 sq. miles are either inaccessible or profitless. With 43% of the forest area without any suitable means of communications, full development of our forests cannot be expected.

Roads.

There are fair weather roads for extraction of forest produce which are mostly impassable in the rains. They are, with few exceptions, not fit for mechanical transport and the loaded bullock and buffalo carts ply with difficulty. There are extensive areas where even fair weather roads are absent.

Whenever communications have been improved the value of forest produce has at once gone up, e.g., in Nepal and Bihar. There are probably not many instances in British India where a railway line has been specially built with a view to develop forests in the country. The forests have benefited only incidentally.

Accurate figures for the whole of India are not available but it is estimated that the expenditure on forest communications does not seem to exceed about 2.8% of the total forest revenue.

The Forest Department has been handicapped in developing the transport system for want of funds.

Water transport

Water transport is often the cheapest means of transport, but it loses much of its usefulness because most of the species in Indian forests will not float. Transport by boats or some other contrivances are sometimes not possible due to the presence of rocks and rapids in the stream beds and the shallowness of the streams. If the rock obstructions be broken down by blasting and other means, a suitable floating channel can be formed and the rapids will lose their danger to a great extent.

Water-ways have been found to have been instrumental in actually creating industries, e.g., in Finland, Canada, Germany, etc. It is therefore necessary that the rivers and streams flowing through or in the neighbourhood of the forests should be examined with a view to make them fit for floating timber.

Wood as a source of power.

The use of wood charcoal as a source of power should be encouraged by all possible means. The making of charcoal by villagers should be encouraged and this may be built into a profitable industry. Recent experience in the Central Provinces, shows that charcoal is able to compete under certain circumstances with petrol as a motor fuel.

Railway freight.

The rates of freight on forest products charged by the Railways are generally too high and should be reduced. Large quantities of fuel and numerous poles run to waste in several forests on account of the high incidence of railway freights to the main centres of consumption.

Part G. Transport.

Are there adequate transport facilities for the development of forests and industries utilising forest produce in your Province? If not, make suggestions for improving these.

Communications.

The value of good communications in developing the resources of a country has always been recognised.

There are three primary means of extracting timber and forest produce, namely, railways, roads and rivers. The full development of forest resources depend upon the adequacy of these means of transport.

Out of the total area of 1,25,010 sq. miles of State forests 54,335 sq. miles are either inaccessible or profitless. With 43% of the forest area without any suitable means of communications, development of our forests cannot be expected. India is one of the very few countries where communications especially in reference to forests are so poor.

Roads.

There are fair weather roads for extraction of forest produce which are mostly impassable in the rains. They are narrow and the alignment of most of them could be greatly improved. They are with few exceptions, not fit for mechanical transport and the loaded bullock and buffalo carts ply with some difficulty. There are extensive areas where even fair weather roads are absent.

Whenever communications have been improved the value of forest produce has at once gone up. The Nepal Durbar constructed a 25-mile length of light railway at a cost of about Rs. 4,50,000|- which has made it possible to extract timber of the value of about Rs. 15,000,000|-. The revenue of one of the divisions in Bihar has gone up from Rs. 20,000|- to Rs. 100,000|- after the construction of railway in its neighbourhood. These are some of the striking examples which show that these forests were practically useless before these railway extensions. There are probably not many instances in British India where a railway line has been specially built with a view to develop forests in the country. The forests have benefited only incidentally.

Accurate figures for the whole of India are not available but it is estimated that the expenditure on forest communications does not seem to exceed about 2.8% of the total forest revenue.

It must not be forgotten that sound forestry is the resultant of two equally important components—silviculture and utilisation. Elementary economics teaches that production by itself is not enough and that distribution and utilisation are equally important. So far we have concentrated almost wholly on silviculture but the Forest Department has been handicapped in developing the transport system for want of funds.

Water Transport.

Water transport is often the cheapest means of transport. In India the transport of forest produce by water loses much of its value because most species will not float. It may be possible however to carry some of these by water in boats or in some other contrivances. Other difficulties are the rock barriers in the stream beds and the shallowness of the streams.

The value of some of the forests is entirely dependent on rivers, for example, the coniferous forests of the Himalayas, the tidal forests of the Sunderbans, the bamboo areas of Chittagong and part of Orissa. There are other forest areas through which rivers flow but on account of the presence of rocks and rapids in their beds they are not at present navigable or fit for floating forest produce; but if the rock obstructions be broken down by blasting and other means, a suitable floating channel can be formed and the rapids will lose their danger to a great extent.

In Finland logs are floated down distances of 500 miles at an incredibly low cost and millions of logs are so transported annually from forests to the mills at sea-ports. In Canada water transport is the backbone of forest utilisation. The export by rail and road over long distances of any except the best and most valuable commodities is uneconomic. Water-ways have been found indeed to have been instrumental in actually creating industries in localities which without them could not have been exploited. A leading authority on inland navigation in Germany has stated that certain valuable products and by-products of the German mines and iron works and the more bulky products of the chemical industries have found a market only on account of the cheap rates at which they can be transported by water. It is said that in Germany the maximum is "not railways or canals" but "railways and canals." This also applies to some forest produce in India. It is therefore necessary that the rivers and streams flowing through or in the neighbourhood of the forests should be examined with a view to make them fit for floating forest produce.

Wood as a source of power.

With the exception of a few cases where timber etc. is transported by ropeway or light-railway constructed by the Forest Department and by rivers, to the consuming centres, the great bulk of all kinds of forest produce is brought by bullock carts from the forests by fair weather and for the most part indifferently aligned forest roads. These roads are not metalled and it requires a real effort on the part of buffaloes or bullocks to pull the loaded carts, raising storms of dust as they go along. The haulage by cart is cheap and has therefore survived. The additional reason for their survival also is that these roads except in a few cases are not fit for mechanical transport and there being no other means, the bullock cart holds the field. As a matter of fact the cart will remain one of the chief methods of extracting forest produce for a very long time to come. There is however no reason why other cheap means should not also be explored. One that readily comes to mind is to use wood as a source of power.

The utilisation of wood, especially of "hardwood" timber species as a source of heat and power is in one sense very old, but in the light of recent intensive research, especially in France, Germany and Italy, such utilization has become very efficient. Wood is now able to hold its own against most common materials that are used in our present civilisation for power generation for transport of forest produce. It is sufficient to note here that about 10 lbs. of charcoal or about 22 lbs. of "hardwood" or 3/4 gallon of crude oil offer about the same magnitude of power as a gallon of petrol. It will, therefore, follow that about annas -2|- worth of charcoal or wood can generate the same power as a gallon of petrol which costs eight to twelve times

as much as in most places in India. Petrol is only slightly lighter than wood charcoal for equal power generating capacity if the two fuels are employed with moving vehicles. Trees or parts of them which are not useful for any purpose other than for fuel can be employed for power generation purposes. Wood from coppice forests can be utilised. The making of charcoal by villagers may be built into a profitable industry. In Germany, there are 800 wood block loading stations that have been installed at about 80 miles interval, on all the important highways in the country. France and Italy have been following suit.

The bulk of petrol and crude oil consumed in this country is imported. As these enjoy almost a monopoly for power production for driving motor cars, lorries, their prices have already gone up after the outbreak of war. In case, war is prolonged it may be difficult to obtain such fuels in requisite quantities.

The use of wood and charcoal as a source of power should therefore be encouraged by all possible means. The cheap but fast mechanical transport will only supplement the slow going bullock cart. At present exploitation is greatly handicapped on account of want of sufficient number of carts.

Railway freight.

The rates of freight on forest products charged by the Railways are generally too high and should be reduced. Large quantities of fuel and numerous poles run to waste in several forests on account of the high incidence of railway freights to the main centres of consumption. Moreover, wood has sometimes to compete with steel and cement. The latter two commodities it is believed, actually enjoy certain concession rates especially as regards the transport of small lots, which fact restricts the sale of wood to a very great extent. Freight for timber and other forest produce should be reduced in order to facilitate its sale (of such produce) because the conditions vary from place to place.

It will be most useful if the Railway Board will agree to the principle that whenever goods come off one railway on to another the freight rate paid to the new railway should be a continuation of the rate applying on the old railway at the point where the transfer to the new railway began. At present goods are handicapped by having to pay at the highest rate on the new railway just as if the railway journey had just begun instead of enjoying the full advantage of the sliding scale of charges they were paying as they left the old railways.

PART H.

FIRES.

Recommendations

It is recommended that—

1. Whenever the agency of fire—either accidental or incendiary—is adversely affecting, or is likely to so affect soil erosion, floods or vegetation, the damage should be minimised by

- (i) Admitting controlled grazing;
- or (ii) Resorting to deliberate light (winter) burning, which prevents later conflagrations that are most injurious;
- or (iii) Partial or complete fire protection as may be warranted by local conditions.

2. To give full effect to the above measures to minimise damage from fires, in the form of soil run-off, inundation, or regressive succession of vegetation, it is strongly advocated that immediate action be taken

- (i) To constitute a separate branch of the Forest Department in each Province or Indian State to deal exclusively with the imperfectly managed private forests. This branch must be given wide powers to override the decisions of individuals or small communes if they go counter to the general well being of the community as a whole.
- (ii) To take private forest owners and residents in their neighbourhood into confidence by entrusting to them the responsibility that fires shall not occur over certain areas.

As an incentive to such voluntary service rewards should be freely granted to successful communes in the form of constructing public utility institutions such as hospitals, tanks, etc., and even by a rebate on land revenue on deserving individuals.

PART H.

FIRES.

Question 1. Protection of forests from the baneful effects of fires is an essential operation of forest conservancy practised in the reserved forests. In general, a very high percentage of area is successfully fire protected as the following figures show:—

(Vide statement VIII annual Return of Statistics relating to Forests Administration in British India for the year 1937-38).

