

AGRICULTURAL DEPARTMENT IN SIND.
SUMMARY OF PRESENT POSITION OF THE WORK
OF
THE AGRICULTURAL DEPARTMENT IN SIND
AND
A FIVE-YEAR PROGRAMME OF DEVELOPMENT,
1936—1941.

INTRODUCTION.

The summary of the present position of the work of the Agricultural Department in Sind and the Five-Year Programme of Development, which are included in this Note, are based upon a review of the activities of the Department, carried out at a series of Staff Conferences, held in March 1936, and presided over by the Chief Agricultural Officer in Sind. At the present stage of the development of agriculture in Sind, it was very necessary that a definite plan should be framed in accordance with which the activities of the Agricultural Department should be directed for the next five-year period. Such a plan or programme will be most useful for the guidance of the staff of the Department and will serve as a measure of the progress which departmental research and district work may achieve in the near future towards the introduction and extension of improved agriculture in the province. In general, the main lines of policy have been indicated but, wherever possible, detailed objectives for the development of departmental activities have been shown.

W. J. JENKINS,
Chief Agricultural Officer in Sind.

Karachi,
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SECTION I.

CROPS.

SUB-SECTION (A)—COTTON.

SUMMARY OF PRESENT POSITION.

Introduction.

One of the main features of agricultural development in Sind since the opening of the Lloyd Barrage and Canal Systems in 1932 has been the rapid and extensive increase in cotton cultivation. The average acreage under cotton in Sind for the five-year period prior to the Barrage, was slightly over 3,00,000 acres. The acreage under cotton in recent years is given below :—

1932-33	...	...	3,41,400 acres.
1933-34	...	...	5,18,400 "
1934-35	...	...	6,76,200 "
1935-36	...	...	7,91,400 "

A notable feature of this increase in cotton cultivation is the great extension in the cultivation of long and medium stable American cotton, especially in the Thar Parkar district. Prior to the introduction of perennial irrigation, the cultivation of this type of cotton in Sind was negligible, whereas in the current season 1935-36, approximately one half of the total Sind crop consists of American types of cotton. The Indian Central Cotton Committee, Bombay, has contributed large grants for research and extension work on cotton cultivation in Sind. At the Committee's Technological Laboratory, Matunga, spinning and fibre tests on improved Sind cottons are carried out annually, the results of which are extremely valuable to the scientific research workers on the botanical improvement of the crop. A Cotton Technological Assistant at the Agricultural Research Station, Sakrand, has been provided by the Central Cotton Committee for fibre examination, etc., of improved strains of cotton evolved at the Station. A Sind Cotton Committee, consisting of both officials and non-officials, has been established to advise and assist in the future development of cotton cultivation in the Barrage areas. Scientific research work on cotton improvement is being carried on by the Agricultural Department in Sind at Sakrand and Mirpurkhas and organised schemes for seed multiplication and extension of improved cottons are being carried out in the districts. A Government Ginning Factory has been established at Mirpurkhas. A summary of the present position of cotton cultivation and a five-year programme of development is included in this section.

(a) *Botanical research work on cotton improvement.*—Botanical research work on the cotton crop of Sind is carried on mainly at the Agricultural Research Station, Sakrand, and, to a lesser degree, at the Government Seed Farm, Mirpurkhas. Scientific work on the Sind *deshi* crop has resulted in the evolution, by botanical selection, of the improved Sind *deshi* strain of cotton known as "27 W. N." or Sind N. R. This selected strain is superior to the local *deshi* crop in yield and ginning percentage and has a bright colour and rough feel which renders it very useful for certain trade purposes, *e. g.*, mixing with wool. The staple is extremely short (about $\frac{3}{8}$ "— $\frac{1}{2}$ "). There does not appear to be any prospect of obtaining a better type of Sind *deshi* cotton by botanical work on the ordinary *deshi* crop. Numerous other *deshi* types of cotton have been imported into Sind from other cotton-growing tracts of India, but, after trial, have all been found inferior and less suitable for Sind conditions than the improved Sind N. R., mentioned above.

With regard to American cottons, botanical selection from Punjab-American types has resulted in the evolution of three improved strains, specially suited for Sind conditions. These are 'Sind Sudhar' (289F-1) Sind 4F-98 and Sind 285F-2. These improved strains have been selected as showing hardiness and disease and insect resistance, under Sind conditions, and show definite improvement in staple length over the bulk Punjab-American crops from which they were evolved by botanical research. They show improvement on these original cottons in yield and are equal to them in ginning percentage. They vary in staple length from 1" to $1\frac{1}{8}$ " (Sind Sudhar and Sind 285F-2) to $1\frac{1}{2}$ " (Sind 4F-98). The 285F-2 is an earlier cotton than the other selected varieties. At present, this work is being continued and new selections of 289F and 4F types are being tested which show promise of further improvement. With regard to 'quality' cottons, *i. e.*, imported Sea Island and Egyptian varieties, two improved strains suitable for Sind conditions, *viz.*, Sind Sea Island 2-4 and Boss III-16 have been evolved in the Botanical Section. These cottons have a staple length of $1\frac{1}{4}$ "- $1\frac{1}{2}$ " and possess hardiness under Barrage conditions of cultivation. Many other imported cottons from America and Egypt have been tested at Sakrand, but none of these have given satisfactory results or were superior to the strains evolved by botanical selection from material previously imported. The Sudan cottons which were tried proved too late maturing for Sind conditions. At present certain imported strains of African cottons of the American Upland type are under test and some of these may prove useful. Hybridization of Punjab-American cottons with imported American varieties has been carried out, but all the hybrid types, except one, were rejected as unsuitable. The hybrid, which has been retained for further

botanical work, is a cross between Punjab 4F and Meade, four strains of which offer promising material for further development and have now been fixed as pure lines. They are under trial with ordinary improved Sind-American cottons in the Botanical Section area and, on a small scale, in the cotton-growing districts.

(b) *Physiological research work on cotton in Sind.*—The Physiological Section at the Agricultural Research Station, Sakrand, was established in 1927 and is financed by grants from the Indian Central Cotton Committee, Bombay. The Section has been carrying out scientific research work on physiological problems of the cotton crop under conditions of perennial irrigation in Sind. The major problems investigated include the optimum sowing date for various varieties of cotton under Barrage conditions, the irrigation requirements and distribution programme for the cotton crop in Sind, varietal development studies, preliminary work on the nature and causative factors of 'red leaf' phenomenon on Sind-American cottons and problems connected with the development of sound seed in the Sind cotton crop. Work on sowing date and irrigation problems has been completed, but further scientific research work on other physiological problems is being continued. In addition, the Physiological Section has carried on research on minor lines of work, e.g., control of white-ants in cotton crops, manurial requirements of the cotton plant at different stages of growth, etc. The work of the Physiological Section of the Agricultural Research Station, Sakrand, will terminate in March 1937, when the grants given by the Indian Central Cotton Committee for the Sind Cotton Physiological Research Scheme cease. After that date there will be no provision for further work on physiological problems of the cotton crop in Sind. The Physiological Section has established and maintained a very useful and up-to-date Meteorological Observatory at Sakrand.

(c) *Cotton cultivation and agronomy.*—In spite of the very considerable and rapid increase in the area under cotton cultivation in Sind in the past five years, it is considered that the methods of cotton cultivation in general use in the districts are, on the whole, improving. The bulk of the cotton crop is still being broad-cast in preference to being sown by the drill method, but more care is being given to preliminary tillage before sowing. In many cotton-growing areas, the crop is being seriously over-irrigated with corresponding reduction in outturn and damage to the soil. Intercultivation of the crop by means of the *deshi* or 'Sircar' plough is extending even in the broad-casted fields. No attempt appears to be made to remove cotton stalks after the crop is picked. With reference to sowing, the seed-rates in common use are, in general, too high. The March closure of the Barrage canals has an adverse

effect on cotton cultivation by delaying sowings and thus limiting the period, during the early part of the season, which is most suitable for the sowing of long-stapled American cotton varieties. The general rotation in the cotton-growing districts is a three year rotation, *viz.*, cotton, wheat, fallow, but, in many tracts, no regular rotation of crops is being practised with the object of maintaining soil fertility and improving cotton yields. Green manuring of the cotton crop has not yet become popular among the cultivators.

(d.) *Insect pests and fungoid diseases of the cotton crop.*—

The major insect pests on the cotton crop in Sind, given in order of importance, are jassids, white-ants, pink and spotted boll-worm, and black-headed cricket. Jassid attack is always prevalent especially on American cotton varieties in the Thar Parkar district, and must cause very considerable losses to the cotton-growers annually. The damage by white-ant is more common on new lands, when brought under cultivation for the first time. There are indications that the severity of the damage by termites decreases as cultivation progresses. They attack 'quality' cottons, *e.g.*, Sea Island and Egyptian, most severely. The attack by pink and spotted boll-worm on the cotton crops in Sind appears to be periodic and evidence is lacking as to the intensity or extent of the damage caused. There is reason to apprehend that damage by boll-worm attack may increase in Sind as cotton cultivation expands. The black-headed cricket is a serious pest of cotton cultivation in the Northern tracts of the Right Bank area in particular, where it is almost a limiting factor to further extension of cotton cultivation. Among minor insect pests of the cotton crop in Sind may be mentioned the dusky cotton bug, the lucerne caterpillar and the red pumpkin beetle. The main fungoid or bacterial diseases of the cotton crop in Sind are 'root rot' and 'boll rot'. The former disease occurs in localized patches which extend as cotton cultivation is carried on year after year. The 'red leaf' phenomenon which is observed on many Sind-American cotton varieties and which is followed by withering of the plants, reduced yields and undeveloped seed, may be due to bacterial infections. In Sind, practically no scientific work has been carried out on insect pests and fungoid diseases of the cotton crop or in the investigation of preventive or control measures. The sole line of approach to the solution of such problems has hitherto been botanical research work towards the evolution of resistant varieties. Minor experimental work on termite control in cotton fields has been done in the Physiological Section, Agricultural Research Station, Sakrand. There is no doubt that the losses suffered annually by the cotton growers of Sind, on account of damage to their crops by insect pests or fungoid and bacterial diseases, are immense and scientific research work on these pests and diseases is most urgently required.

(e) *Multiplication, distribution and extension of seed of improved varieties of cotton.*—The present organization for the multiplication of pure seed of improved varieties of cotton was commenced in 1931 and is based upon the 'unit' system, *i.e.*, one 'unit' of 25,000 acres under one improved variety of cotton in a period of five years.

The programme of seed multiplication of one 'unit' as originally fixed is given hereunder :—

1st year	...	2½ acres	...	'Seed Patch.'
2nd year	...	25 "	...	'Increase Block.'
3rd year	...	250 "	...	'Field Scale Plantings.'
4th year	...	2,500 "	...	'Village Groups.'
5th year	...	25,000 "	...	'District Groups.'

It was originally decided that the 1st and 2nd stages of multiplication should take place at the Agricultural Research Station, Sakrand, and on Government Auxiliary Farms, respectively. The 3rd stage, *i.e.*, 'Field Scale Plantings' should be organised on the lands of 'A' class registered seed-growers and the 4th stage, *i.e.*, 'Village Groups' on 'B' class registered seed-growers and through co-operative organizations. After the 4th stage, the seed produce should pass into general cultivation as 'DISTRICT Groups'. At the present time, eleven such 'units' of multiplication are being supervised by the Agricultural Department, these 'units' being distributed among the different varieties of improved cottons as under :—

7 'units'	...	Sind-American cottons, <i>i.e.</i> , Sind Sudhar and Sind 4F-98.
3 'units'	...	Sind N. R. (Deshi).
1 'unit'	...	'Quality' cottons, <i>i.e.</i> , Sind Sea Island and Boss III-16.