Province	Percentage of forests under fire protection to total area of reserved forests.	Actual area in sq. miles attempted to be protected.	Actual area successfully protected.	Percentage of success (average of 5 yrs. ended 1936-37).
Bengal	26.0	1,688	1,658	99.0
U.P.	74.0	4,565	4,490	95.5
Punjab	60.2	920	911	98.5
Bihar	86.1	1,128	1,006	91.3
Orissa.	33.0	655	632	97.2
Assam.	76.5	14,848	14,267	96.2
Coorg.	44.0	230	228	98.2
N.W.F.P.	50.4	148	138	94.8
Ajmer.	99.4	142	141	98.7
Madras.	30.3	4,539	4,350	94.2
Bombay.	55.0	7,438	7,116	94.2
Sind.	62.0	668	654	97.5
Total	50.7	36,985	35,620	95.3

In Baroda, 95% of the forest is successfully fire-protected.

Question 2. To minimise the damage to forests from intense fires in the hot weather, departmental firing in the cold weather is resorted to in large areas of the reserved forests which are liable to damage from fires and which cannot be completely fire protected, on account of the shortage of funds or staff. This consists in running a light surface fire through the area as the fallen leaves and grass become just dry enough to burn. Under proper control such early burning is the lesser evil and appears to have little deleterious effect on tree growth nor does it greatly promote soil erosion, as the ground is never completely bared of vegetative cover and the root system of perennial plants that are burnt black or charred is not killed and thus continues to act as a soil binder. Even such early burning operations are being carried out to a steadily decreasing extent in the interest of preserving the grass growth for purposes of grazing. Controlled grazing of such areas as a fire protective measure is now considered a better alternative.

In Bihar, departmental firing as a measure of fire protection has been totally discontinued except for the burning of fire lines, and fire-tracing the main roads and paths by clearing and burning all inflammable growth over 10 to 30 feet wide strips on either side. Early burning was tried as an experimental measure when it was found that it was positively injurious in the comparatively drier types of the forest. Departmental firing where rank grass and weed growth obtains, to get a clean forest floor for obtaining regeneration of tree species. It is suggested that even such operations should be postponed as they have a psychological effect on the popular mind which cannot appreciate its beneficial effect, until the public have been convinced of their necessity by intensive propaganda and visual demonstrations.

In the moist forests of Bombay, where departmental early burning is regularly practised in the interest of reproduction of tree species, to obtain a clean bed and to prevent the occurrence of late fires, such firing does not appear to promote soil erosion or floods. In drier mixed forests some deleterious effects may occur, but it is pointed out that burning stimulates the activity of soil bacteria and no alternative and equally effective practicable treatment for minimising the damage from late fires has so far been found.

In the United Provinces, out of a total area of 6,1650 sq. miles, 1,6000 sq. miles i.e., 26% is not protected from fires. (half of this area is in the Tarai and Babar Estate forests where there is no danger of erosion). In the remaining 4,564 sq. miles attempted to be protected, the failures amount to less than 1.6%. The area successfully protected from intense late fires by departmental (controlled) early burning is 862 sq. miles in extent and mainly comprises the chirpine forests of the hills and the miscellaneous, grassy and Bundelkhand forests of the plains. The effect of such burning on soil erosion and floods are summarised below:—

- | | |
|--|---|
| (i) Grassy forests. | None, as fresh green grass grows up again before the monsoon breaks. |
| (ii) Bundelkhand forests & Chirpine forests. | Run off and erosion are increased to some extent by burning off the leaf litter but at least the forests survive, and early burning is the lesser evil. |

Question 3. In general owing to lack of proper management and the popular belief that burnt areas give a better crop of grass, late fires are extremely common, and in fact almost a regular feature in the drier types of forests adjoining intensively cultivated tracts. Such fires, year after year, aided by continuous and intensive grazing result in the gradual but certain disappearance of the vestigial vegetation and then sheet erosion and rapid runoff of rainfall and consequent floods. Examples of every stage of such devastation are only too common all over the country to need any specific mention. There is little doubt that rigid fire protection will go a long way in checking this retrogressive succession to semi-desert conditions.

Question 4. The necessity for remedial measures to check the process of regression brought about by continuous firing either deliberate or as the result of lack of proper control, is everywhere realised. The actual remedial measures will depend on the degree of damage which differs greatly from place to place.

The areas which still carry a scrub forest and where therefore the process of denudation has not yet commenced, the urgent need is to prevent the recurrence of destructive late fires, by suitable measures, admission of controlled grazing as a first measure in the hot weather. Later remedies will rigidly protect the forests from fires as is done in reserved viz. by fire-tracing them, and appointing special fire patrols and thus induce regeneration of tree species.

The Central Provinces suggest that a separate branch of the Forest Department should be constituted to deal with the vast and improperly managed areas of private forests. This is work of a special nature which the Revenue Department cannot be expected to do. The suggested branch of the Forest Department should be given wide powers in the interest of the community.

Bihar, reports that areas in which for various reasons adequate fire protection has not been possible or has been imperfect, form a very large percentage of the total forest area. The damage done has been very great and the protective measures not always adequate. In short the cost has been incommensurate with the beneficial results accruing therefrom. It is therefore suggested that the villagers should be taken into confidence by assigning to groups of villages the responsibility of seeing that fires shall be prevented in a specified area entrusted to their care. For doing this they should be suitably rewarded, say by constructing wells, schools, tanks, hospitals, etc. in their villages. This should be a sufficient incentive to them for refraining from incendiary practices.

Bombay, suggests that firing of tree growing areas should be stopped, and grassy areas should be fired under control. Similarly growing of field crops for stall feeding should be encouraged to wean away the people from the baneful habit of deliberately burning pastures on the mistaken belief that this results in a better grass crop in the next season.

In the United Provinces two main categories of private forests and waste lands are distinguished viz.

(a) The intensively grazed dry areas such as ravines, usar, bhur, khola etc. These are seldom burnt for the simple reason that on account of heavy grazing they are usually bare of inflammable vegetation before the fire period commences.

(b) The comparatively moist areas such as tarai and khadir and occasional inaccessible areas which are not grazed. These are usually burnt but such burning does not result in

erosion or floods as the areas are rapidly colonised by coarser grasses.

Type (a) is much more extensive than type (b) and on the whole it may safely be said that fires are not nearly so important a factor promoting erosion, floods or denudation as is over grazing. Thus the primary need is to control the grazing.

APPENDIX A.

Terms of Reference of the Sub-Committee on Soil Conservation and Forestry generally, including Afforestation, Grazing and Utilization:

This sub-committee deals with:

- a. The protection against erosion, floods and other detrimental factors affecting the soil;
- b. Treating it with manure and fertilizers;
- c. Providing drainage and other facilities needed to guard against water-logging, weeds, etc.;
- d. Planting of new forests in areas denuded of forests;
- e. Care of existing forests and silviculture;
- f. Establishing or developing industries needed to develop forests ;
- g. Development of forest produce;
- h. Provision of transport facilities needed to develop forests;
- i. Reclamation of land;
and all other pertinent questions connected with silviculture and industries founded on forest produce.

APPENDIX B

QUESTIONNAIRE ON SOIL CONSERVATION & AFFORESTATION

Part A. General.

1. Do you think that there is a balanced and proper distribution of the available land area of your province for the following purpose?

- (a) Food crops;
- (b) cash crops, including market gardening;
- (c) fodder crops;
- (d) grazing for cattle.
- (e) forests;
- (f) orchard and fruit trees;
- (g) trees of economic importance with special reference to needs of rural communities.

Give the area of each category wherever possible.

What are your suggestions for remedying present maladjustments, if any?

2. What broad lines of improvement would you suggest for the improvement of the existing system of land and forest utilisation in your province? What changes, if any, in respect of the following would you suggest to give effect to your proposals?

- (a) Government policy;
- (b) Legislation;
- (c) Agricultural advisory work;
- (d) Organisation of research;
- (e) Training in agriculture and forestry;
- (f) Collation and dissemination of technical and scientific information;
- (g) General propaganda.

3. How do you think our agricultural practices are based on reliable and adequate knowledge of the soils derived from systematic studies? What are your proposals to improve the present position of our soil management and advisory work?

4. What are your views and suggestions regarding the promotion of soil studies in India?

5. (a) Do you consider that the present facilities for research and training in the basic agricultural sciences are adequate?

(b) Do you think the facilities offered in our agricultural institutions have been properly co-ordinated with those which the universities are in a position to afford? How, in your opinion, could the position be improved upon?

6. (a) Could you give a summarised statement enumerating the main types of soils of your province and giving information regarding their,

1. chemical compositions including contents of plant nutrients,
2. mechanical composition,
3. physical properties including moisture relationships,
4. nature and content of exchangeable bases,
5. conditions of acidity and alkalinity,
6. compositions of acid and water extracts,
7. conditions of drainage.

Kindly mention the points including those not mentioned above on which information is not available and on which you consider information should be gathered by investigation or otherwise.

(b) Do you consider that a systematic survey of the soils should be made? If so, what should be the scope and purpose of such surveys? What is the minimum period of time required for such a survey? What are your views regarding the desirability of a rapid survey of land utilisation as it exists at present?

7. How have the establishment of factories, working of mines, quarries, growth of cities and towns, development of railways and similar factors affected forests or lands available for agricultural purposes? Do you consider that in view of the rapid growth of urban population and other changes towns and villages require to be developed according to definitely laid down principles and plans?

Part B. Soil Erosion and Reclamation.

1. (a) What is the nature and extent of soil erosion, including sheet, rill, gully and other forms of water erosion, wind erosion and wave erosion, in your province, and what damage has it caused? To what extent are deforestation and grazing by cattle contributing factors to such damage?

(b) What preventive and remedial measures against erosion have been taken and what are the results thereof? What are your suggestions for improvement?

2. What is the area or percentage of

(a) culturable waste (including mild usar that can be economically reclaimed).

(b) unculturable waste, including reh or severe usar that cannot be economically reclaimed, and lands that are physically impossible to cultivate, such as arid and desert tracts.

(c) water, waterlogged land, and land liable to regular flooding (river beds, khadir, etc.)

(d) roads, railway and canal land, town and village sites etc.?

Part C. Conservation of Soil Moisture and Regulation of Water supply.

1. Is the supply of water from natural sources sufficient for agricultural purposes in your province, or, is there any room for improvement by irrigation or by conservation of soil moisture?

2. What measures have been taken in your province for the conservation and regulation of soil moisture and with what success? To what extent could this be done by afforestation, arboriculture, suitable methods of cultivation, rotation of crops, etc., especially in rural areas and planting of trees in rural areas?

3. What is the nature and extent of damage done to soils and crops by floods in your Province? What steps have been taken to cope with them and with what results? What are your suggestions for improvement?

4. How far is water-logging a menace to the agriculture of your Province? Is water-logging caused by sudden excessive rainfall, low drainage or is it due to flooding by rivers? How can the existing drainage be improved to prevent water-logging?

5. Has any adverse effect of irrigation been noticed anywhere in your Province? If so, what is the nature and extent of the damage? Have any remedial measures been taken and with what success? What steps are being taken to keep watch over possible soil deterioration or total loss as a result of irrigation?

Part D. Soil Fertility and Crop Production.

1. What are, in your opinion, the limiting factors regarding the yield of agricultural produce in the soils of your Province? What percentage increase in yield do you think would be possible if adequate attention were paid to all productive factors?

2. (a) What are the main crops grown in your Province? Does the nutrient status of the soils answer their requirements satisfactorily? If not, what alternative crops and rotations do you suggest which would be more suitable for the existing soil conditions?

(b) To what extent, do you think, the fertility of the soils could be maintained and increased by the application of manures and fertilisers? Mention the manurial requirements of the different kinds of soils of your Province and for the different crops separately.

3. Mention localities known to you in which manures and fertilisers are being increasingly used in recent years. What has been the percentage increase in the yield of crops as a result of their use which cannot be traced to irrigation and other causes? Has their use produced any undesirable after-effect? If so, give details.

4. What is the extent of mixed farming in your Province? Do you advocate it? If so, how would you improve the present position?

5. Is fallowing and rotation of crops practised in your Province? If so, what has been its effect on soil productivity? Do you advocate them?

Part E. Forests.

1. Mention the different types of forests found in your province and give their total area. What proportion of the total forest area is owned by the state and private owners respectively?

2. Do you consider that the methods adopted by the Forest Department and private owners for the maintenance of forests

and silviculture need revision? If so, indicate the directions in which such revision is desirable.

3. What are your views regarding the adoption of a long term policy of afforestation of the areas denuded of forests in your Province, mentioning particularly the schemes of this nature already in operation?

4. To what extent is afforestation, control of grazing, or formation of grass reserves likely to prevent erosion of steep hill sides in these areas?

5. Is there scope for schemes of planting village forests to supply both fuel, fodder and grazing for the villages? How and by what agency should such areas be managed?

Part F. Forest Produce.

1. What are the most important forest products in your Province? What industries, (e.g., paper pulp, artificial silk cellulose products, plywood and veneers, distillation products, resin, tanning extracts, etc.) and occupations are based on them? What scope is there for their further development, or for new industries, to increase production and reduce unemployment? What causes have hindered the development of such industries up to now?

2. The value of timber (teak and other species) annually imported into, or exported from India during the last five years is as follows:—

Imports of Wood and Timber into India.					
(In lakhs of rupees).					
	1935-36	1936-37	1937-38	1938-39	1939
					(April-Sept.)
Total	249	249	298	287	135
Of these teak alone					
was of the value of	176	186	206	200	93
Others	73	63	92	87	42
Manufacture of wood excluding furniture (Wood pulp)	no data	no data	19	16	8
Exports from India (In lakhs of rupees)					
Teak	3.0	2.9	3.7	7.9	2.2
Sandalwood	9.2	9.08	10.1	6.5	4.1
Other wood	4.8	12.1	12.6	4.0	1.5
Total value	17.0	24.8	26.4	18.4	7.8

To what extent can this import be reduced or eliminated altogether by the development and increased exploitation of Indian Forests?

3. What is the total quantity of wood and charcoal consumed in your Province either as domestic fuel or fuel in industrial undertakings?

4. From what sources is the charcoal obtained? What proportions of the charcoal is produced in bye-products recovery ovens and how are the bye-products utilised?

5. Are there any large scale industries in your Province which use charcoal as the principal fuel? Is there further scope for the development of such industries?

6. Give a list of forest products (other than timber, fuel and charcoal) of your Province, mentioning the total annual production of each. To what extent and in what manner are these products utilised locally or are exported to other countries?

7. How are the waste products of the saw mills and other industrial undertakings in your Province utilised at present? What improvements do you suggest in such utilisation?

Part G. Transport.

1. Are there adequate transport facilities for the development of forests and industries utilising forest produce in your provinces? If not, make suggestions for improving these.

Part H. Fires.

1. Are the reserved forests of your province fire protected? What proportion is successfully protected on the average? Give figures.

2. Is departmental firing done as a measure of fire protection? If so, how does it affect soil erosion, floods or vegetation?

3. Are private forests and waste lands burnt most years? If so, how does it affect soil erosion, floods or vegetation?

4. If any of the above adversely affect soil erosion floods or vegetation, what suggestions have you to improve matters?

APPENDIX C.

List of Sub-Committees, to the Chairmen and Secretaries of which a copy of the questionnaire was sent.

River Training & Irrigation	(1|2)
Land Policy, Agriculture Labour & Irrigation	(1|4)
Animal Husbandry & Dairying	(1|5)
Crop Planning and Production	(1|6)
Horticulture	(1|7)
Fisheries	(1|8)
Rural & Cottage Industries	(II|1)
Power and Fuel	(II|2)
Chemicals	(II|3)
Transport Services	(V|1)
National Housing	(VI|1)
Technical Education	(VII|2)

Appendix D. Part I.

A brief account is given below of recent efforts made by the government of the United States of America to tackle the problem of soil conservation:

As a result of several factors public opinion in U.S.A. has been roused regarding the grave conditions resulting from the misuse of soil and from unsound exploitation of soil resources by the pioneer settlers from Europe. The progress of soil science, which has materially helped us to understand the factors governing the formation, growth and decay of soils, has contributed in no small measure to a realisation of the tragic consequences of the misuse of the soil. The dust storms in that country which

took place on a colossal scale have materially helped to focus public opinion on the problem of soil conservation.

To quote from Dr. Lowdermilk (Transaction 3rd International Congress of Soil Science Vol. 2, p. 181):

"Soil wastage from accelerated erosion has been heralded in a dramatic way by unprecedented dust storms in the United States during the spring months of the past two years. Gigantic clouds of dust have been blown aloft out of the Great Plains region blotting out the sun at midday and, as an ominous yellow pall, have swept eastward over a front of hundreds of miles up to 10,000 feet in height. For the first time in history, dust clouds blown out of the farm fields of Western Kansas, Texas, Colorado, Oklahoma and Nebraska have repeatedly cast yellow gloom over cities of the Atlantic sea coast. The dust cloud of May 11th, 1934, was observed 300 miles off shore in the Atlantic.** These repeated dust storms on such a gigantic and fearsome scale have been effective as never before in calling the attention of the American people to the problems of soil wastage in erosion, by wind and by water".

Another factor in raising public opinion in America has been the depression in prices following the enormous demand for agricultural produce and the consequent profit during the last great war. Something had to be done to save American agriculture and the farmers from ruin. It is not difficult to give a graphic description of the problems and causes of soil misuse in U.S.A., China and India and many other countries from the national stand point which can be really called "a chamber of horrors". But such a description should be widely circulated in order to rouse public opinion so that this colossal problem which is so tragic in its consequences can be properly tackled and with promptness.

The following account has been taken from "Soils and Men", (extracts from pp. 11 et sequel), 1938. Year Book of Agriculture, United States Department of Agriculture.

"It is recognised by the workers of America that 'Education' of the public must 'rank as the first remedy'; such education 'includes good schools in poor areas' with a view among other things to secure a reduction in the pressure on the land 'by imbuing young people with the ambition to seek better opportunities elsewhere' and to help this reduction 'vocational education is given to train them for occupations other than farming'. Those who remain on the soil have to be taught 'the needs of the soil and the adjustments in agricultural practice required to conserve it'. 'A wide spread change in the attitude of the people, towards the soil' must also be the purpose of such education and 'the schools, the press, the pulpit, the radio, the motion picture and the discussion group all have a part to play' in it. "Where the land has been abused for generations it will not be easy to develop the necessary knowledge, convictions, and attitudes, nor will it be done quickly." "Two other principal agencies do this work through direct contact with farmers" and "deal with local problems, yet see these also as part of the broader national problem". "The county agents of the Extension Service form a connecting link between farm people and the research agencies—the State experiment stations and the Department of Agriculture. These agents carry on demonstration work and use many other means of education, including bulletins, newspaper articles, motion pictures, radio talks, exhibits, talks at meetings, and discussion groups". The other agency is the soil conservation

service. It conducts "soil conservation demonstrations in selected watersheds throughout the country. This work is new and it is an outcome of the recent recognition that soil erosion and flood control are major national problems. Each demonstration is carried out on the farms of those who agree to cooperate. A staff of technicians works with these farmers analysing the erosion-control problems, formulating an effective plan to deal with it, and helping each farmer to put the plan fully into effect. Ordinarily the Government furnishes not more than half the required materials and supplies, and if necessary some additional labour from Civilian Conservation corps camps or elsewhere. In many cases problems that appeared impossible are being effectively solved; an attitude of despair has been changed to one of hope. The important point, however, is not what is accomplished for a relatively few individual farmers. It lies in proving what can be done, as a practical matter, so that other individuals and groups will do likewise".

"Research goes hand in hand with education. ***Lack of fundamental data limits future progress. If soil science has been slow to develop in this country, however, it is because soil problems were not generally recognised until so late."

What, in brief, are the broad lines of investigation needed in a research programme? It should identify map soils in the field; determine the characteristics of the soil types from every angle; investigate the responses of each type to the known management practices; and determine its use, capabilities on the basis of the scientific data and the accumulated experience of farmers. Some of this work has been in progress for the past 40 years—notably the mapping of soils, now carried on by the soil survey Division—but also much of the earlier work needs of present-day analysis. There are two things the soil scientist would stress—not to oversimplify the soil problem and generalize from too few particulars; and not to tie the scientist too closely to practical programmes, but to let him pursue his researches wherever the facts may lead.