As a result of the past year's experience in the working of this organization, it has been found—

- (a) that the number of 'units' being dealt with are insufficient to meet the demand for pure seed of improved cottons after the 3rd stage of multiplication ;
- (b) that the 'A' class registered seed-growers, upon whose lands the multiplication in the 3rd stage is carried out, should be gin-owners as well as large cotton-growers in order to facilitate supervision of ginning and control of seed produce.

- (c) that, at present, co-operative organizations are ineffective in the scheme of seed multiplication and distribution and that the control of the work must remain with the Department of Agriculture up to the end of the 4th stage;
- (d) that it is essential that the 'B' class registered seed-growers, *i.e.*, in the 4th stage, should be assisted to market their kapas' so as to obtain an adequate premium for pure cotton produced from departmental seed.

There have also been difficulties in getting control of the pure seed produced in the 3rd year from the lands of 'A' class registered seed-growers and in ensuring correct supervision of roguing in the fields and ginning in the factories.

All these difficulties, which have been experienced during the past five years, have been carefully considered in framing the new proposals for the multiplication and distribution of pure seed of improved cotton varieties which are given under item 14 of the new Programme of Development for the next five-year period which is detailed in the following paragraphs.

CROPS SECTION.

SUB-SECTION (A)—COTTON.

Programme of Development for the next five-year period, *i.e.* 1936—1941.**(1) Programme of scientific botanical research work on cotton improvement.**

With regard to Sind *deshi* cotton, it is practically certain that no material improvement on the present improved variety, *i.e.*, Sind N. R., can be obtained by further botanical selection within the ordinary Sind *deshi* crop. The importation of other *deshi* cottons from other cotton-growing tracts of India, with the object of obtaining a better type of *deshi* cotton for Sind, is not required and shows no promise of valuable results. No further botanical research work on Sind *deshi* cotton is necessary, except what may be found essential to maintain the high ginning percentage of the improved Sind N. R. strain.

With regard to Sind-American cottons, selection work among Punjab-American types should be continued, special attention being given to obtaining strains possessing the following characters:—

- (a) Ability to stand late sowings, *i.e.*, after 15th May, without susceptibility to jassid attack.
- (b) Early maturity.
- (c) Hardiness and resistance to adverse environmental conditions.
- (d) Ease of picking, *i.e.*, clean and rapid extraction of kapas from the bolls.

Staple length and ginning percentage of any new selections must be at least equal to present improved types of Sind-American cottons.

With regard to 'quality' cottons, no further botanical selection work appears to be necessary. The improved varieties Sind Sea Island 2-4 and Boss III should be maintained pure and extended in cultivation in suitable tracts on good land. The Ashmouni variety should be rejected.

With regard to hybrid cottons, the cross 4F Meade should be continued under study and tested in the districts under different sowing dates, for yield, early maturity and resistance to jassid attack and 'red leaf' in comparison with established improved Sind-American varieties. The possibility of effecting crosses between Sind-American and Cambodia cottons should be examined with the object of evolving a jassid resistant type of long-staple cotton for Sind.

With regard to fresh importations of foreign cottons for trial in Sind, the best types of African cottons should be obtained and tested in the districts. Similarly any new and improved strains of Sudan, Egyptian and Iraq cottons should be imported and tested for jassid resistance.

Selection work on Sind-American 4F types of cotton should be commenced at the new Right Bank Research Station at Dokri with the object of isolating early maturing strains for extension in the Right Bank tract.

(2) Future organization of botanical research work on cotton improvement.

It is essential that future botanical research work on medium and long stapled American and Egyptian cottons in Sind should be duplicated at the Agricultural Research Station, Sakrand, and at the Government Seed Farm, Mirpurkhas.

Arrangements should be made with prominent land-owners to procure 4 centres of about 10 acres each in Hyderabad and Thar Parkar districts for the testing of improved varieties of cotton in the districts.

The sub-station at Jamesabad should be resumed as a testing centre for improved varieties of cotton.

(3) Research work to be conducted at the Government Ginnery, Mirpurkhas.

At the Government Ginnery, Mirpurkhas, the Agricultural Engineer, in consultation with the Botanist in Sind, should undertake research and experimental work on (a) cleanliness and technique of ginning different varieties of Sind cottons, (b) grading of cotton seed and (c) storage of cotton seed.

(4) Research work on cotton suitable for cultivation in non-Barrage areas of Sind.

The Botanist in Sind should commence botanical research work to evolve improved strains of cotton suitable for cultivation under the irrigation and environmental conditions which prevail in the non-Barrage areas of Sind. Subsequent tests of such improved strains should be carried out in the districts concerned at centres where cotton cultivation might be introduced.

(5) Appointment of a Physiologist for work on physiological problems of cotton cultivation.

The Physiological Section, Agricultural Research Station, Sakrand, will close down in March 1937, but in view of the important physiological problems of cotton cultivation which require

further investigation, a Physiological Assistant should be retained and attached to the Botanical or Chemical Section at the Sakrand Station for physiological research and for the continuance of the records, etc., at the Meteorological Observatory at the Station. The correct and regular maintenance of such records is of primary importance to the work of all scientific sections at the Station.

(6) Further work on cotton physiology at Sakrand.

Further physiological research work on the cotton crop at Sakrand should be concentrated upon (a) varietal development studies, (b) the nature and causative factors of the red leaf phenomenon on American cottons in Sind, (c) relation between different soil types and growth and maturity of the cotton plant and seed and (d) factors influencing the development of sound, viable seed in Sind cottons.

Experimental work on physiological problems of cotton cultivation at Sakrand should, as far as possible, be duplicated at Mirpurkhas.

(7) Investigation of physiological problems of cotton growing in the Right Bank tract.

Physiological experiments to determine the optimum sowing dates and irrigation requirements of different varieties of cotton grown in the Right Bank tract, should be commenced at the Right Bank Research Station, Dokri.

(8) Programme of research work on cotton cultivation and agronomy.

Future research work on problems of cotton cultivation and agronomy should be concentrated upon :—

- (a) Comparative seed rates of different varieties of cotton in different tracts.
- (b) Effect and economics of drilling *versus* broad-casting the cotton crop (both being intercultivated).
- (c) Spacing of different varieties of cotton to obtain highest outturns.
- (d) Study of factors contributing to bad and careless picking of Sind cottons and research into practical methods of improving harvesting technique.
- (e) Possibility of cultivation of cotton as a ratoon crop in inundation tracts.
- (f) Determination of optimum number of intercroppings in cotton cultivation.

(9) Research work on rotational cropping with cotton as a main kharif crop.

In the cotton-growing tracts, four or five permanent experiments should be arranged on zamindars' lands for research and demonstration of suitable systems of crop rotation with cotton as the main kharif crop. Such experimental areas, which should be at least 16 acres each, should be utilized also for demonstrations of improved methods of cotton cultivation.

Leaflets in vernacular should be prepared and distributed which will illustrate clearly and simply suitable crop rotation systems, with cotton as main kharif crop, suitable for East Sind, Lower Sind and the Right Bank tract.

(10) Programme of work of Crop Pest Section, Sakrand, on insect pests and fungoid diseases of cotton.

The Crop Pest Section, Agricultural Research Station, Sakrand, when established, should commence a detailed survey of insect pests and fungoid diseases of cotton in Sind as a preliminary step to investigation of preventive and control measures. To commence with, the jassid pest on cottons in the Left Bank areas and the black-headed cricket in the Right Bank areas should receive the attention of the Entomological Assistant. The Mycologist should study the 'root rot' and 'boll rot' diseases of cotton in Sind after collecting full information of work already done on these diseases in other cotton-growing tracts of India and abroad.

(11) Investigation into extent of boll-worm damage to cotton in Sind.

Arrangements should be made to conduct a detailed investigation in the main cotton-growing tracts to determine to what extent the pink and spotted boll-worm may be considered to be major pests on the cotton crop in Sind.

(12) Reporting of attacks of insect pests and fungoid diseases on the cotton crop.

Instructions in detail should be drafted and issued to district officers of the Revenue, Irrigation and Agricultural Departments in Sind as to means of identifying the major insect pests and fungoid diseases of the cotton crop, and instructions given with regard to the early reporting of serious attacks by such insect pests or fungoid diseases to the Crop Pest Section, Sakrand.

All district officers of the Agricultural Department in Sind should be instructed with regard to the correct method of packing and despatching samples of insect pests or fungoid diseased material through the post so as to arrive in an undamaged and identifiable condition.

(13) Scheme for detailed entomological investigation into blackheaded cricket in North Sind.

A detailed scheme and estimates for an entomological investigation into the black-headed cricket in North Sind should be prepared and submitted to the Indian Central Cotton Committee for provision of the necessary financial assistance.

(14) Re-organization of multiplication, distribution and extension scheme for seed of improved varieties of cotton.

The basis of the scheme should remain the 'unit' system, *i.e.*, each 'unit' aiming at supplying sufficient pure seed of one improved variety of cotton for 25,000 acres in a period of five years.

Commencing with 1937, 21 "units" of multiplication (instead of 11 as at present) should be commenced. The total areas required each year for the development of 21 'units' of seed multiplication are given below :—

1st year (Seed Patch)	...	52½ acres.
2nd year (Increase Blocks)	...	525 "
3rd year (Field Scale Plantings)	...	5,250 "
4th year (Village Groups)	...	52,500 "
5th year (General Cultivation)	...	525,000 "

The arrangements proposed for the supervision, control and distribution of the seed during each stage of multiplication is given below :—

1st year.—The 52½ acres required for the 'Seed Patch' stage of the multiplication scheme will be grown at the extended Agricultural Research Station, Sakrand, from seed (produce of selfed plants) supplied by the Botanist in Sind from the cotton-breeding area of the Botanical Section. This 'Seed Patch' stage will be carefully rogued.

2nd year.—The seed produce from the 'Seed Patch' area of the previous year will be grown on 525 acres of 'Field Scale Plantings' on (a) Auxiliary Government Farms and (b) on a special Seed Farm of 500 acres, to be acquired near Mirpurkhas. (*N. B.*—This Farm will be organised on the hari system and should be self-supporting. As an alternative, the necessary area may be obtained on some large cotton-growing estate by arrangement with the land owners.) The 525 acres of the 'Field Scale Plantings' stage will be carefully rogued by the Department.

3rd year.—The seed produce of the 'Field Scale Planting' area of the previous year will be grown on 5,250 acres of land, belonging to 'A' class seed-growers of the Agricultural Department in Sind. These growers should, as far as possible, be also gin-owners in order to facilitate the pure ginning of the seed obtained from their lands, *i.e.*, from the 'Field Scale Plantings.' The growers will be under agreement, as at present, to supply the seed back to the Agricultural Department at a fixed premium over ordinary local seed price of the same variety or varieties and to store the seed with them until required by the Agricultural Department for further distribution next season. This 'Field Scale Plantings' stage (5,250) acres will be rogued by the Department with the assistance of the 'A' class registered seed-growers.

4th year.—The seed produce of the 'Field Scale Plantings' area of the previous year will be supplied, on indent to 'B' class registered seed-growers and will be grown on their lands to an extent of 52,500 acres. The lands of these 'B' class registered seed-growers will be inspected, at least twice annually, by the district staff of the Agricultural Department and if a definite standard of purity of crop is reached, the 'B' class registered seed-grower will be issued with a Certificate of Purity by the Department. At the same time, a list of 'B' class registered seed-growers whose crops have received a 'Certificate of Purity' will be prepared and furnished to a number of approved gin-owners, under agreement with the Department to purchase and gin pure the departmental seed of 'B' class registered seed-growers whose crops are certified pure by the Department, and who are prepared to assist in the further distribution of such seed for sowing purposes at a reasonable premium over the price of ordinary feeding seed of similar varieties in the same locality. The Agricultural Department will arrange to notify Mill-owners Associations, exporters, etc., in advance the names of the gin-owners and the quantities of certified crop available from 'B' class registered seed-growers at each approved ginnery in order to facilitate and promote sale of pure and unmixed cotton. The Department will also make public the names of such approved ginneries where supplies of pure seed will be available for sowing next season, *i.e.*, the 5th stage: 'General Cultivation' and will assist such ginneries to dispose of this seed under a departmental seal.

The satisfactory working of this scheme would result in pure and unmixed seed of improved cotton varieties, sufficient to sow 525,000 acres, being available to the cotton-growers each year. A new series of 21 'units' of multiplication will be commenced annually. When sufficient pure and improved cotton seed is available in Sind, steps should be taken to prevent the importation of cotton seed for sowing from the Punjab.

The proposed distribution of 21 'units' of cotton seed multiplication between different improved varieties of cotton and different cotton-growing tracts is given hereunder :—

Sind Sudhar (289 F-1)

Thar Parkar	...	...	7 'units.'
Hyderabad	...	...	2½ 'units.'
Nawabshah	...	...	2 'units.'
			Total ... 11½ 'units.'

Sind 4F-98

Thar Parkar	...	...	3 'units.'
Hyderabad	...	...	1 'unit.'
Nawabshah	...	...	½ 'unit.'
Right Bank	...	...	1 'unit.'
			Total ... 5½ 'units.'

Sind N.R. (deshi)

Hyderabad	...	...	1 'unit.'
Nawabshah	2 'units.'
			Total ... 3 'units.'

'Quality' cottons,

(Sea Island, Boss III)	1 'unit.'
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Special attention will be given to the distribution of the seed of improved long staple varieties of cotton in Thar Parkar district with the object of establishing rapidly a compact block of long stapled cotton of at least 300,000 acres in that district.

(15) Formation of a Cotton Seed Distribution Committee.

A departmental Committee, to assist in the direction and control of the above noted scheme for improved cotton seed multiplication and distribution should be formed, consisting of :—

The Chief Agricultural Officer in Sind.

The Botanist in Sind.

The Deputy Chief Agricultural Officers.

The Cotton Supervisors, Left and Right Banks.

The Committee should meet at least once a month to discuss all matters relating to the working of the scheme, propaganda, etc.

(16) Publicity towards the extension of the cultivation of improved cottons in Sind.

The Publicity Expert, Indian Central Cotton Committee, Bombay, should be consulted with the object of initiating a campaign of propaganda towards the extension of the cultivation of improved varieties of cotton in Sind. Press Notes giving information regarding facilities for obtaining pure seed, lint, etc., should be issued periodically by the Cotton Seed Distribution Committee.

Agricultural Implement Depots, Auxiliary Farms, etc., should be fully utilized for storing and sale of small quantities of improved seed to small cultivators.

(17) Programme of work of Government Ginning Factory, Mirpurkhas.

Arrangements should be made by the Cotton Seed Distribution Committee to supply up to 25,000 maunds of kapas of improved varieties of cotton, grown on Government Farms and by registered seed growers each year.

(18) Development of cotton growing in the Right Bank areas.

The programme of development of cotton growing in the new cotton growing tracts in the Right Bank should aim at the undernoted increase in acreage under cotton:—

1937	...	...	...	40,000 acres.
1938	...	...	...	50,000 „
1939	...	...	...	60,000 „
1940	...	...	...	70,000 „
1941	...	...	...	80,000 „

(19) Trade exhibitions of improved cottons.

The Agricultural Department in Sind should organise and hold trade exhibitions of improved cottons from Sind in Karachi—and if possible, in Bombay and Ahmedabad—every second year to keep the cotton trade, exporters and mill-owners in touch with the developments of cotton cultivation in Sind.

*Agricultural Leaflets dealing with cotton and kindred subjects
issued by the Agricultural Department in Sind since 1930.*

- No. 19 ... "Green manuring of Cotton with Guar."
No. 23 ... "Calendar of Main Agricultural Operations at
Agricultural Research Station, Sakrand."
No. 32 ... "Cotton Cultivation in the Indus Right Bank
areas."
No. 34 ... "The sowing of Cotton Crop by Drill
Method."
No. 35 ... "The Irrigation of Dry Crops in Barrage
areas including a suggested Time-table
of Agricultural Operations and Irrigation
Water."
No. 48 ... "Cropping Chart for Barrage areas in Sind."
No. 49 ... "Improved varieties of Cotton for Sind and
their Cultivation."
No. 51 ... "The Irrigation of the Cotton Crop in the
Barrage areas of Sind."

SECTION I—*contd.*

CROPS.

SUB-SECTION (B)—WHEAT.

SUMMARY OF PRESENT POSITION.

Introduction.

The importance of wheat as a crop to be grown in the Barrage areas of Sind has been universally recognized. It was anticipated that wheat would be, by far, the most extensively cultivated crop under Barrage irrigation and that the total area under this crop would rise from half a million to two million acres. The area of wheat in Sind during the five years 1927-1931, prior to the opening of the Barrage Canal Systems, was approximately 5,09,400 acres. The areas under this crop during the past four years, 1932-1936, are given hereunder :—

1932-33	...	...	9,69,300 acres.
1933-34	...	...	13,06,200 "
1934-35	...	...	10,68,000 "
1935-36	...	...	10,23,800 "

It is therefore apparent that, during the past three years, there has been no real increase in wheat cultivation in Sind. This position is due to many causes, mainly the low prices which zamindars have been obtaining for their wheat crops, the rapid increase of kharif cultivation, especially cotton, which results in an 'overlap' of agricultural operations at the commencement and end of the wheat growing season and to the lack of experience of rabi irrigation and cultivation on the part of cultivators in the Barrage tracts. The Agricultural Department in Sind has had under consideration the possibility of adopting methods of increasing wheat cultivation in the Barrage areas or, as an alternative, the extension of rabi oil-seed crops with a longer range of sowing periods and a higher economic return to the cultivators under present conditions. The extension of rabi cultivation in the Barrage areas is essential to the final success of the Barrage Project.

(a) *Botanical research work on wheat improvement.*—The Botanical Section of the Agricultural Department in Sind have been carrying out scientific work on the improvement of the wheat crop in Sind at the Agricultural Research Station, Sakrand, (on irrigated wheats) and at the Government Wheat Farm, Jacobabad, on *boisi* wheats. The latter institution was closed down in 1932 on account of financial stringency. As a result of this work, improved strains

of wheat have been evolved from the major wheat varieties in common cultivation in different tracts of Sind. These improved wheat varieties are C. Ph. 47 (improved Phandani) suitable for irrigated tracts and North Sind, A.T.38 (improved Thoree) suitable for both irrigated and bosi conditions in North Sind and Right Bank areas and H.S.W. 3 (improved Bujri (awned) wheat) suitable for Lower Sind. These selected types are superior to the ordinary bulk crops in yield and in resistance to fungoid diseases, *e.g.*, 'rust'. A series of 'Major Wheat Varietal Tests' of these improved varieties, in comparative replicated plots, has been carried out in all the main wheat-growing tracts in Sind over a period of four years. The results of these scientific and organised experiments have furnished conclusive evidence as to the respective suitability of these different varieties for general cultivation in the wheat-growing districts. The organization for the distribution of the seed of improved wheat varieties is based on the results of these tests. In addition to botanical improvement by selection among indigenous wheats, the Botanical Section has succeeded in acclimatizing certain imported varieties of wheat from other wheat-growing tracts of India and in extending their cultivation in Sind. Among such introductions the Punjab variety, Punjab 8-A and the Pusa variety, Pusa 114 are most important. The former is widely grown under irrigated conditions in Middle and East Sind and the latter, which has a high quality of grain and is extremely 'rust' resistant, is suitable for cultivation under irrigated conditions over all the Province. Other direct importations from foreign wheat-growing countries, *e.g.*, Canada, Africa, America, etc., have proved unsuitable under Sind conditions. Three Australian wheat varieties, *viz.*, Yetna, Bald Early and Khalif are promising and are being tested against the improved varieties mentioned above. Work has been done on the hybridization of wheat varieties and five or six crosses between indigenous Sind wheats and imported wheats have been made with the object of improving grain quality and obtaining further increase in yield. Some selected strains from these crosses are promising, but have not yet been tested on a field scale in the districts with other improved wheat varieties. From time to time, practical milling and baking tests on improved Sind wheats have been arranged and carried out in England, America and Holland as a complement to scientific botanical work in Sind.

(b) *Wheat cultivation, agronomy and irrigation.*—Under Barrage conditions of irrigation in Sind, the bulk of the wheat crop is sown between the beginning of November and mid-December. In Lower Sind, sowings start earlier, *i.e.*, in October. Harvesting takes place in March and April. The rapid extension of cotton cultivation and the inadequate methods for harvesting and threshing

the wheat crop are limiting more rapid wheat extension in the Barrage areas as the operations, connected with cotton, in the kharif season and wheat in the rabi season, overlap. Under bosi cultivation, the wheat crop is mostly drilled owing to the necessity of sowing the seed at the optimum depth to obtain adequate moisture for germination. Except in parts of Upper Sind, the irrigated wheat crop is sown broadcast as there is inadequate preliminary tillage for a successful drilled crop. The seed rate in common use is almost invariably wasteful, e.g., 80 lbs. per acre for irrigated wheats and 100-120 lbs. per acre for bosi wheat. It is commonly realized that the drilled wheat crop requires much less irrigation than the broadcast crop, but in the absence of suitable preliminary tillage, the practice of broadcasting persists with corresponding excessive use of irrigation on the bulk of the wheat-growing lands in the rabi season. Harvesting and threshing methods are slow and primitive and improvements in this direction have been suggested under the Agricultural Engineering Section of this Note. No harvesting or rolling of the wheat crop in its early stage of growth is practised to induce tillering and thereby increase yields. Wheat, after harvesting, is generally stored in godowns or rooms, in bags or loose heaps, and is thereby exposed to loss and damage by insect attack, e.g., grain weevils.

(c) *Insect pests and fungoid diseases of the wheat crop.*—In Sind, the wheat crop is practically free from attacks by any major insect pest, but over the whole wheat-growing tracts, the crop suffers severely from 'rust' disease. The attack of this fungoid disease is more severe and acute in some years than in others, but cloudy weather in February and March almost always results in a marked increase of damage by 'rust'. Over irrigation also tends to induce 'rust' attack in the irrigated wheat tracts. All varieties of wheat are liable to 'rust' attack, but the improved varieties, evolved or introduced by the Agricultural Department are less susceptible to the disease. The acclimatised Pusa improved variety, i.e., Pusa 114, is practically immune. In a year of serious 'rust' attack, approximately half the normal yields of grain are obtained in affected areas. In some tracts, damage is caused to the wheat crop in the fields by rats. The grain weevil is a major insect pest on wheat in storage.

(d) *Multiplication, distribution and extension of seed of improved varieties of wheat.*—The Agricultural Department in Sind has organised in 1931, a scheme for the multiplication, distribution and extension of the seed of improved varieties of wheat, based on the 'unit' system, as in the case of cotton. The 'unit' in the wheat multiplication scheme was 50,000 acres under the seed of one

improved variety in a period of five years. The stages of multiplication of a 'unit' were as under :—

1st year (Seed Patch)	5 acres.
2nd year (Increase Block)	50 "
3rd year (Field Scale Plantings)	500 "
4th year (Village Groups)	5,000 "
5th year (General Cultivation)	50,000 "

Nine such 'units' were started annually for improved varieties of wheat as shown below :—

C. ph. 47	4 $\frac{1}{2}$ " units "
A. T. 38	2 "
Punjab 8-A	1 $\frac{3}{4}$ "
Pusa 114	1 "

Experience has shown that the first three stages of multiplication, *i.e.*, 'Seed Patch', 'Increase Blocks' and 'Field scale Plantings' can be easily organised, the first two on Government Research Stations and Farms and the third on the lands of 'A' class registered seed-growers. After that stage, however, *i.e.*, after the 3rd year, the scheme broke down owing to the absence of a suitable financing agency to purchase the improved seed grown by 'A' class registered seed-growers in order to store it for distribution next sowing season. In the absence of such agency, the 'A' class registered growers were unable to retain the stocks in their own godowns and had to sell off in the local markets. Attempts were made to enlist the assistance of co-operative organizations in the 4th and 5th stages of distribution, but such methods were not successful owing to lack of experience on the part of the distributing agencies.