"One of the major functions of soil research is to furnish a solid foundation for land-use classification, which in turn develops into land-use planning** If planning is to be most effective, however, both local and national farm leaders must participate. Technicians and public officials should not attempt it alone. It is for this reason that county agricultural planning committees have recently been established in most agricultural counties of the Nation.

"For the present, the job is to no small extent one of coordination. A good deal of information exists, but it is scattered and in some cases contradictory, and it needs to be supplemented by more systematic fact-gathering. A good many agencies, local, state, and national, are concerned with land use, but they sometimes work at cross purposes or duplicate one another's efforts. The immediate need is to bring some order out of this chaos. As a step in that direction, an office of Land Use Coordination has been set up in the Department of Agriculture.

"But education, research, and planning are not enough by themselves. They are continuous processes, but they must be supplemented and made effective by action programmes.

"The most obvious place for the application of direct remedies for soil misuse is on publicly owned land, the national forests, and the areas belonging to States, counties, and towns.

This soil at least should be well managed, though as a matter of fact much of it has not been.

"The 162,000,000 acres of public domain in the West consists of land so poor that nobody would take it as a gift on a homestead basis**The great need today is to restore this range cover. It can be done by such means as regulating the number of livestock within safe limits, regulating the seasons of use, reseeding especially bad areas, and fencing, a water development, and other management devices. The new Taylor Grazing Act finally makes this possible, but it will require many years to restore the land.

"The national forests contain 175,000,000 acres of forest and range land. In 1905 the Secretary of Agriculture laid down the policy that this land was to be devoted to its most productive use for the permanent good of the whole people, and not for the temporary benefit of individuals or companies.** The power is there; the problem is to apply it by developing sound methods of managing soil and vegetation. This is being done, in the forests and on the forests range, through a combined programme of research and practice which is pushed as far as funds will permit.

"In many or most such cases the land is submarginal and unprofitable for private owners. The time has come to recognize the fact that this kind of land will inevitably become public property."

"In general, it may be said that Federal purchase of land to correct maladjustments in agriculture** should be confined to cases where no other measures would be effective."

"A survey of the possibilities for regulating the use of private land shows that several things may be done. Each has a limited but worth-while field of usefulness. Most of the efforts in this direction are new.

"First there is zoning. Zoning ordinances, which are an established practice in towns and cities, depend on what is commonly known as the police power—that is, the power of the State to regulate private conduct where necessary to protect public health, safety, morals, or welfare. Urban zoning is applied to harmonise land uses, relieve congestion, and stabilize property values. Rural zoning is new. **It is not State-wide and mandatory but local and permissive."

"In the West, the development of grazing associations offers a new means of regulating the use of grazing lands through the co-operative action of stockmen. **Essentially, they rest upon a private contract between members to manage a given area, centralize the leasing of lands, work out plans for range improvement, and develop rules and procedures for distributing grazing privileges."

"The Soil-Conservation Districts' Laws are another now development. To enable farmers within watershed or other natural area to cooperate in applying erosion-control measures uniformly throughout the area, a standard act was devised by the Department of Agriculture in cooperation with the State, and recommended to the States by the President in 1937. By June 1, 1938, 25 States had adopted legislation based on the act, and 59 soil conservation districts had been organised.

"The act requires a petition from 25 land occupiers to establish a district and a favourable vote from a majority of all land occupiers before it can finally be established. Once established a district can carry on re-

search, conduct demonstration projects, apply preventive and control measures, enter into contracts with farmers and give them financial and other assistance, take over State and Federal erosion-control projects, recommend land-use plans for soil conservation, and formulate an ordinance prescribing land-use regulations—which cannot go into effect, however, until it has been submitted to a referendum of land occupiers and approved by a majority of the votes cast. The regulations may be amended or repealed by referendum. Failure to observe the regulations is punishable by a fine, and a court may order that the necessary work be done by the supervisor and costs collected from the land occupier. A board of adjustment is provided and its decisions are subject to review in the local courts. Funds may be provided only by direct appropriations out of the State treasury or grants-in-aid by a Federal agency.”

“Resettlement as a policy for aiding distressed farm families at present bristles with questions. ** Much more study will be needed before resettlement can have more than a limited application.”

“In the case of reclamation projects—the irrigation of arid lands in particular—several changes in policy can be made that would prevent the repetition of certain past failures and shortcomings. The technical questions involved in successful irrigation are considered elsewhere. ** The Federal Government should not participate in any project that is not proved by careful investigation to be economically feasible. **

“Three faults of the tenancy system were brought out in the previous section—it provides no incentive for the tenant to maintain or improve the farm; in some instances it forces him to take a loss for improvements; and there are many miscellaneous maladjustments in lease contracts. These faults suggest their own remedies.

(1) State laws might increase the security of the tenant by requiring among other things “an inexpensive legal mechanism for quickly settling minor differences between landlord and tenant.” The landlord’s lien for the collection of cash rent might be limited by statute, particularly in the case of crop failure or economic depression.

(2) The tenant’s financial interest in improvements might be protected by giving him the right to take away removable improvements and receive compensation for those not removable. At the same time, the landlord should be compensated, in the form of higher rent, for improvements made by him. A tenant should be penalised for unwarranted deterioration, but on the other hand he should be compensated, when he leaves the farm, for unexhausted improvements. This compensation might be paid by the new tenant, perhaps over a period of time.

(3) Miscellaneous maladjustments in tenancy are mostly local and due to local peculiarities. They need detailed study and probably could best be corrected through educational programmes.”

“In the field of agriculture finance there is need for property tax reforms, better management of farm credit, and changes in mortgage financing.”

“The principal evil of farm credit from the standpoint of soil use seems to be the assumption by the farmer of a debt that is beyond the earning capacity of the farm to pay.”

“Farm mortgages should be made to help rather than hinder soil conservation.”

"Such changes as these suggested throughout this discussion are desirable in themselves as well as for their effect on soil conservation. But most of them could only be brought about gradually. Meanwhile there is need to make an effective start in soil conservation work at once and on a fairly wide scale. Many farmers, however, cannot afford the necessary expense, especially in a depression period, or they are not convinced that they have anything to gain by better practices. To meet obstacles, the device of giving direct aid to farmers, in the form of conditional grants and of technical and other services, has been used."

"Grants-in-aid for various purposes—child welfare, public health, and so on—are not new, but they were first used for soil conservation in 1936, under the Soil Conservation and Domestic Allotment Act. ** Whether conditional grants have a permanent place in soil conservation is a question that will have to be decided after further experience."

"It appears that farmers need less and less help as a conservation programme proceeds and they see its benefits. Those who have carried on this work believe there is no question but that it has speeded up the adoption of erosion control and soil conservation practices, but there is doubt as to whether the kind of help that has been given to individuals so far would be justified on more than a demonstration basis."

"In the discussion of the obstacles to soil conservation, it was shown that one of the major factors is economic instability both the instability peculiar to agriculture, and industrial and financial instability that profoundly affects agriculture. Without efforts to correct these deeper causes, any attack on the soil conservation problem in the Nation as a whole can be only piecemeal and partial. It need hardly be said, however, that soil conservation is only one more reason for making these efforts, which are vital to national well-being from every standpoint."

"On the strictly agricultural front the main attack on the problem in recent years has been through the Agricultural Adjustment Act. From its early emergency stages and through legal vicissitudes, this has evolved into what is essentially a three-point programme, the goal of which is a higher and more stable farm income:

(1) Voluntary acreage control. This gives a moderate adjustment of crop acreage but not enough to equalise the flow of products to market from year to year.

(2) Commodity loans and crop insurance. These are devices to induce the storage instead of the marketing of surpluses in years of high yield. The method is intended to equalise the flow of products, and thus stabilise and improve income, under ordinary conditions.

(3) Marketing quotas to take care of emergency conditions. These are aimed to prevent the dumping of unusually heavy storage stocks, which might be built up if there were several successive years of high yields.

Such a programme is not simple to carry out; and no responsible person believes that by itself it is the complete solution for instability in agriculture."

"Finally it is important to realise clearly that soil conservation has legal as well as economic, social and individual aspects. Agricultural programmes can be put into effect only with a definite constitutional framework, and the final arbiter in deciding whether they fit this framework is the Supreme Court."

APPENDIX D. PART II

From "Crop Management and Soil Conservation"—
by Cox and King, 1937

"The Federal Agricultural Conservation Programme has classified crop into two major classes, namely, soil depleting and soil conserving crops. A drought resistant group of crops has also been recognised. Although it is granted that the use made of any crop, chiefly the extent to which the growth it develops is removed from the land either by harvest or grazing, indirectly influences the effect of the crop on soil fertility and erosion control, yet there are, nevertheless, sound and meritorious reasons for the broad classification of crops in accordance with the effect of growing the crop on the land in preventing erosion and in maintaining or depleting fertility."

"Soil depleting crops include all cultivated raw crops, small grain crops, and legumes and grasses cut for hay or seed."

"Soil-conserving crops are those that provide cover to the land, thus preventing erosion by wind or water, and increase the content of humus or organic matter in the soil."

"The Agricultural Adjustment Programme during the three years from 1933 to 1935 encouraged the use of contracted acreage retired from the production of basic commodity crops such as corn, wheat, cotton and tobacco, for the planting of pasture grasses and new seedlings of clovers, alfalfa, sweet clover, lespedeza, for the planting of cover, emergency forage crops, for planting crops to be incorporated in the soil as green-manuring crops, and for the planting of farm wood-lots".

"From 35 to 40 million acres were shifted from the soil-depleting crops to soil-conserving crops during the period 1933 to 1937, thereby greatly improving the rotation practices of between 3 and 4 million farms of the nation, aiding in a large way toward the preventing of erosion losses to the soils of America, and helping as well in the balancing of crop production".

"Payments averaging 7.50 dollar per acre in 1936 were made for diverting acreage in soil-depleting crops to soil-conserving crops in the Agricultural Conservation Programme".