CROPS SECTION—*contd.*

SUB-SECTION (B)—WHEAT.

Programme of Development for the next five-year period, i.e., 1936—1941.**(1) Programme of botanical research work on the wheat crop.**

Further botanical work in the direction of improvement by selection among indigenous Sind wheats is not likely to be useful and should be stopped with the exception of botanical selection in North Sind wheats, suitable for cultivation under *bosi* conditions. This work should be continued, the sub-station at Shikarpur being utilised for the purpose.

The scientific comparative yield trials of imported wheats against local improved strains should be continued and the most-promising hybrids included in these tests, which should be carried out under both irrigated and *bosi* conditions in all parts of Sind.

In future botanical work on wheat improvement in Sind, special attention should be given to—

- (a) resistance to 'rust' disease,
- (b) ability to stand early sowings, i.e., in October,
- (c) early maturity, especially under late conditions of sowing, even if yield has to be slightly sacrificed in obtaining these important characters.

The improvement of quality in Sind wheats will be most rapidly obtained by botanical work on the acclimatisation of improved Pusa varieties and imported Australian wheats.

Arrangements should be made to have periodic milling and baking tests carried out on Sind and imported wheats, and on new hybrid varieties, in view of a possible recrudescence of the export trade in Indian wheats to other countries.

(2) Research on wheat cultivation and agronomy.

Future experimental work on the improvement of wheat cultivation in Sind should be directed towards—

- (a) comparative trials of drilling *versus* broad-casting the wheat crop, with special reference to irrigational requirements under each system of sowing,
- (b) seed rate experiments,

- (c) determining the effect on outturn of harrowing or rolling the young wheat crop before or after the 1st irrigation after germination,
- (d) improvement of yield by grading of sowing seed,
- (e) spacing.

(3) Organization of district experimental and demonstration plots for wheat cultivation.

In each wheat-growing taluka, six demonstration plots should be arranged annually (4 acres each) for experimental work on wheat cultivation and agronomy. These plots should also be utilised for demonstration of improved methods of wheat cultivation and for district varietal tests.

(4) Research work on fungoid diseases and insect pests of wheat.

The Mycologist in the Crop Pest Section, Agricultural Research Station, Sakrand, should undertake investigations into the 'rust' disease of the wheat crop in Sind. As a preliminary step to this work he should collect and summarize the results obtained from research work on this disease by other workers in India and other wheat-growing countries.

Entomological research work on the prevention and control of insect pests of wheat in storage should be undertaken by the Crop Pest Section.

(5) Re-organization of scheme for the multiplication, extension and distribution of seed of improved wheat varieties.

With effect from *rabi*, 1936-37, eleven 'units' of wheat seed multiplication should be commenced annually by the Agricultural Department in Sind. These 'units' should be distributed between the improved varieties of wheat, handled by the Department, and the main wheat growing tracts of the Province as under :—

C. Ph. 47—

(North Sind including Right Bank) ... 2 units.

A. T.-38—

North Sind ... 2½ units.

Punjab 8-A—

Middle Sind ... 2½ units.

Lower and East Sind ... 3½ units.

Pusa 114—

Lower and East Sind 1 unit.

The stages of the multiplication of each 'unit' will be as—

1st year (Seed Patch)	5 acres.
2nd year (Increase Block)	50 "
3rd year (Field Scale Plantings)	500 "
4th year (Village Groups) :	5,000 "
5th year (General Cultivation)	50,000 "

The total areas required for the 1st and 2nd stages of 11 'units' of multiplication in the 1st and 2nd years, respectively, *i.e.*, 55 acres and 550 acres will be found on Government Research Stations and Farms. The seed for the 1st stage, *i.e.*, 'Seed Patch' stage (55 acres), will be the produce of selfed plants, provided by the Botanical Section, Sakrand.

In the 3rd stage, *i.e.*, Field Scale Plantings, 5,500 acres will be grown on the lands of 'A' class registered seed-growers, under contract to place not less than half their total seed produce at the disposal of the Agricultural Department, after harvesting, at a small premium above local market rates.

This seed, amounting to approximately 25,000 maunds, should be purchased and stored by the Agricultural Department in Sind at Government Farms, village depots, hired godowns, etc., until next sowing season when it should be issued to 'B' class registered seed-growers by the Department.

N. B.—It will be essential for the Department to obtain the assistance of a financing agency to enable this purchase of 'A' class registered seed-growers' produce to be carried out. The Sind Provincial Co-operative Bank or the Imperial Bank of India, should be approached in this connection. As the price of wheat seed at sowing time is almost invariably 8-10 annas higher per maund than at immediately after harvesting, the transaction should be on a sound financial basis.

Efforts should be made to organise wheat 'mandis' at suitable centres for the sale of the produce of 'B class registered seed-growers' produce in the 4th year. The produce of 'quality' wheat, *i.e.*, *Pusa 114*, should, if possible, be sold in organised auction sales.

(6) Formation of a Wheat Seed Distribution Committee.

A. Wheat Seed Distribution Committee should be organised on similar lines to the Cotton Seed Distribution Committee, to or-

ganise and direct the departmental scheme for wheat seed multiplication and distribution in Sind.

Agricultural Leaflets dealing with Wheat and kindred subjects already issued by the Agricultural Department in Sind since 1930.

No. 23—"Calendar of Main Agricultural Operations at the Agricultural Research Station, Sakrand."

No. 29—"The Rat Pest on Rice and Wheat."

No. 33—"The Three-coultered Rabi Seed Drill."

No. 35—"The Irrigation of Dry Crops in Barrage areas including a Suggested Time-table of Agricultural Operations and of Irrigation Water."

No. 38—"The Advantages of Cultivation of Pussa 114 Wheat in Sind."

No. 39—"Improved Varieties of Wheat for Sind."

No. 47—"A Practical Method of utilising Irrigation Water during October for growing Wheat Crop in Barrage Areas."

No. 48—"Cropping Chart for the Barrage Areas in Sind."

SECTION I—*contd.*

CROPS.

SUB-SECTION (C)—RICE.

SUMMARY OF PRESENT POSITION.

Introduction.

The cultivation of rice in Sind is carried on in both the Barrage and non-Barrage tracts, the acreage under this crop being about equally divided between these two areas. Since the opening of the Lloyd Barrage and Canal Systems, rice cultivation in Sind has slightly decreased. The decrease in the Barrage tracts is largely due to the prohibition of rice cultivation in 'non-established rice areas' and, in the non-Barrage tracts, to adverse inundation conditions during the past few years. In the five years, prior to the Barrage opening, rice cultivation in Sind averaged 12,02,000 acres annually. The annual acreages for the past four years are given hereunder:—

1932-33	...	...	11,08,000 acres.
1933-34	...	...	11,18,000 „
1934-35	...	⋮	11,29,000 „
1935-36	...	...	10,43,000 „

Except in the Rice Canal areas, and, to a smaller extent on the Dadu Canal and in the Eastern Nara tract, rice cultivation is not encouraged in the areas supplied by irrigation from the Barrage Canal System. It is, however, the main crop on the Fuleli Canal (Hyderabad district), in Karachi district and is extensively grown on inundation canals in North Sind. In general, the methods of cultivation of the rice crop are satisfactory. In Upper and Lower Sind, the crop is largely transplanted. In East Sind rice-growing tracts, broadcasting the crop is usual. In most of the rice areas, there is considerable room for improvement in the technique of irrigation, especially in the direction of better and more economic utilization of the water-supply available at the commencement of the season. The rice crop in North Sind is often severely damaged by a fungoid disease, known as 'rati' or 'brown spot' which causes sterility in the ear-heads and reduces the outturns very considerably. Other forms of sterility, due to unsuitable environmental conditions, *e.g.*, water logged soils, directional winds, to other fungus diseases and to an insect pest of rice, *i.e.*, stem-borer, are often found. In Lower Sind, the rice crop suffers from the attack of a jassid pest, locally known as 'ruro' or 'mahlo', which causes much loss to growers in years when cloudy, dull weather prevails. The crop is also attacked by field rats and by crabs. In the Lower Sind rice-growing areas, inferior quality rices, both white and red, are generally grown, the commonest varieties being Gunja, Ratyra and Motya. In the Upper Sind districts, the main variety in cultiva-

In addition, however, there is considerable cultivation of Sugdasi (scented) rices, *e.g.*, Jajai, Bengalo, &c., which are of good quality and in demand for local consumption. The bulk of the rice crop grown in Sind is utilised locally, only a small percentage being exported, mostly as 'par-boiled' rice to Cutch and to ports on the Persian Gulf.

(a) *Research work on rice and rice cultivation and irrigation.*—Scientific work on the improvement of the rice crop in Sind is carried out at the Government Rice Farm, Larkana. A small sub-station for botanical work on Lower Sind rices has recently been established in the Fuleli Canal tract. With reference to the rices commonly grown in Upper Sind, improved strains of all the local varieties have been obtained by botanical selection. Kangni 27, the improved strain of the important Kangni variety, is characterised by high yield, early maturity and better milling characters. It is now the standard rice in the Larkana district where its cultivation has extended very considerably. Among Sugdasi rices, similar improvement by botanical selection has been obtained. The improved strains, Jajai 77 and Bengalo 1, have better quality and better milling characters than the original Sugdasi varieties from which they were evolved. In Sind, imported rices from other rice-growing countries have almost invariably been unsuccessful. Many such imported varieties have been tested at Larkana, but no useful material has been obtained from foreign rice-growing countries. Two important crosses have been made between the improved Kangni 27, as one parent, and Kolumba (a Deccan rice) and Torh, as the other parent. The Kangni Kolumba cross has given a very valuable strain, now known as 'Silver Jubilee' rice which is superior to the improved Kangni parent in yield, early maturity, quality of grain and resistance to 'rati' disease. Some of the strains obtained from the Kangni Torh cross are high yielding and suitable for cultivation in *kalar* land, but are of inferior quality. Botanical improvement in the Lower Sind rice crop was only commenced in 1932. Botanical selection within the local Ratyra, Motya and Gunja varieties is in progress and some promising strains have been obtained and grown on pure lines. Early maturing varieties of rice from Upper Sind are being introduced in the Lower Sind tract where early maturity, *i.e.*, short period of growth, is a most desirable character for rices, in view of the short inundation period of irrigation. Experimental work on the improvement of cultivation and irrigation methods in rice cultivation has been directed towards (a) examining the advantages of early transplanting, especially under Barrage conditions of irrigation, (b) preparation of seed beds and economy in seed rate and (c) technique of 'dubari' cultivation in rice fields and effect of such cultivation on subsequent rice crop yields. During the past year, a large scale 'duty' experiment, to determine the adequate 'duty' for rice cultivation in the Fuleli Canal tract, was completed near Badin and gave interesting and valuable results.