"Under the 1936 Agricultural Conservation Programme of the Agricultural Adjustment Administration", "approximately 3,000,000 applications for grants of awards, representing 4,000,000 farmers, or about two-thirds of the farmers of America, were filed. Crop land on the 3,000,000 farms included in the programme totalled 284,000,000 acres or 63 per cent of all the crop land in the United States. Conservation practices were carried out under the programme on 53,000,000 acres. Of this total, 34,000,000 acres were planted to new seedlings of soil-conserving crops, either legumes alone or in mixtures. Seven and one-half million acres were planted to green-manure crops, and nearly 2,700,000 acres to new or improved pastures. Applications of limestone, superphosphate or other chemicals were made on 2,500,000 acres, and mechanical erosion controls, such as terracing, contour furrowing and protected summer fallowing were placed in effect on 5,000,000 acres. A still more important part of the programme, from the standpoint of conservation and of supporting farmer's income, was its diversion of about 20,000,000 acres of land from soil-depleting to soil-conserving crops or practices.

APPENDIX E—PART I.

Agricultural Statistics of British India.

Classification of Area. (Thousand acres)

	1917-18	1927-28	1936-37
Area under forest	86,925	86,985	89,173
Area not available for cultivation	142,783	149,643	155,004
Culturable waste other than fallow	111,485	155,477	154,302
Fallow land	48,466	51,029	48,638
Net area sown	227,848	223,82	238,885
Irrigated area	45,867	43,321	51,636
Area by professional survey	620,335	670,038	679,482
Area according to village papers	617,507	666,996	679,002
<i>Area under food crops. (Thousand acres)</i>			
Rice	80,668	76,607	81,678
Wheat	26,428	24,569	25,250
Barley	8,505	6,825	6,531
Jowar	21,118	21,248	24,013
Bajra	12,699	14,062	11,451
Ragi	4,265	3,852	3,585
Maize	6,486	5,943	5,955
Gram	16,724	13,973	15,796
Other food grains and pulses	30,544	29,600	29,777
Total food grains	207,437	196,679	204,036
Sugar	2,993	3,046	4,472
Other Food crops	3,330	7,844	8,181
Total food crops	218,760	207,569	216,689

Agricultural Statistics of British India.

Area under non-food crops.

	1917-18	1927-28	1936-37
Linseed	2,781	2,212	2,342
Sesamum (til or jinjili)	3,374	3,541	3,729
Rape and Mustard	4,359	3,277	3,318
Groundnut	1,904	4,700	5,517
Coconut (c)	...	635	665
Castor (d)	...	568	417
Other oilseeds	1,690	1,190	1,806
Total oil seeds	14,108	16,123	17,794
Cotton	15,403	14,804	15,358
Jute	2,700	3,294	2,540
Other fibres	888	713	760
Indigo	701	67	43
Opium	221	54	10
Coffee	95	92	98
Tea	619	743	794
Tobacco	1,015	1,145	1,151
Fodder crops	8,194	9,152	10,792
Other non-food crops (e)	1,771	1,763	1,507
Total non-food crops (d)	45,716	47,950	50,847

Agricultural Statistics Of British India.

Number of Cattle

	1917-18	1927-28	1936-37
Bulls	49,332	5,342	51,308
Bullocks	...	45,763	...
Cows	37,471	37,911	38,347
Young Stock (Calves)	43,073	31,363	34,879
Male Buffaloes	5,583	5,442	5,115
Young Stock (Buffaloe calves)	(f)	10,951	...
Cows	13,653	14,374	15,354
Total	149,112	151,146	158,528*
Total revenue from land excluding Cesses	352,951	385,310	399,162
(f) Included under "Young stock" (calves)			
* Includes 1929-30 census figures of Bengal and Bihar and Orissa where no census was taken in 1934-35, but excludes those for the two Agency districts of the N. W.F. Provinces.			

Summary of Tables—Continued
Area Cultivated and Uncultivated in 1936-37 in each Province.

Province	Cultivated			Uncultivated		Forests
	Net area according to survey	Net area actually sown	Current fallows	Culturable Waste other than fallow	Not available for cultivation	
	Acres	Acres	Acres	Acres	Acres	Acres
Ajmer-Merwara	1,770,921	325,146	215,007	293,825	840,161	96,782
Assam	35,484,800	6,613,476	1,345,522	18,756,295	4,577,400	4,292,107
Bengal	49,254,596	24,466,300	4,690,883	5,949,866	9,692,231	4,455,316
Bihar	44,324,194	19,916,600	6,542,460	5,133,501	6,292,366	6,439,267
Bombay	48,721,608	28,154,019	5,593,158	877,850	5,683,376	8,413,105
Burma	167,517,971	18,165,172	3,802,944	62,071,697	61,468,789	22,009,369
C. P. & Berar	63,004,800	24,593,915	3,746,418	13,985,674	4,906,582	15,873,082
Coorg	1,019,520	142,402	166,938	11,690	334,045	364,445
Delhi	368,931	214,186	11,513	62,674	80,558	...
Madras	80,104,239	31,705,506	8,490,987	10,792,613	15,722,154	12,320,947
N. W. F. P.	8,437,566	2,317,893	409,883	2,811,357	2,684,673	352,932
Orissa	20,594,776	6,486,300	2,695,473	3,613,873	6,172,556	2,637,771
Punjab	31,001,600	27,905,978	3,220,828	14,120,422	12,958,234	1,969,098
Sind	30,027,932	4,710,753	5,104,775	5,782,391	13,706,511	723,502
United Provinces	67,848,920	36,166,954	2,601,588	10,037,803	9,884,560	9,275,348
Total	679,482,374	231,884,600	48,638,377	154,301,631	155,004,196	89,173,071

Area Under Irrigation in 1936-37 in each Province.

Area Irrigated

Provinces	By canals		By tanks	By Wells	By Other sources	Total area irrigated
	(Govt.) acres	(Private) acres				
Ajmer-Merwara	...	...	20810	102840	221	123871
Assam	240	348890	1451	...	304545	655126
Bengal	199326	235152	899899	56714	479798	1870889
Bihar	614622	783602	1458124	522295	940015	4318658
Bombay	253865	59239	79926	666955	40659	1105644
Burma	703410	260115	156140	17182	341147	1477994
C. P. & Berar	*	369035	*	128510	51661	1049236
Coorg	2374	...	1646	...	...	3993
Delhi	23019	...	1348	19603	...	43970
Madras	3789753	170160	3111441	1400726	269714	8741794
N. W. F. P.	435898	422285	...	83871	83047	1025101
Orissa	305399	49449	295084	8467	697085	1355484
Punjab	10885910	466288	33760	4086756	131993	15604707
Sind	3687057	6587	...	35682	332553	4061879
U. P.	3,121382	28926	64209	4765940	2217409	10197866
Total.	24027228	3699728	6123838	11895571	51636212	18815201

* Included under "Private canals."

Crops Irrigated

Provinces	Rice acres	Wheat acres	Barley acres	Jowar or cholum acres	Bajra or cumbu acres
Ajmer-Merwara	34	11101	16714	1325	1717
Assam	630239	...	...	...	...
Bengal	1665743	13488	3335	65	114
Bihar	2747798	256840	131088	3505	1496
Bombay	136764	185830	13000	290049	49721
Burma	1419223	467	...	145	...
C. P. & Berar	888439	31479	1484	74	...
Coorg	3993	...	...	...	...
Delhi	14	18498	2696	480	35
Madras	7668576	3118	12	435139	30629
N. W. F. P.	38746	355974	57543	19810	8303
Orissa	1233206	852	...	1	...
Punjab	798723	5150898	238495	185320	33609
Sind	1181918	930776	14020	392854	234013
U. P.	402545	3388162	1826927	33442	2433
Total.	10347483	23155314	13622009	940222	*

* The original has not supplied this figure.

Crops Irrigated

Provinces	Maize acres	Other cereals and pulses acres	Sugarcane acres	Other food crops acres	cotton acres	Other non-food crops acres	Total acres
Ajmer-Merwara	32,693	21,546	91	10,288	22,858	5,404	133,771
Assam	...	1,032	...	12,028	...	11,827	655,126
Bengal	3,065	46,575	32,259	94,337	688	15,992	1,876,661
Bihar	38,634	690,250	152,489	190,208	2,261	74,089	4,318,658
Bombay	28,746	86,817	81,919	155,561	51,599	180,664	1,260,870
Burma	395	10,089	3,643	35,929	2,034	74,714	1,546,639
C. P. & Berar	239	4,878	28,834	85,265	81	8,463	1,049,236
Coorg	...	...	...	...	...	...	3,993
Delhi	240	2,975	4,219	7,147	1,496	6,170	43,970
Madras	4,929	1,183,606	114,656	262,946	27,145	571,989	10,822,408
N. W. F. P.	346,628	41,242	71,469	34,173	13,857	137,757	1,025,502
Punjab	486,820	1,477,332	463,575	304,043	2,678,163	3,741,763	15,861,290
Sind	2,801	631,211	6,454	52,006	893,976	266,096	4,606,155
U. P.	106,563	2,366,419	16,40,903	3,56,575	300,114	361,300	10,794,383
Total	984,041	6,780,649	2630,343	1,619,994	4,247,698	5,475,207	55,519,151

* Includes the area irrigated at both harvests.

*Area Under Different Crops Cultivated in British India,
in 1936-37*

	Rice	Wheat	Barley	Jowar or cholum (Great millet)	Bajri or cumbu (Spiked millet)	
Total	81,578,278	25,249,687	6,531,294	24,012,881	11,451,033	
	Linseed	Seasamum	Rape & Mustard	Ground-nut	Cocoanut	
Total	2,342,204	3,728,840	3,318,490	5,516,881	664,527	
<i>in 1936-37</i>						
	Ragi or marua (millet)	Maize	Gram	Other food grains & Pulses	Total	
Total	3,585,220	5,954,317	15,796,220	29,776,991	204,035	
	Castor	Other oil- seeds	Total	Condiments & spices	Sugar	* Others
Total	416,941	1,806,344	17,794,227	14,13,872	42,85,178	186,191

* area under sugar yielding plants other than sugar cane.