Work on the fungus diseases of the rice crop has been conducted at the Government Rice Farm, Larkana, since 1930. A Rice Mycologist and his staff are situated there and provision for laboratory work has been made. This work is financed by grants from the Sir Sassoon David Trust Fund, Bombay. The Rice Mycologist has been mainly employed on scientific research dealing with the 'rati' disease of rice in North Sind, but has also carried out preliminary work on the insect pest causing 'ruro' disease in the Lower Sind rice-growing tracts. With regard to 'rati' disease, the breeding of resistant strains of rice and their extension in cultivation in the 'rati' affected tracts holds out most promise of success. Control measures against field rats, by means of the 'Cyanogas' pump have been evolved, but have not been adopted in the districts where hand-killing is preferred by the growers. Consignments and samples of Sind rices have been sent to Europe and close touch is being maintained between botanical research work and trade requirements in quality, etc., of rice for foreign consumption.

(b) *District work on rice crop improvement and extension of improved varieties.*—The pure seed of improved varieties of rice grown on Government Farms in Sind is in great demand by rice cultivators. No regular scheme for the extension of pure seed of rice varieties in the districts has yet been organised although many attempts have been made in this direction, especially among the smaller growers. In general the rice-grower disposes of his crop as soon as it is ready for market, and does not retain any seed for further distribution to other cultivators. In the rice-growing tracts of the Barrage areas, the advantages of the early transplanting of the rice crop, *i. e.*, in April and May, have been demonstrated on zamindari lands with a certain measure of success. The introduction of early maturing rice varieties, *e. g.*, Kangni 27, into inundation tracts of Lower Sind has been successfully accomplished and such varieties are now becoming well-known and popular. In the Barrage areas, 'dubari' cultivation in rice fields is decreasing, but this practice which adds to the fertility of rice lands is extending in the non-Barrage tracts. Dry ploughing of rice lands, originally introduced by the Agricultural Department, is now the common agricultural practice of the majority of rice-growers. Campaigns against the rat pest have been organised and carried out in Lower Sind. The growers, however, have not adopted the control measures suggested, *i. e.*, use of Cyanogas pumps, to any appreciable extent on account of cost and difficulty in labour. In all areas where rice is grown, the scarcity of labour at the time of harvesting is a serious problem. In the Barrage tracts, the conversion of 'non-established' rice lands, to suit them for dry crop cultivation, is engaging the attention of the Agricultural Department. The problem of water-logging in many areas is intimately connected with rice crop cultivation and further intensive research on this association is urgently required with the object of obtaining practical and economic methods of solving one

CROPS SECTION.

SUB-SECTION (C)—RICE.

Programme of Development for the next five-year period, *i.e.*, 1936—1941.**(I) Programme of botanical research work on rice improvement.**

There does not appear to be any prospect of further improvement by means of botanical selection among the common rice varieties grown in Upper Sind. Work in this connection should be confined to the Sonhari, Basmati and Sada Gulab varieties with the object of isolating strains with higher yield, better quality and improved milling character. Attention should be paid to stem strength in order to reduce risk of lodging.

Among Lower Sind rices, botanical selection work should continue in the Ratyra, Motya and Gunja varieties with the object of isolating early maturing (*i.e.*, with short period of growth) varieties, even if such strains are slightly lower in yield than existing varieties.

In Lower Sind tracts, trials of early maturing rices from other rice-growing tracts should be continued.

Imported rices from Northern India and varieties of Patna rice should be tested at Larkana in comparison with existing improved varieties. Further importation of Japonica group of rices for test in Sind may be discontinued.

The sub-strains of local improved varieties, obtained by the Rice Mycologist, and sub-strains of hybrid rices should be studied further with special reference to 'rati' resistance.

Hybrid rice strains should be tested fully with reference to their comparative characters of (*a*) improved quality, (*b*) better milling characters, *e.g.*, thin husk, less breakage in hulling, (*c*) early maturity, (*d*) 'rati' resistance and (*e*) suitability for par-boiling.

Experimental work should be commenced with the object of obtaining, if possible, a rice-variety which could be grown under dry crop conditions in Lower Sind.

In further botanical work on rice improvement, special attention should be paid to the 'shedding' character of the strains evolved, in view of the labour difficulty at time of harvesting.

(2) Investigations into stacking and storing of rice.

With the object of improving the keeping quality of rice seed for sowing purposes, research work should be carried out on different methods of stacking the rice crop in the field after harvesting and before threshing, and the effects of different stacking methods on keeping quality, milling character, &c., should be compared.

Additional research work on different methods of storing rice seed after threshing, with the object of conserving germination power, should be undertaken at Larkana and in Lower Sind.

(3) Future work on agronomical research on rice cultivation.

Future agronomical and irrigational research work on rice crop cultivation should include—

- (a) investigation of more efficient methods for preparing the surface of rice fields for cultivation, *e.g.*, clod-crushing, &c.;
- (b) in Lower Sind, research into comparative efficiency and economics of different methods of preparation of rice seed beds in advance of inundation conditions;
- (c) 'rabbing' of rice seed-beds and alternative materials, *e.g.*, amonium sulphate, as 'rab' substitutes, from agricultural and economic aspects.
- (d) economic eradication of weeds in rice fields;
- (e) practical and economic methods for the conversion of old rice lands to dry crop cultivation,

(4) Physiological and irrigational research work on rice cultivation.

The undernoted problems, connected with the physiology of the rice crop and its irrigation, should be investigated :—

- (a) the factors causing 'sterility' in the rice crop in Upper Sind, specially in relation to different environmental conditions;
- (b) the relation between the irrigation practice of utilising 'pancho' water in rice cultivation and of occasional drying of rice fields, on crop yields, with reference to different soil types;
- (c) the factors, resulting in the decrease of 'dubari' cultivation in the Barrage areas;
- (d) the water requirements, *i.e.*, 'duty' of irrigation water, for rice cultivation in the Barrage areas;

- (e) additional experimental work on the economics and technique of early transplanting of the rice crop, with special reference to 'double-cropping' with rice in the same season;
- (f) the effect and economics of three day rotational irrigation on rice crop growth and yields in comparison with continuous irrigation.

The above noted items of research work should be undertaken on the rice crop experimental area at the Right Bank Research Station, Dokri, when established.

(5) Investigation into fungoid diseases and insect pests of the rice crop.

The Mycologist, Crop Pest Section, Sakrand, should investigate the factors responsible for 'rati' resistance in different strains of rice.

The life-history and methods of control of the jassid insect pest, causing 'ruro' disease on the Lower Sind rice crop, should be worked out in detail in the affected areas, by the Entomological Assistant, Crop Pest Section, Sakrand.

(6) Re-organization of departmental arrangements for multiplication and extension of seed of improved rice varieties.

About 6,000 maunds of pure seed of improved varieties of rice are produced annually on Government Farms in Sind. In future, the production of this seed should be regulated in 'units' the multiplication of such 'units' being as under :—

For one 'unit'—

1st year	...	...	...	1½ acres.
2nd year	...	...	...	25 „

The multiplication in both 1st and 2nd year will be on Government Farms. Sixteen 'units' should be started annually as under :—

Kangni 27	...	...	...	8 units.
Silver Jubilee	...	...	...	6 units.
Jajai 77	...	...	...	1 unit.
Bengalo 1	...	...	...	1 „

The seed available from Government Farms at the end of the 2nd year, *i.e.*, approximately 6,000 maunds should be distributed to permanent 'registered departmental rice seed growers'. Each

such registered grower must agree to grow at least 200 acres of one variety of improved seed, provided by the Department in a compact block and to permit his crop to be inspected by the officers of the Department during the growing period.

Further he will be bound to give the Agricultural Department the option of purchasing, at local market rate between specified dates, up to three times the quantity of seed supplied to him by the Department for sowing in the previous season. The Department will assist him in the disposal of his other improved seed produce to other zamindars for sowing purposes.

The progress under this scheme will be reviewed annually with the object of increasing the available supply of seed of improved rice varieties as experience in distribution is obtained.

(7) District experiments and demonstrations in rice crop cultivation.

A regular programme of varietal trials to compare improved varieties of rice in different rice-growing tracts should be drawn up and put into effect as soon as possible.

Experimental work on early rice transplanting should be carried out at centres on zamindari lands in the districts in the rice-growing areas of the Barrage tracts.

Seed rate experiments work on the rice crop should be organised in Karachi district.

Further experimental work on the spraying of the rice crop with 'Malirol' against 'ruro' disease should be done in Karachi district on zamindari rice fields.

Experimental work on the economic possibility of whole-sale production of seedling rice plants, in advance of normal irrigation period, for sale to rice growers when irrigation commences, should be organised in Karachi district and on rice-growing Government Farms.

The improved strains of Rattrya rices, evolved in the Fuleli sub-station, should be tested in the Eastern Nara rice-growing tract.

(8) Further investigations into local and foreign trade demand for different qualities, shapes, colours, &c., of rice for consumption.

The necessary steps should be taken to collect all possible evidence regarding trade requirements with regard to quality, shape, colour, &c., of rice required for local consumption in Sind, in external

is in other parts of India and in the Persian Gulf and in
 e. Arrangements should be made to send consignments of
 improved Sind rices to consuming centres in order to obtain valua-
 tions, &c., for use in further development work on rice cultivation
 in Sind.

*Agricultural Leaflets, dealing with rice and kindred
 subjects already issued by the Agricultural
 Department in Sind, since 1930.*

- No. 2.—“Rati Disease of the Rice Crop.” (Second Edition
 in press).
- No. 3.—“Improved varieties of Rice for Sind.”
- No. 7.—“Scum on the water surface of Rice Fields.”
- No. 25.—“Preparation of lands, formerly under Rice cultiva-
 tion, to render them suitable for Dry Crop cultiva-
 tion.”
- No. 29.—“The Rat Pest on Rice and Wheat.”
- No. 32.—“Cultivation of Kangni Rice in Karachi district.”
- No. 43.—“Irrigation and Cultivation of the Rice crop in Bar-
 rage areas of Sind.”
- No. 46.—“Early Rice Transplanting in the Barrage areas, its
 Importance and Advantages.”
- No. 50.—“A Note on Irrigation in the Barrage and non-Bar-
 rage areas of Sind.”

SECTION I.—*contd.*

CROPS.

SUB-SECTION (D)—JOWAR AND BAJRI.

SUMMARY OF PRESENT POSITION.

Introduction.

Since the opening of the Lloyd Barrage and Canal Systems, the areas in Sind under (a) jowar and (b) bajri have declined, largely on account of the rapid and extensive increase in cotton cultivation in the Barrage areas during the kharif season. In the five-year period, prior to the construction of the Barrage, the annual average acreage under these crops was:—

Jowar	...	...	...	592,000 acres
Bajri	...	...	...	1,077,000 „

whereas, during the past four years, *i.e.*, 1932-1936, the average annual acreages are:—

Jowar .	...	...	...	492,000 acres
Bajri	...	...	...	931,000 „

There have also been indications that, since the commencement of perennial irrigation, the yield and quality of the jowar crop in Sind has deteriorated in many tracts, possibly on account of the disappearance of the "Sind fallows" which were a common feature of kharif cultivation in pre-Barrage days and possibly on account of environmental changes in climate, &c., resulting from perennial canal irrigation. It is most essential, therefore, that early efforts must be made to improve the yield per acre of both jowar and bajri crops, in respect of both grain and fodder, in order to compensate for the reduced acreage which, in the meantime, shows no signs of increase. The introduction of improved high-yielding and disease and pest resistant types of jowar and bajri, and the extension of the cultivation of such types in the districts is therefore a matter of great importance in Sind where the grain and fodder of these two cereals form a high proportion of the food of human-beings and live-stock.

(a) *Scientific research work on jowar and bajri improvement.*—Considerable work has already been done on the botanical improvement of the jowar crop in Sind at the Agricultural Research Station, Sakrand. By botanical selection among the local types of jowar, the under noted improved strains have been evolved and

seed has been distributed in the jowar-growing tracts for which each improved strain has been found to be suitable :—

Grain jowars.