*Area Under Different Crops Cultivated in British India,
in 1936-37—Continued*
Dyeing and Tanning

Fibres			Materials			Drugs and Narcotics		
Cotton	Jute	other fibres	total	indigo	others	opium	Tea	coffee
15,357,464	2,539,933	760,351	18,657,748	43,384	16,337	10,250	793,503	97,827
Drugs and narcotics			Miscellaneous crops					
Tobacco	other drugs & Narcotics	Fruits & Vegetables including root crops	Food	non. food	Total area sown	Deduct area sown more than once	Net area sown	
1,151,874	259,210	10,792,310	1,932,123	1,230,983	267,535,500	35,650,900	231,884,660	

APPENDIX E—PART II

Agricultural Statistics of States and Agencies.

Classification of Area. (Thousand acres)

	1917-18	1927-28	1936-37
Area by professional survey (a)	82,299	134,596	147,390
Area according to village papers	82,274	134,635	147,125 m
Area under forest	9,887	17,533	18,678
Area not available for cultivation	19,075	23,898	27,557
Culturable waste	13,682	16,370	18,715
Fallow land	6,613	12,103	12,699
Net area sown	33,017	64,731	69,427
Irrigated area	6,487	8,420	10,349
<i>Area under food crops.</i>			
Rise	2,593	3,728	4,031
Wheat	5,333	6,168	6,759
Barley	1,337	1,072	822
Jowar	3,329	13,851	14,898
Bajra	2,648	6,041	6,295
Ragi	2,380	2,671	2,605
Maize	1,101	2,099	2,216
Gram	4,115	4,613	5,690
Other food-grains and pulses	5,037	6,996	6,481
Total food grains	27,873	47,239	49,787

Area under food crops (continued)

	1917-18	1927-28	1936-37
Sugar	160	181	357
Other food crops (b)	2,314	2,535	2,992
Total food crops (d)	30,347	49,955	53,136
<i>Area under non-food crops.</i>			
Linseed	623	665	880
Sesamum (til or Jinjili)	537	1,404	1,521
Rape and Mustard	399	414	418
Groundnut	78	836	1,453
Coconut (g)	48	692	812
Castor	(f)	917	1,034
Other oilseeds	352	613	979
Total oilseeds	2,037	5,541	7,097
Cotton	1,724	6,691	7,163
Other fibres	73	166	160
Indigo	21	3	5
Opium	35	28	17
Coffee	115	112	116
Tea	61	60	84
Tobacco	51	206	185
Fodder crops	1,310	3,493	3,117
Other non-food crops (c)	920	913	1,353
Total non-food crops (d)	6,347	17,213	19,294

Number of Cattle

	(Thousands)		
	1917-18	1927-28	1936-37
Bulls	4,244	1,203	14,271
Bullocks		9,796	
Cows	4,559	10,472	14,045
Young stock (calves)	3,888	7,194	12,515
Male Buffaloes	239	952	1,082
Cow	1,624	4,022	5,963
Young stock (Buffalo calves) (e)		2,536	4,865

- (a) Excluding areas for which no returns are available.
- (b) Condiments and spices, fruits and vegetables and miscellaneous food crops.
- (c) Cinchona, Indian hemp, other dyes and tanning materials, other drugs and narcotics and miscellaneous non-food crops.
- (d) The total of food crops and non-food crops shown here does not agree with the total of sown area shown in Summary Table for the reasons stated in the table.
- (e) Included in "Young Stock" (calves)
- (f) Included in "Other oilseeds"
- (g) Figs. for earlier years are included in "fruits and vegetables" (other food crops)

Area Cultivated and Uncultivated in 1936-37 in each State or Group of States.

States	Cultivated			Uncultivated		
	Net area according to survey	Net area actually sown	Current fallow	Culturable Waste other than fallow	Not available for cultivation	Forest
	Acres	Acres	Acres	Acres	Acres	Acres
Baroda State	5,105,137	3,252,624	—	666,753	789,988	395,775
Bombay States (a)	3,081,714	1,686,367	279,470	648,594	248,592	150,875
Central India States (b)	12,228,007	5,102,126	1,335,641	2,012,103	2,100,580	1,677,557
Gwalior State	12,811,901	4,558,032	473,469	2,894,292	3,108,971	1,777,137
Hyderabad State	45,260,570	27,941,420	3,731,828	1,969,983	5,234,024	6,383,315
Kashmir State	8,071,983	2,238,944	411,219	856,526	2,589,765	1,892,725
Madras States	6,062,517	3,035,285	388,406	434,765	658,347	1,681,704
Mysore State	17,494,154	6,306,792	1,545,240	1,109,505	6,708,411	1,824,116
Punjab Agency States (g)	12,065,571	6,723,160	773,780	2,606,704	1,513,064	442,627
Punjab States	1,180,379	387,857	88,954	307,502	106,235	290,398
Rajputana States (c)	20,196,021	7,328,991	3,416,845	4,777,583	3,876,738	794,624
United Provinces States (d)	3,831,939	865,092	254,450	431,123	622,373	1,366,679
Total	147,389,896	69,426,690	12,699,302	18,715,523	27,557,088	18,677,529

There is no reference to the Eastern Agency States, e. g., in Bengal, Orissa, Assam.

Area Under Irrigation in 1936-37 in each State or Group of States.

	By canals		By tanks	By wells	By Other sources
	(Government)	(Private)			
	Acres	Acres	Acres	Acres	Acres
Baroda State	352	—	176	151,396	672
Bombay States (a)	13,981	—	3,497	89,486	714
Central India States (b)	352	18,475	34,746	305,966	13,343
Gwalior State	—	69,485	17,673	136,384	4,556
Hyderabad State	90,862	17,670	922,509	507,174	22,200
Kashmir State	124,311	649,345	5,411	7,273	17,219
Madras States	374,474	100,567	237,787	29,512	548,450
Mysore State	188,314	4,688	575,205	86,243	196,141
Punjab Agency States (g)	2,286,851	135,057	25	772,112	21,873
Punjab States	9,664	24,502	5	8,268	14,101
Rajputana States (c)	516,817	16,660	80,714	636,932	110,961
United Provinces States (d)	9,643	45,195	7,517	68,070	16,591
Total	3,615,621	1,081,644	1,885,265	2,798,816	966,821

There is no reference to the Eastern Agency States, e. g., in Bengal, Orissa, Assam.

Area Cultivated and Uncultivated in 1936-37, in each State or Group of States.

	Total area irrigated	Rice	Crops Irrigated	
	Acres	Acres	Wheat	Barley
	Acres	Acres	Acres	Acres
Baroda State	152,596	1,075	61,139	—
Bombay States (a)	107,678	1,308	41,816	59
Central India States (b)	372,882	33,900	89,993	59,168
Gwalior State	228,098	13,521	100,095	25,095
Hyderabad State	1,560,415	1,042,582	10,987	13,811
Kashmir State	803,559	478,722	94,750	17,451
Madras States	1,290,790	297,956	69	—
Mysore State	1,050,591	726,388	1,721	—
Punjab Agency States (g)	3,215,918	45,211	949,241	33,652
Punjab States	(f) 57,210	2,276	28,201	1,645
Rajputana States (c)	1,362,084	3,608	282,407	173,085
United Provinces States (d)	147,016	40,939	15,160	23,396
Total	(f) 10,348,837	2,687,486	1,675,579	347,362

(a) Six States. (b) Seven States. (c) Eleven States. (d) Three States. (e) The figure excludes 7 acres cultivated out of unsurveyed block. Includes 48,575 acres for which details are not available. (f) Includes 670 acres for which details are not available. — (g) Ten States.

There is no reference to the Eastern Agency States, e. g., in Bengal, Orissa, Assam.

Area Under Irrigation, in 1936-37 in each State or Group of States (Continued).

States	Crop Irrigated		Crops Irrigated		
	Jowar	Bajra	Maize	Other cereals and pulses	Sugarcane
	Acres	Acres	Acres	Acres	Acres
Baroda State				23,564	3,630
Bombay States (a)	20,252	1,302	1,946	8,770	6,471
Central India States (b)	17	4	4,290	26,492	28,961
Gwalior State	36	2	2,632	33,926	14,962
Hyderabad State			6,719	3,101	58,601
Kashmir State	395	1,367	81,808	36,248	3,900
Madras States	2,289	197	2,687	444,382	272
Mysore State	27,353	9,023	1,356	127,431	52,686
Punjab Agency States (e)	127,206	75,153	75,146	556,699	41,405
Punjab States	2	81	1,081	16,277	762
Rajputana States (c)	47,967	12,391	66,202	229,868	22,721
United Provinces States (d)	1		10	23,613	16,472
Total	225,518	99,520	243,887	1,530,371	250,843

(a) Six States. (b) Seven States. (c) Eleven States. (d) Three States. (e) Ten States.

Table 14. Area Under Irrigation in 1936-37, in each State or Group of States (Continued).

	Crops Irrigated		Other non-food crops	Total area of crops irrigated.
	Other food crop	Cotton.		
	Acres	Acres	Acres	Acres
Baroda State	20,739		43,936	154,083
Bombay States (a)	11,280	6,062	10,576	114,732(f)
Central India States (b)	126,942	2,602	41,778	414,147
Gwalior State	7,852	7,562	36,271	241,944
Hyderabad State	682,126		320,752	2,138,679
Kashmir State	108,053	3,894	39,084	865,672
Madras States	400,669	613	137,274	1,294,510(g)
Mysore State	62,119	2,955	56,263	1,067,295
Punjab Agency State (e)	180,279	612,491	731,969	8,428,462
Punjab States	66,999	1,458	10,161	128,999(h)
Rajputana States (c)	299,381	108,345	156,863	1,403,838(i)
United Provinces States (d)	3,562		1,296	148,449(j)
Total	1,970,001	745,982	1,586,223	11,400,820(k)

(f) Includes 4,890 acres for which details are not available. (g) Includes 8,102 acres for which details are not available. (h) Includes 56 (i) Includes 1,000 (j) Includes 24,000 (k) Includes 38,048

There is no reference to the Eastern Agency States, e. g. in Bengal, Orissa, Assam.

*Areas under different crops,
in 1936-37.*

Rice	Wheat	Barley	Jowar or cholum	Bajra or cumbu	Ragi or marua	Maize	Gram (Pulse)	Other food grain & pulses	Total
4,021,508	6,758,848	821,979	14,897,823	6,294,587	2,604,633	2,215,779	5,690,575	6,481,316	49,787,048
Fibres		Dyes & Tanning Materials			Drugs and Narcotics				
Cotton	Sann	Other fibres	Total	Indigo	Others	Opium	Tea	Coffee	
7,162,868	110,771	49,651	7,323,290	1,702	359	16,588	84,456	116,293	

There is no reference to Eastern Agency States, e. g. in Bengal, Orissa, Assam.

*Areas Under Different Crops
in 1936-37—Continued*

Oilseeds							Sugar			
Linseed	Sesamum (til or jinjili)	Rape & mustard	Ground- nut	Coconut	Castor	Other oil seeds	Total	Condi- ment & Spices	Sugar- cane	Others
879,681	1,521,314	418,078	1,452,413	812,176	1,033,621	979,311	7,096,594	11,155,813	354,454	2,796
Drugs and narcotics				Miscellaneous crops						
Tobacco	other drugs & Narcotics	Fodder crops	Fruits & Vegetables including root crops	Food non. food	Total area sown (e)	Deduct area sown more than once	Net area sown			
165,236	45,639	3,116,623	955,592	890,845	1,307,339	73,060,026	3,633,336	69,426		

There is no reference to the Eastern Agency States, e. g., in Bengal, Orissa, Assam.

**RESOLUTIONS OF THE NATIONAL PLANNING COMMITTEE
ON THE REPORT OF
THE SUB-COMMITTEE ON SOIL CONSERVATION AND
AFFORESTATION**

The final report of the Sub-Committee of Soil Conservation and Afforestation was, in the unavoidable absence of the Chairman of the Sub-Committee, Prof. J. N. Mukherjee, presented by Prof. S. P. Agharkar, Secretary of the Sub-Committee on the 22nd June. Discussion continued on the 23rd and 24th June, and the following resolutions were passed.

1. Soils and Forests constitute a national heritage. On their successful conservation depend the present and the future of the nation. The State must, therefore step in and accept responsibility for their conservation.

2. The problems of conservation of soils and forests must be treated as a whole. For this purpose, the system of land utilisation as it obtains at present requires the closest investigation. A land utilisation survey should be conducted by a body of experts, and land utilisation may be prepared on the basis of the information gathered. The position should be reviewed every ten years with a view to watch and regulate where necessary the trend of changes in land utilisation.

3. Official statistics show that out of about 827 million acres of the land area, 173 million acres are "cultivable waste, other than fallow", 61 millions as "current fallow", and 183 millions as "not available for cultivation". One of the most important of the problems which should be tackled by the surveys proposed above and the Land Development Board (mentioned below) is to determine:

- a) the area actually available for utilisation, under the head "cultivable waste other than fallow", and "current fallow";
- b) the conditions under which it could be utilised; and
- c) the causes why so large a proportion is classified as "cultivable waste, other than fallow".

4. The information regarding land utilisation, for example, that is given in "The Agricultural Statistics of India", though useful for some purposes, is not of much help for Planning. The collection of necessary and adequate statistical data should therefore, be the first item in the programme of Soil Conservation.

5. For the purposes of coordination and working out of programmes of conservation, a statutory organisation, to be called the Land Development Board, should be established both at the centre, in the Provinces and States. The Provincial and State Organisations should look after the local aspects and the organisation at the centre should take up matters of interest to more than one Province. This will serve the purpose of coordinating all efforts for conservation of soils and forests and enable the problems to be visualised and grappled as a whole.

6. The Central Land Development Board should deal with:
 - a) Soil Conservation including soil surveys, soil maps, soil fertility and land reclamation;
 - b) Anti-erosion measures;

- c) Afforestation, reafforestation and improvement of existing forests; and
- d) Land utilisation and coordination.

Other connected subjects, such as, irrigation and drainage, crop production, grass lands and pastures, industrial utilisation of agricultural and forest produce, and marketing of produce from the land, should be dealt with in consultation and cooperation with corresponding organisations.

Among the functions of this Board will be:—

- i) Preparation of soil maps of India after necessary surveys
- ii) Correlation of results of manurial and varietal trials in selected areas with types of soils, agricultural practice, and land reclamation.
- iii) A complete erosion survey.

7. The whole area in a Province or a State should be divided into physiographic units, each having a coordinated programme of soil conservation suited for its special needs. The programme to be followed should be based on thorough investigation and research in typical localities.

8. There should be a Central Institute for the study of soil, problems, and especially those of erosion.

9. There should be provision for a fully equipped research station in each of the different soil areas for soil and silvicultural research and developmental utilisation.

10. Adequate facilities should be provided for training in forestry and agriculture in the universities and technical institutes, especially with a view to making the results available to the public.

11. One of the most striking features of the present utilisation of the total available area is the small proportion devoted to village or minor forests, grasses, legumes, and other soil-conserving crops, pastures, fruit and other trees, to meet the needs of the rural communities for food, fodder, fuel, timber etc. A policy of well-distributed afforestation, especially with reference to village or minor forests, should be pursued by the State, in particular with regard to those lands which have been thrown out of cultivation or which are at present regarded as culturable waste and can be reclaimed.

12. Soil Erosion:—

- i) Shifting cultivation must be controlled or eliminated, as also breaking of virgin forest land. Contour ridging, terracing and levelling of fields and other measures required for the control of erosion should be encouraged by means of remission of land revenue, education and propaganda.
- ii) Cooperative activities should be enlarged to include land reclamation, village afforestation and forest management.
- iii) Afforestation work should be extended in the plains with a view to provide (a) shelter belts, (b) fodder trees, (c) hedgerow timber and (d) fuel supply.

13. Reclamation: Vast stretches of saline and alkaline soils, sand deposits, arid and semi-arid soils, swamps and other types of water logged soils, ravines and soils afflicted by defects not covered by the above, are known to exist in the country. It is necessary in the first place to provisionally classify these soils according to their more obvious characteristics and to obtain a broad idea of their extent of occurrence. This should form part

of the survey programme. Projects of reclamation should be based on careful research in which all scientific aspects should be taken into consideration.

14. **Soil Moisture:** Improvements in agriculture and soils should be made through the regulation of water-supply, conservation of soil moisture, and drainage, and all necessary information for this should be gathered through the surveys contemplated. The extent and causes of water logging and remedial measures should be studied in detail.

15. **Soil Fertility:** Agriculture should be so planned as to maintain soil fertility at its optimum level. The suggestions made by the Sub-Committee in this behalf deserve consideration more particularly those dealing with the conservation of organic matter and the cheapening of fertilisers.

16. **Forests:** Forests must be preserved as a national heritage, and Forestry should be judged by the long-term financial results rather than the immediate surplus.

17. The following measures are especially recommended for protecting and improving the forest wealth of the country:—

- i) In Provinces or States where there is no special "working plans branch," such a branch should be established, as such working plans are the essence of forest management.
- ii) Contour of grazing, control of fire, contour trenching and gully plugging.

The general position in privately-owned forests is unsatisfactory. Such forests should, therefore, be acquired by the State or strictly controlled by the State in the public interest.

18. Forests should be developed and worked with a view to produce the raw materials for the following, among other, industries;

- 1) Timber, particularly teak.
- 2) Paper, including newsprint, packing and wrapping papers, "kraft" papers, strawboards.
- 3) Insulation boards and similar other materials.
- 4) Rayon.
- 5) Plywood and veneers.
- 6) Matches and pencils.
- 7) Machine and tool parts made of wood.
- 8) Lac for gramophone records, electrical insulation, plastics.
- 9) Resins and varnishes
- 10) Essential Oils.
- 11) Tanning materials.
- 12) Medicinal plants.
- 13) Wood and charcoal to produce gas for internal combustion engines.
- 14) Dyes.

19. Forest cottage industries should be encouraged and the possibilities for these should be investigated. (e.g. rope-making, baskets, wicker-work, toys, etc).

20. **Capacity of forest to furnish employment:** The census returns of 1931 show that directly or indirectly the forests offer employment to about 2,000,000 people in British India alone. With more efficient utilisation of forest resources, it should be possible to find employment for a much larger number.

21. **Wild Life Sanctuaries:** This Committee considers that the organised large-scale hunts, with the help of hundreds of beaters, are not only inhuman, but are leading to the extinction of valuable wild life in the jungles and should be disallowed. For the protection and preservation of wild life in the jungles, national parks and sanctuaries should be established in various parts of the country.

22. **Communications:** Out of the total area of 125,000 sq. miles of State forests, 54,000 sq. miles, that is 43 per cent, are either inaccessible or profitless. It is urgently necessary to provide suitable means of communications, rail and rope-ways, roads, waterways and paths, as otherwise fuller development of our forest resources will not be possible. Freight rates on forest produce are generally too high and should be reduced.

23. **Fires:** Effective measures should be taken to minimise damage from forest fires, and for this purpose a Fire Protection Section of the Forest Department is recommended.

SUMMARY OF DEVELOPMENT

As already noted in the Introduction, the importance of Soil Conservation for maintaining the agricultural wealth of the country, and for preserving it against the wasteful and denuding action of floods and erosion, has been fully recognised. But the steps taken so far to give effect to the proposals for remedies suggested are not yet all that might be desired. The increasing demands upon land, thanks as much to the steady growth in population, as also to the uneconomic methods of cultivation, make these steps doubly necessary and urgent. A programme of scientific land utilisation, preserving and conserving the country's natural endowments, and promoting its capacity to yield, will consist, not merely in remedying and repairing the physical difficulties, chemical deficiencies of the soil; but also for counteracting the social handicaps from which the agricultural land suffers. Such a programme, it need hardly be pointed out, was beyond the power of a Foreign Government lacking the whole-hearted support of the people and generally suspected of ulterior motives. But, with the advent to power of a really popular, National Government, hopes would naturally rise high in this regard. The time, is therefore, more than opportune for emphasising once again the steps necessary in this behalf, so that no needless delay or wastage might occur.