Saoro Kartuho 1	...	For Middle Sind.
Bagdar 1	...	For Upper Sind.
Acho Kartuho 1	...	For general cultivation.
Red Janapur 3	...	For inundation tracts.
Allakh 2	...	For inundation tracts in Upper Sind.
Acho Kodri 25	...	For Right Bank tracts.
Acho Bazigar	...	For inundation (bosi) conditions where early maturing type is necessary.

Fodder jowars.

Acho Kartuho Turi 56	}	For both Barrage and inundation conditions.
Achi Turi		
Red Turi		

In addition to selection within local types of jowar, the Botanical Section have tried out many varieties of jowar imported from other parts of India. Imported grain jowars have proved unsuitable for general cultivation in Sind. Among fodder varieties, the Honey Sorghum and certain improved Punjab types appear to be useful and are being fully tested in comparative trials with local improved varieties.

Certain hybrid strains of jowars have been produced largely with the object of increasing yield by combining the large number of grains in an earhead, characteristic of one parent, with the large size of grain, characteristic of the other parent. These hybrids, which are mostly crosses between improved local jowars and the Torh variety, are being further tested and developed.

A hybrid between Saoro Kartuho 1 and Acho Kartuho Turi 56 has been made to endeavour to combine the best characters of a grain and fodder jowar in the same plant. This hybrid is in the F 3 generation and is being studied further at Sakrand.

Agronomic research work on jowar cultivation has been confined to experimental work to determine the optimum sowing date for different varieties.

With reference to bajri, work on the botanical improvement of this crop has only recently been commenced at the Agricultural Research Station, Sakrand. A collection of bajri varieties from other bajri growing tracts of India has been made, in addition to local varieties, and botanical work has been commenced within this material with the object of isolating pure strains with high-yielding capacity for both irrigated and bosi conditions. Special work is being done on long-headed types of bajri obtained from Sujawal (Karachi district), the Punjab and from Jamnagar State. Botanical work on awned bajri, suitable for cultivation in districts liable to bird or locust attack, has also been carried out at Sakrand and Mirpurkhas.

(b) *District work in connection with extension of improved varieties of jowar and bajri.*—In the districts, the areas under jowar and bajri show signs of progressive decrease and it is therefore important that propaganda work towards the extension of high yielding, improved varieties should be intensified. So far, it has been found that the demand for improved seed from the districts is largely for fodder varieties of jowar. As the growers of such fodder jowars generally cut and sell the crop green and do not retain any for seed production, the extension of improved fodder varieties into general cultivation is greatly handicapped. The Agricultural Department has no organised scheme for the multiplication, extension and distribution of the seed of improved jowar varieties. There is little demand for the seed of improved grain jowars, which shows that the value of these improved strains has not yet been adequately demonstrated to the growers. With regard to bajri, practically the entire crop in Sind is confined to Thar Parkar district, only small percentages being grown in Nawabshah and Hyderabad districts. As bajri grows better on kalar lands than jowar, the extension of this crop in alkaline tracts is desirable.

CROPS SECTION.

SUB-SECTION (D)—JOWAR AND BAJRI.

Programme of development for next five-year period i.e., 1936-1941.**(1) Programme of scientific research work on jowar and bajri improvement.**

No further selection work among local types of jowar is likely to yield strains superior to the improved strains already obtained. Botanical research work should be directed with the main object of obtaining a "dual purpose" jowar, *i.e.*, a jowar which will yield high outturns of grain and good quality of *kadbi*.

The hybrid strains of jowar evolved by the Botanical Section should be fully tested in comparative yield trials with the local improved varieties.

Scientific botanical research work should be commenced with the object of obtaining a high-yielding fodder jowar suitable for sowing in February — March (*adhaoon*).

Sundhiar and Kamandri varieties of jowar should be tested further with the object of utilising them, either as pure strains or as parents in hybrid strains, for obtaining better quality fodder jowars.

The Crop Pest Section, Agricultural Research Station, Sakrand, should commence scientific investigation into the "smut" diseases of jowar and into the control of the insect pest of stem-borer.

With the object of checking the deterioration of the jowar crop in the Barrage areas, experimental work on the cultivation of leguminous fodder crops, in mixture with jowar or in rotation with jowar, should be carried out.

Experiments to determine the effect of grading jowar seed for sowing purposes should be undertaken.

With regard to bajri, an improved fodder variety is required and botanical work in this direction should be commenced at Sakrand.

The quality of drought resistance in different varieties of bajri should be compared, with the object of obtaining a type suitable for general cultivation in the non-Barrage tracts

African varieties of bajri should be imported and tested under Sind conditions.

(2) Demonstration of improved varieties of grain jowars in the districts.

A series of field demonstrations of the cultivation of improved varieties of grain jowars, in comparison with ordinary local varieties, should be commenced and carried out annually by the district staff, especially in Naushahro Division of the Nawabshah district, Sehwan taluka of the Dadu district, and in Larkana, Sukkur and Upper Sind Frontier districts.

(3) Extension of arrangements for multiplication of seed of improved fodder jowars.

At present, the production of the seed of improved jowar varieties on Government Farms in Sind is approximately 400 maunds per year. Of this amount, about $\frac{1}{4}$ is fodder jowar seed and $\frac{3}{4}$ grain jowar seed. In future, cropping schemes should be arranged so that approximate $\frac{1}{2}$ of the total seed production of improved jowars on departmental institutions should be of improved fodder types, for which there is an extensive demand from the districts. In distribution of seed of improved fodder jowar to cultivators, a condition should be made that the grower will reserve sufficient area for seed production to meet his requirements in future, *i.e.*, the Agricultural Department will not continue to supply seed of improved fodder jowars to the same applicant in successive years.

(4) Comparison of economics of the cultivation of (a) grain and (b) fodder jowars.

The Agricultural Department should undertake comparative trials of the cultivation of (a) grain jowar and (b) fodder jowar for seed production, and should base the respective prices for the seed of improved varieties of jowar of these two types on the results of the economics of these experimental trials.

(5) Arrangements for distribution of small quantities of seed of improved varieties of jowar to smaller cultivators.

At all Government Auxiliary Farms, village depots, &c., the Agricultural Department should stock a supply of seed of improved varieties of jowar, both fodder and grain, for sale to smaller cultivators, *e.g.*, peasant proprietors, haris, etc., in given quantities not exceeding 20 lbs. at a time. The village depots where jowar seed should be stocked should be those situated in Dadu, Nawabshah, Sukkur, Upper Sind Frontier and Karachi districts.

(6) Extension of improved varieties of bajri.

Demonstration plots of improved varieties of bajri should be organised in Thar Parkar, Nawabshah and Hyderabad districts and in tracts in other districts where light or *kalar* soils predominate.

Arrangements should be made for the trial of improved varieties of bajri in the Desert Division of Thar Parkar district through the Revenue Department officers in this area.

Trials of different varieties of bajri should be conducted in the non-Barrage tracts of Karachi district under inundation conditions.

Agricultural Leaflets dealing with Jowar and Bajri and kindred subjects, already issued by the Agricultural Department in Sind since 1930.

No. 22—"Control of Grain Smut (Kani) on Jowar."

No. 23—"Calendar of Main Agricultural operations at the Agricultural Research Station, Sakrand."

No. 35—"The Irrigation of Dry Crops in the Barrage areas."

No. 37—"Improved varieties of Jowar for Sind" (2nd edition).

No. 44—"Fodder Crops suitable for cultivation in the Barrage areas of Sind."

No. 48—"Cropping Chart for the Barrage areas in Sind."

SECTION I.—*contd.*

CROPS.

SUB-SECTION (E).—OIL SEED AND PULSES.

SUMMARY OF PRESENT POSITION.

Introduction.

In the Barrage areas of Sind, the introduction of alternative crops to cotton, in the kharif season and wheat, in the rabi season, is of much importance in future agricultural development of the province. The most likely alternative money crops are the oil-seeds and pulse crops and the extension of suitable improved varieties in general cultivation is most essential. The numerous important varieties of oil-seed crops which can be grown successfully in Sind, with their different sowing dates and harvesting periods, offer a simple and economic solution to the problem of utilising irrigation water and field labour to the best advantage throughout the year.

The expansion of the cultivation of leguminous crops would assist considerably in maintaining soil fertility under intensive cropping and perennial irrigation. Many of these oil-seed and pulse crops would give good profits to the cultivators in the Barrage areas, especially in the rabi season, where the wheat crop is the only other alternative for the grower. In view of the importance of extending oil-seed and pulse cultivation in Sind, an Oil-seed Branch of the Botanical Section, Agricultural Research Station, Sakrand, was established in 1932 and has been financed by grants obtained from the Sir Sassoon David Trust Fund, Bombay. This Branch is carrying on botanical research work to evolve suitable strains of oil-seed and pulse crops for general cultivation under Sind conditions. A small laboratory has been erected for research on the oil-content, etc., of various oil-seed crops. In addition, detailed investigations have been carried out on the economics of oil-seed and pulse cultivation, e.g., study of foreign and local demand, comparative profits per acre, systems of marketing, etc. Consignments of Sind-grown oil-seeds have already been sent to consumers for valuation.

(a) *Research work on oil-seed and pulse crop cultivation.*—At the Agricultural Research Station, Sakrand, botanical research work on the evolution of particular strains of oil-seed and pulse crops, suitable for general extension in cultivation in Sind, has followed a definite plan. To begin with, a large and representative collection of different varieties of oil-seeds and pulses were obtained from all parts of Sind, from other provinces of India and, in certain cases,

from other countries. Botanical selection was carried out among the bulk material thus obtained and, at the present time, the Agricultural Department has obtained improved strains of all the major oil-seed and pulse crops, suitable for cultivation in Sind. These strains are still being tested in comparative tests to determine respective yields, oil-content, disease resistance and other characters of economic importance before distribution of seed in the districts is undertaken on a large scale.

Among the main kharif oil-seed crops, special attention has been given to castors, ground-nuts, til and soya-bean, and among the kharif pulse crops, to guar, tur and mung. Selected improved strains of all these crops have been obtained as a result of botanical research and a beginning has been made with the distribution and extension of seed in the districts.

With regard to rabi oil-seed crops, linseed, turio, rape, mustard and jambho have been taken up for botanical work and, as in the case of the kharif oil-seeds, improved strains have been evolved. Work on rabi pulse crops has been confined to gram, lentil and white peas. In addition to the comparative varietal tests which have been conducted, agronomic investigations into (a) the optimum sowing period for main oil-seed and pulse crops, (b) spacing in castors and soya-beans and (c) cultural methods, have been carried out at Sakrand. In addition, much laboratory work has been done in determining the oil-content, etc., of the improved strains and steps have been taken to study the economics of oil-seed and pulse cultivation with special reference to trade demands for such produce, both in India and abroad.

(b) *District work towards the extension of cultivation of oil-seed and pulse crops.*—It has not yet been found possible to create any great interest in the extension of oil-seed and pulse cultivation among the general body of cultivators in Sind, especially with reference to kharif crops. The cultivation of rabi oil-seeds, e.g., turio, mustard, jambho, etc., is extending, especially on lighter types of soil which are suited to these crops. The main factors which are hindering extension are (a) absence of an adequate marketing organization among the primary producers, (b) risk of frost damage in the case of rabi oil-seeds and pulses and (c) ignorance of methods of cultivation and tillage. Such crops, e.g., rape-seed, jambho, etc., which can find a local market among country 'ganis', i.e., oil-presses, are progressing, but more difficulty is experienced in extending the cultivation of oil-seed crops for export, e.g., castors turio, linseed, ground-nut, etc.