... A considerable amount of scientific work and research have already been brought to bear upon this subject. Every Province in the country as a whole has awakened to this necessity; and methods and measures are being adopted in several places to make a careful study of the soil, and devise remedies which such a study may reveal to be necessary. Cross sections of the soil, and not merely the superficial substance, are being studied to take into account all the layers that may have their bearing upon crops. Mention has already been made in the Introduction of the most outstanding example of such work, in the careful classification of the Black Cotton Soil in the Bombay Canal areas, and investigations regarding the suitability of those tracts for sugarcane cultivation. In the Imperial Agricultural Institute, soil-survey and soil mapping are being carried on intensively. A Soil Map of India has been prepared on the basis of available data for the different Provinces and States; while a new scheme of Soil Survey has quite recently been launched to collect further data and collate material already available or to be obtained. In the two largest of the Indian States,—namely, Hyderabad (Deccan) and Mysore,—large-scale Soil Survey has been completed in connection with their Irrigation Projects. The increasing demand for sugarcane cultivation has necessitated similar Surveys in the largest single sugarcane growing Province of British India,—the United Provinces. The Department of Agriculture in Bombay supplies Soil Maps, wherein all the necessary information required for economic cultivation of sugarcane is supplied.

Note will be taken hereafter of the remedial value of re-afforestation in areas denuded of forests from the point of view of soil conservation. While the menace of periodical floods is recognised, the significance of Soil Erosion is not yet well understood. Erosion, it may be added, consists in rubbing off the surface

soil due to excessive run off; and is of two types, i.e., Sheet Erosion and Gully Erosion.

The most important means to prevent floods and guard against erosion is a correct scientific utilisation of land. The prevention of floods, which cause both types of soil erosion, the proper bunding and canalisation of rivers so as to reduce the force of floods and utilise all sudden excess of water in the rainy season, is under active consideration in several regions by the Central as well as Provincial Governments concerned. The great projects of the Damodar River Valley and Koshi River are modelled on the lines of the Tennessee Valley Administration of the United States. These are intended to secure, not only adequate irrigation of those basins with all the adjuncts in respect of soil conservation; but also to provide electrical power on a large-scale and cheaply so as to reclaim those regions and build up Canal Colonies wherever suitable. These examples may be followed in the valleys of the other great rivers, like the Mahanadi, the Godaveri, the Brahmaputra, or the Meghna, wherever the terrain allows of such utilisation, conservation, and preservation.

Proper utilisation of land varies with different crops and in different seasons. For cold weather or Rabi crops, the cultivator aims mainly at the conservation of moisture in the soil, and preparation of a good seed-bed to ensure proper germination. For this purpose the land is given repeated ploughings or harrowings, which produce a surface very much above the moist sub-soil. For the hot weather or Kharif crops, the preliminary cultivation is much less thorough since the sowings must commence as soon as the rains begin. Other items in the method of cultivation need not be detailed here at any length, as they have no direct bearing on Soil Conservation; and also because they will be more fully considered elsewhere.

The improvement of the soil by means of irrigation, i.e., from canals, wells, or tanks, and by proper manure, has already been referred to; and will be more fully considered in the Volume dealing with Irrigation, River Training and Water Supply. It is enough to add here that all these matters are mutually interconnected and dependent; so that none of the remedies, improvements, or extensions can be considered separately, each by itself in a compartment of its own. It is the collective and simultaneous effect of all these in a well integrated common Plan which only will bring about the desired objective.

The importance of Forests has nowadays been recognised, as much for purposes of attracting rainfall and adequate preservation of the soil, as for the other incidental advantages that are desired therefrom. The larger forests have been used from time immemorial for pasture as well as for timber all over the country in a haphazard manner. A carefully coordinated scientific policy for the proper utilisation of forests, and their re-establishment wherever they are used up or exhausted, is, however, of relatively recent date. Careful classification of forests, with an adequate well-trained Forest Service to attend to them, and a programme of planting new forest trees, was adopted in the latter half of the last century, and has been developed very intensively since World War I. The main developments, however, in regard to the utilisation of Forests and Reafforestation lie in the direction of a more scientific study or Silviculture and Forest Research; better provision of educational facilities and a more coordinated organisation of Forest Services throughout

the country. The earliest training institute, established in the last century at Dehra Dun has now expanded into a high grade Forest College and Research Institute, organised and equipped to deal with every aspect and problem of Forest Research. The work it has done in the past and is still doing has gone a long way to improve the productivity of the Forests of India, and has brought about a fuller and better utilisation of their products. Increase in net revenue from this source is only one item of these benefits, while expansion of employment in forest industries or handicrafts is another.

Until the Government of India Act 1935, the Administration of Forests was a Central subject with the exception, since 1920, only of Bombay and Burma, the Provincial Governments of which were entrusted with the management of their forests. Since 1935, however, this has been made a Provincial subject; and all Provinces are now equally interested in their development. Considerable revenue is obtained by the various Provincial Governments from Forests, the net surplus in 1940-41 being Rs. 1.33 crores. This is, however, not a fraction of what is possible to obtain from this source not only for the Exchequer but also for the community collectively,—if only our forest wealth were more intensively exploited and developed.

The basic principles of the policy governing Forests have been enunciated to be:—

- a) conservation of the soil structure for maintaining uniform climatic conditions throughout the country;
- b) supplying the general needs of the community in respect of the physical and chemical properties of the soil;
- c) recognition of the prior importance of land cultivation for food grains or raw materials of industry,
- d) attending to the needs of the local consumer in respect of pasture, fuel, and minor forest produce, irrespective of revenue considerations, but without undue wastage of the forest resources of the country.
- e) obtaining maximum revenue after attending to the preceding aims of a proper Forest Policy.

This policy is based on the recognition of the contribution of Forests in helping to maintain uniform climatic conditions, preserving soil structure, providing the general needs of the community, and the basic material for several industries. As, however, proper development of Forests is necessarily a long-term enterprise, private capital would not be easily attracted. The responsibility for this task lies, therefore, upon the State for managing and developing forests to the degree necessary for achieving the above objectives.

Even where Forests are private property, the interests of the community as a whole must take precedence; and necessitate careful and detailed control of the utilisation of such forests by private initiative. The policy, however, though commendable in principle, lacks any definite target being laid down regarding the percentage that should be under forest area. This may be very difficult to prescribe, as forests are gifts of nature rather than creations by man; and so cannot be had always where and how we like. The total forest area of British India under the control of the Forest Department in 1941 is given as 98,288 square miles which is 11.4 per cent of the total area. Of this the bulk, Reserve Forests, amounted to 72,936 square miles. Protected Forests to 6,772 and Unclassed Forests, to 18,580 square miles. As against this the optimum forest area demanded by

the Sylviculture enthusiast is 20 per cent. But in a land as ancient and populated as India, it is next to impossible to achieve such an aim. There are 144,000 square miles of cultivable waste in the whole country, and another 44,000 square miles not available for cultivation. The bulk of this is covered by Forests, Rivers, Road, Towns, etc. Quite a good bit may, however, be obtained from both these sources put together to add considerably to the area under cultivation; and at the same time make a more even distribution of forests throughout the land to help achieve some of the objectives mentioned above. It has, therefore, been proposed that an active programme of Reafforestation should be undertaken, side by side with a similar programme in private forests with a view to securing as near the target above named as possible.

The utilisation of forests, from the point of view of modern industry, leaves still much to be desired. Small scale or Cottage Industries based on minor forest produce,—such as grass for basket-weaving, rope-making and the like, bamboo for paper or hutments and the working up of all by-products of forest animals hunted or snared, are immemorial in this country. But the larger mechanised, modern industries of paper-making, drugs and medicine plant cultivation, resin and turpentine production, or the manufacture of power alcohol from such products as the prickly pear, have yet to receive their due attention. Forests have been used from time immemorial for timber needed for house or boat-building; but, even here, considerable room for improvement still awaits a scientific plan of integrated simultaneous development of all our natural resources.

The utility of Forests in supplying domestic fuel has been recognised also from time immemorial. But the danger in the search of such fuel to the preservation of forests themselves and the protection of the soil cannot be over-emphasised. If any alternative fuel in the shape of coal or gas or electricity is made available on a large-scale, forests would be spared; and their better utilisation for industrial purposes could be more easily ensured. The use of Forests as providing good pasture ground, and, therefore, serving as a basis for large-scale stock-breeding, together with all its by-products, as well as for the dairy industry, is also no novelty in this country. Its development on a large-scale and scientific lines requires much more intensive enterprise.

The cultivation of plants and trees for such industries as Sericulture and Silk Weaving, for Pyrethrum, Santonin, Quinine and other Medicines, Disinfectants, or Insecticides, Paper, and the like, need only to be mentioned to show the great service forest produce can render in the building up of an all-round industrialisation in this country.

The two main handicaps in the effective carrying out of this programme may be mentioned at this stage. The lack of proper transport facilities is the biggest of these handicaps. Unless and until rapid as well as economic transport suited to the peculiar exigencies of forest produce and its intensive, industrial utilisation is provided, the large-scale development of forests and forest industries would be extremely difficult. This lack is not unperceived; but no steps have yet been taken to remedy it. For meeting these transport needs, as well as for developing the industries, the second great need would be that of an abundant and economic power-supply. This can only be obtained from electrical energy, which, in those parts of the country where

forests abound, is not difficult to provide by means of suitably located Hydro-Electric Works. This aspect of the problem has been considered in another Report and there is no need to repeat it here.

Most of these lines of advance have already received some attention in recent years from the authorities concerned, though not in the measure that the importance of the subject requires. As stated already the advent of a Popular National Government, with the whole-hearted support of the people, and with a pre-concerted Plan of simultaneous advance on all fronts in the country, would, it is hoped, help to develop this immense source of natural wealth with which this country is endowed.

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Printed by M. E. Rao, New Age Printing Press, 190-B, Khetwadi Main Road, Bombay 4 and published by Mr. M. K. Vora for Vora & Co. Publishers, Ltd. 3 Round Building, Bombay 2.