There appears to be very great possibilities for the expansion of such crops and, in addition, safflower and rape, if their handling and marketing for an export trade can be efficiently organised. With regard to leguminous fodder crops, the rapid and extensive increase of cotton cultivation in the Barrage areas is, at present, hindering extension, as cultivators are inclined to utilise the whole of their kharif irrigation supply for cotton production. The extension of rabi oil-seed and pulse crop cultivation is most important as, thereby, full use of irrigation water in October and January, when, at present, it is in excess to wheat crop requirements, can be made by the cultivators in the Barrage tracts. Efforts have been made to establish an "Oil-seed Growers' Association" in Sind, but this step would appear to be premature and should be postponed until the growers are more fully educated in the technique and economic possibilities of oil-seed crop cultivation.

CROPS SECTION.

SUB-SECTION (E)—OIL-SEED AND PULSES.

Programme of development for next five-year period, i.e., 1936—1941.**(1) Programme of scientific research work on oil-seed and pulse crops.**

Botanical research work should be concentrated upon.

In the kharif season.—Castor, til, ground-nut, guar, mung and cow-peas.

In the rabi season.—Linseed, safflower, turio, mustard and gram.

Special attention should be given to—

- (a) disease, insect pest and frost (in rabi crops) resistance,
- (b) in pulse crops, in obtaining high yields of both grain and fodder,
- (c) high oil-content in oil-seeds,
- (d) earliness of maturity.

Agronomic research work on all oil-seed and pulse crops should be directed towards—

- (a) determining optimum dates of sowing,
- (b) determining suitability of different oil-seed and pulse crops, or selected strains of such crops, for differing soil conditions,
- (c) ascertaining optimum seed rate and spacing for cultivation of different oil-seed and pulse crops,
- (d) study of the irrigation requirements of oil-seed and pulse crops,
- (e) investigation of effect of oil-seed crops on soil fertility.

(2) Investigation into harvesting and shelling of ground-nuts.

Research work should be undertaken with the object of devising the most practical and economical methods of harvesting and shelling the ground-nut crop. The Agricultural Engineering Section should be associated with this research,

(3) Study of economics of oil-seed and pulse crop cultivation.

As soon as sufficient seed of the improved strains of oil-seed and pulse crops, evolved by the Botanical Section, is available, steps should be taken to study the economics of their cultivation on a field scale in comparison with cotton and wheat, as standards for the kharif and rabi seasons, respectively.

(4) Arrangements for district experimental work on oil-seed and pulse crops.

In each district of Sind, a central plot of 4 acres should be obtained, either on Government Farms or Sub-stations or on leased land, which should be utilised, during the next five-year period, solely for experiment and demonstration work on oil-seed and pulse crop cultivation. On these plots, particular attention must be given to—

- (a) cultivation of castor under inundation conditions of irrigation and on *kalar* lands,
- (b) cultivation of ground-nuts on light lands, especially in Right Bank tract and in Karachi district,
- (c) linseed cultivation in all districts.
- (d) cultivation of gram as dubari crop, *i.e.*, after rice, in North Sind,
- (e) comparison of early and late varieties of turio under both irrigated and bosi conditions,
- (f) late-sowing (December-January) of mustard.

(5) Association of commercial organizations with departmental work on the extension of oil-seed and pulse crop cultivation.

Trade organizations, *e.g.*, the Karachi Chamber of Commerce, the Indian Merchants' Association, Karachi, the Buyers and Shippers Association, Karachi, etc., and prominent firms dealing in oil-seeds and pulses, should be requested to assist the Department in the early stages of the extension of oil-seed and pulse crop cultivation, to obtain buyers for the produce grown under the Department's instructions and direction. Rough estimates of probable extent of demand and prices *f. o. r.* Karachi of different oil-seeds and pulses should be obtained in advance of the cultivation seasons in order to fix programme of extension in the districts.

(6) Arrangements for distribution of seed of improved oil-seed and pulse crops.

Small stocks of seed of improved varieties of oil-seed and pulse crops should be maintained at Government Auxiliary Farms and at village depots for distribution to the cultivators. Efforts should be made to utilize similar centres as collecting centres for oil-seed and pulse crop produce grown by neighbouring cultivators, supplied with improved seed, with the object of organising sales in bulk, *i.e.*, a shipment (50 tons) at a time, so as to interest exporting firms in Karachi.

(7) Formation of an Oil-Seed Growers' Association.

Within the next five years, an Oil-seed Growers' Association should be organised in Sind, on co-operative lines, to promote and extend the cultivation of improved varieties of oil-seeds and pulses and to assist in co-operative marketing of members' produce.

Agricultural Leaflets, dealing with oil-seed and pulse crops and kindred subjects, already issued by the Agricultural Department in Sind since 1930.

No. 16—"Ground nut Cultivation in Sind."

No. 27—"Castor Cultivation in Sind."

No. 30—"The Cultivation of Rabi Oil-seed Crops in the Barrage areas of Sind."

No. 35—"The Irrigation of Dry Crops in the Barrage areas of Sind."

No. 36—"The Cultivation of Kharif Oil-seed Crops in Sind."

No. 44—"Fodder Crops suitable for Cultivation in Barrage areas of Sind."

No. 48—"Cropping Chart for the Barrage areas of Sind."

SECTION I.—*contd.*

CROPS.

SUB-SECTION (F)—MISCELLANEOUS.

SUMMARY OF PRESENT POSITION.

(a) *Sugar-cane*.—The cultivation of sugar-cane in Sind is at present small only about 4,000-5,000 acres. The cane produced is mainly sold for chewing purposes, but small quantities are crushed for the manufacture of *gur*. A factory for the manufacture of white sugar has recently been erected at Pritamabad, Nawabshah district. Cane cultivation in Sind is extending, specially in non-Barrage tracts. The danger of frost damage to the crop in January-February and insufficiency of water for cane cultivation, except in special areas, *e.g.*, tails of canals, are limiting factors to extension in the Barrage zone. The varieties of cane grown are Sindhi white, Sindhi red, and Lahori Pundhia. Experimental work on cane cultivation has been carried out at Sakrand and a Coimbatore variety, C. O. 213 has been found eminently suitable for Sind conditions. It is a high yielding and frost resistant variety. Other Coimbatore varieties are being tested in the Agricultural Section, Sakrand, along with C. O. 213 and other imported canes from other cane-growing tracts. It is essential to grow an early maturing cane in Sind which can be harvested before danger of frost damage is serious. Experiments on the manuring of cane with bone-meal and compost are in progress and research work into the optimum sowing dates for different varieties of cane in Sind is being conducted at Sakrand. The Java "trench" method of cane cultivation is adopted. Sets, sufficient to sow about 20 acres, are distributed from Sakrand to cane-growers in the districts each year.

(b) *Berseem*.—Berseem (Egyptian clover) is a leguminous fodder crop which grows very well in Sind and has been found useful for cultivation in crop rotations for the reclamation of *kalar* lands. The demand for seed of this crop is increasing. At present, the seed is not being produced in sufficient quantity in Sind and has to be imported from Peshawar at a cost of Rs. 20-25 per maund. This Peshawar seed is of inferior quality, being badly mixed with chickory and other weeds. Experimental work at Sakrand, where the cultivation of berseem is the basis of 'reclamation' rotations of cultivation, has shown that seed can be produced in Sind after two or three cuttings of the crop have been taken for fodder purposes. Berseem is a rabi crop which requires about twice the quantity of irrigation required for wheat. Its cultivation contributes to the maintenance of the fertility of the land, it is an excellent and high-

yielding fodder crop and, especially in *kalar* tracts, the extension of berseem as a rabi fodder crop is most desirable. Experimental work at Sakrand has been mainly directed towards seed production in berseem and in addition, trials of imported varieties from Egypt have been carried out by the Agricultural Section.

(c) *Potatoes*.—The cultivation of potatoes in Sind amounts to about 3,500 acres annually, mostly in Karachi (Malir) and Sukkur districts. The varieties generally grown are Italian White Round (early) and Italian White Long (late). The seed potatoes of these varieties are imported from Italy annually. Small quantities of potatoes are also grown from seed produced at Quetta, Dehra Dun and Northern India. Potato cultivation is carried out most successfully on the lighter types of soils and could be extended considerably in the Barrage tracts. The crop, especially if late sown, is very liable to damage by frost in January and February. At the Agricultural Research Station, Sakrand, experimental work on potato cultivation is being conducted in the Agricultural Section. Experiments on the manuring of the crop with organic and inorganic manures, spacing during sowing and improved technique in cultivation and irrigation have been completed. Early sowing to avoid risk of frost damage is under investigation. The main insect pests on the potato crop in Sind are eel-worm and potato caterpillar. At present the seed supply is a matter of difficulty on account of the cessation of imports of seed potatoes from Italy.

(d) *Onions*.—The onion crop is extending in cultivation in Sind and approximately 10,000 acres are being cultivated under onions annually. The main centres of onion cultivation are Hyderabad and Sukkur. Local varieties, Sindhi red and Sindhi white, are commonly grown, both of which are good yielders. The Agricultural Section, Sakrand, has introduced the cultivation of the Nasik Red variety of onion to Sind and this variety is well suited to cultivation in the irrigated tracts. Yields of from 500 to 600 maunds of bulbs per acre are being obtained. Experimental work on seed production, green and compost manuring and flat *versus* ridge systems of sowing have been carried out at Sakrand. The demand for the seed of the Nasik Red variety is now considerable and the cultivation of this crop is extending in the districts.

(e) *Chillies*.—There is only a small area, about 1,200 acres under chillie cultivation in Sind, where this crop is grown in Sukkur, Hyderabad, Thar Parkar and Karachi districts. Its cultivation, however, is extending under Barrage conditions of irrigation. At Sakrand numerous varieties of chillies, obtained from all over India, have been tested and varieties suitable for cultivation under Sind

conditions have been obtained. These selected varieties are now being grown in comparative yield trials. The technique of the cultivation and irrigation of the chillie crop has been investigated. The need for a variety which will keep well after drying and which will be popular with the consumer should be met from selection within the varieties under test at Sakrand.

(f) *Tobacco*.—Tobacco cultivation in Sind is carried on in Hyderabad, Sukkur, Nawabshah and Dadu districts on a small scale, the average annual acreage under this crop being about 7,000 acres. The crop produced is consumed locally for 'hookah' smoking. Considerable importations of cigarette and 'bidi' tobacco are made into Sind annually. The Agricultural Section, Sakrand, has been experimenting with this crop for a number of years and have introduced improved high-quality cigarette tobacco plants from Pusa and Gunter (Madras), which grow well, and give high yields under Sind conditions. The cultivation and the irrigational requirements of the tobacco crop, especially of the superior quality varieties, are being investigated and sowing date experiments are in progress to ascertain whether it will be possible to advance the period of growth of the crop so as to avoid damage by frost in the early months of the year. Seed of improved tobacco varieties is already being supplied to growers from Sakrand. There is much need for research work into the technique of curing tobacco leaf under Sind conditions if the cultivation of improved varieties is to be extended in the districts.

(g) *Barley and oats*.—These cereal crops are not grown to any great extent in Sind at present, and, if cultivated, are utilised for fodder purposes only. Barley is cultivated under inundation conditions in Karachi district. The cultivation of oats as a rabi fodder crop has been developed at the Agricultural Research Station, Sakrand, where it supplies the main cereal fodder crop in the rabi season. As under Barrage conditions of agriculture, the areas under the main kharif fodder crops, *i.e.*, jowari and bajri, are decreasing, it is most essential that fodder cultivation in the rabi season—when ample irrigation supply is available—should be encouraged. For this purpose, oats and barley offer a useful rabi fodder supply under irrigation conditions in Sind.

CROP SECTION.

SUB-SECTION (F)—MISCELLANEOUS.

Programme of development for next five-year period, i.e., 1936—1941.**(1) Programme of scientific research work on sugar-cane.**

Scientific research work on the sugar-cane crop should be continued at the Agricultural Research Station, Sakrand, special attention being given to—

- (a) botanical investigations towards obtaining early maturing types of cane;
- (b) comparative trials of different sowing dates of different varieties from October to February;
- (c) examination of the sucrose content of cane varieties found suitable for cultivation in Sind;
- (d) the cultivation of subsidiary crops, *e.g.*, ground-nuts, between sugar-cane rows with reference to economic returns to the cultivator and maintenance of soil fertility;
- (e) research into the optimum seed rate for the cultivation of different cane varieties under Sind conditions.

The Crop Pest Section Agricultural Research Station, Sakrand, should commence scientific research work upon stem borer and 'red-rot' of the sugar-cane crop in Sind.

(2) Development of supply of sets of improved cane varieties for distribution in the districts.

The area under sugar-cane at the Agricultural Research Station, Sakrand, should be increased from one acre to five acres and the cane produced made available for distribution to growers in the districts. For the same purpose, an area of half an acre should be cultivated under improved varieties of cane on each Auxiliary Farm in Sind.

(3) Demonstration of improved cane varieties in the districts.

The Agricultural Department should organise demonstration plots of half an acre each for demonstrating the cultivation of improved varieties of cane in potential sugar-cane growing tracts. Such demonstration plots should be situated in Dadu, Larkana, Sukkur, Hyderabad, Nawabshah and Karachi districts. Improved methods of crushing and gul-making should be demonstrated at the time of harvesting these district demonstration plots.

(4) Research work on berseem cultivation.

Future research work on berseem cultivation in Sind should be directed towards investigation of the irrigational requirements of this crop with the object of ascertaining whether the quality of irrigation water now applied, *i.e.*, approximately double the quantity required for wheat, can be decreased economically. Trials should be continued with imported varieties of berseem from Egypt to endeavour to obtain a variety suitable for cultivation in Sind under *bosi* conditions, *i.e.*, suitable for introduction in the non-Barrage areas.

Research work to determine the optimum seed rate of berseem for (a) fodder production and (b) seed production, should be commenced.

Trials should be made with the cultivation of a mixture of berseem and senji with the object of finding out the economics of fodder production by such method as compared with the cultivation of berseem as a pure crop.

The effects of the number and the time of cuttings for fodder on seed production in berseem should be experimented upon at Sakrand.

(5) Extension of production of seed of berseem in Sind.

In view of the high price and inferior quality of imported berseem seed, it is essential that the production of pure seed in Sind should be extended. The area under berseem at Sakrand should be extended for seed production purposes and at least one acre of berseem (for seed) grown at each Auxiliary Farm annually.

Efforts should be made to organise the seed production of berseem on the lands of private zamindars who should be supplied with stocks of pure seed for multiplication by the Agricultural Department.

(6) Research work on potatoes, onions and chillies.

Future research work on potatoes, onions and chillies should be concentrated upon:—

- (a) comparative yield trials of improved varieties of these crops,
- (b) manurial (organic and inorganic) experiments,
- (c) sowing date experiments,

This research work should be undertaken at Sakrand and at sub-stations in the districts.

The Crop Pest Section, Agricultural Research Station, Sakrand, should undertake scientific research for preventive and control measures against eelworm and potato caterpillar, thrips and wilt disease of onions, and white-ants and mosaic disease on chillies.

(7) Storage experiments on the potato and onion crops.

With regard to the potato crop, the supply of seed potatoes for cultivation in Sind must be fully investigated and experimental work commenced at Malir (Karachi district) on the preservation of seed potatoes from one season to another under different systems of storage, refrigeration etc., with regard to the comparative economics of the methods under investigation. The successful storage of the onion crop for a period of two to three months should be investigated as this would enable the growers to obtain much better returns from their onion cultivation.

(8) Demonstration work on potato, onion and chillie cultivation.

District demonstration plots of improved methods of cultivation of potato, onion and chillie crops should be organised in tracts where these crops are not being cultivated at present. The introduction of potato cultivation on lighter soils should receive special attention.

(9) Research work on tobacco cultivation and curing methods.

Scientific research work on the tobacco crop should aim at obtaining early maturing strains which will be resistant to damage by frost and mosaic disease.

Varietal tests of improved types of tobacco should be continued at Sakrand and extended into tobacco-growing tracts in Sind. It

is most essential that a curing shed be provided in order to study the correct methods of curing the improved varieties of tobacco found suitable for cultivation in the Barrage areas. This curing shed should be of the 'flue barn' type and should be constructed at Sakrand.

(10) Work on other miscellaneous crops in Sind.

Research work on the cultivation of sugar-beet, turmeric, suran, ginger and sweet potatoes under Sind conditions should be commenced at Sakrand, Mirpurkhas and at Malir with the object of ascertaining whether suitable varieties or strains of these crops can be obtained which would be suitable for extended cultivation in Sind.

(11) Demonstration of cultivation of rabi cereal fodder crops.

In view of the great importance of extending the cultivation of cereal fodder crops in the rabi season in Sind, the Agricultural Department should arrange to organise demonstration plots of the cultivation of oats and barley on all Government Farms and on zamindari lands in the districts.

Agricultural Leaflets, dealing with Miscellaneous Crops and kindred subjects, already issued by the Agricultural Department in Sind since 1930—

No. 13—"The Cultivation and use of Berseem in Sind."

No. 14—"Green Manuring."

No. 15—"Potato Cultivation in Sind."

No. 18—"Onion Cultivation in Sind."

No. 23—"Calendar of main Agricultural Operations at the Agricultural Research Station, Sakrand."

No. 26—"The Cultivation of Oats as a Green Fodder in the Rabi season."

No. 35—"The Irrigation of Dry Crops in the Barrage areas."

No. 44—"Fodder Crops suitable for Cultivation in Barrage areas of Sind."

No. 48—"Cropping Chart for the Barrage areas in Sind."

SECTION II.

SOILS AND IRRIGATION.

SUMMARY OF PRESENT POSITION.

The establishment of perennial irrigation and intensive cultivation in Sind, under the Lloyd Barrage and Canal Systems, has given rise to many new problems which must be solved in the interests of agricultural development in the province. The most important and complex of these problems are connected with soils and irrigation, not only in the tracts under Barrage irrigation, but also in the non-Barrage areas. The soil and irrigation research work of the Agricultural Department in Sind is centred in the Chemical and Agricultural Sections at the Agricultural Research Station, Sakrand. The main problems under investigation at this Station are connected with the prevention of the formation of *kalar* lands under conditions of perennial irrigation, the reclamation of *kalar* lands, the maintenance of soil fertility under Barrage conditions of irrigation and agriculture and the water requirements of various crops. The alluvial soils of Sind are so varied in their physical and chemical characters that investigation into soil problems—and the practical applications of the results of such investigations—are necessarily of extreme complexity. Soil and irrigation research in Sind will be greatly accelerated by the establishment of an additional Research Station to deal with the problems of the Right Bank areas, which has now been sanctioned. The aim of the Agricultural Department in its research work on soil and irrigation problems has been to concentrate upon the solution of such of these as are of the greatest practical importance to agricultural development in Sind. Successful results have already been obtained and consideration is now being given to methods whereby such results may be rapidly brought to the notice of the cultivators and embodied in general agricultural practice.

(a) *The kalar problem.*—In Sind, scientific research work on alkali lands includes (a) the investigation of methods of preventing excess accumulations of alkali salts in fertile lands and (b) the reclamation of *kalar* lands, *i.e.*, lands which are already unfertile on account of such accumulations in the past. At the Agricultural Research Station, Sakrand, the methods which have been adopted in reclamation experiments may be classified as (a) mechanical, (b) chemical and (c) agronomical. The mechanical method consists of leaching the affected lands with heavy doses of irrigation water which percolate down to the lower layers of the soil carrying in solution the injurious salts. It is obvious that the effectiveness of this method of *kalar* reclamation must depend largely upon the nature of the soil and sub-soil strata and of the sub-soil drainage.

conditions. It is only applicable by itself where no impervious layer exists near the soil surface and is generally effective where the upper layers of the sub-soil consist of sand or coarse silt. The chemical method depends upon the application of dressings of certain chemical substances to the *kalar* land with the object of improving its physical texture and thus increasing the rate of percolation and facilitating the washing out of injurious salts or, of neutralising and off-setting the effect of such injurious salts on plant growth. At the Chemical Section, Sakrand, experiments with many chemical correctives have been carried out, but only one, *i.e.*, calcium chloride, has been found to be useful in accelerating reclamation. Unfortunately, the expense of such treatment of *kalar* soils with applications of calcium chloride—which costs about Rs. 100 per ton—renders this method unsuitable for wide practical application. In the Agricultural and Chemical Section areas, at Sakrand, very striking results have been obtained in the reclamation of *kalar* areas by a combination of the mechanical method with the agronomical method, *i.e.*, the continued cropping of such lands under a crop rotation which includes a high percentage of crops, known to be resistant to *kalar* and which have a beneficial effect on the physical texture of the soil and on the maintenance of its fertility constituents. The use of berseem (Egyptian clover) as a fodder crop in the rabi season has given particularly successful results in such rotations. The solution of the problem of the reclamation of *kalar* land in Sind has been shown to be in the adoption of suitable combinations of the mechanical and agronomical methods of treatment, worked out at Sakrand, whereby the effect of the injurious salts on plant growth is gradually diminished by their being washed down into the deeper layers of the soil, and the general fertility of the land maintained and increased by the establishment of better physical and chemical conditions in the upper soil layers as a result of good cultivation and cropping under a suitably designed 'fertility' rotation of crops. Under the Sakrand 'System A' rotation of crops, designed for adoption to reclaim excessively alkaline lands, reclamation has been completely achieved in a period of 5-6 years. This system involves the concentration of available irrigation supply for reclamation purposes, *i.e.*, fractional reclamation, and the cultivation of berseem over the whole area under reclamation every year. Other similar 'systems' are under trial in the Agricultural Section. It has been found that, under certain conditions of soil and sub-soil, accumulations of injurious *kalar* salts are liable to re-appear in reclaimed areas unless agronomic and cultural measures to ensure the permanence of reclamation are adopted. The factors of importance in this problem have been studied and experimental work on its solution is in progress at Sakrand. It has also been found that applications of organic manure accelerates the reclamation of *kalar*

lands by increasing permeability and facilitating soil drainage. work is in progress to determine the stage at which such applications would be most effective and a scheme has recently been submitted to the Imperial Council of Agricultural Research, and approved by the Advisory Committee of that body, for the investigation of the micro-flora in *kalar* soils in Sind. The results of such an investigation would be exceedingly valuable to research work at present in progress at Sakrand.

(b) *Maintenance of soil fertility*.—Under perennial irrigation from the Lloyd Barrage and with a much more intensive system of agriculture, the maintenance of soil fertility in the Barrage areas is a subject of the greatest importance. The main lines along which this problem is being investigated by the Agricultural Department in Sind are—

- (a) the adoption of crop rotations in which restorative crops occupy a large proportion, *i.e.*, 'fertility' rotations ;
- (b) by conserving crop residues and waste organic materials and converting them into useful organic manures, *e.g.*, compost ;
- (c) by the use of green manure crops and inorganic manures.

In order to encourage cultivators in the districts to take steps to maintain the fertility of their lands, Government has granted very important concessions in connection with the cultivation of green manure crops, which are permitted, under certain conditions, to be cultivated free of assessment. Practically no advantage of these concessions has been taken in the districts. The system of land tenure in Sind, *i.e.*, zamindar and hari, the rapid extension of cotton cultivation in the kharif season and the inherent fertility of Sind soils are all factors which militate against the extension of green manuring in the province. The cultivation of leguminous crops is also not making such progress as might be desired in view of the beneficial effect which the cultivation of such crops has on soil fertility. There is an increase in the care and conservation of farm yard manure for field manuring in the Barrage areas and greater use is being made of inorganic manures, especially on garden crops, *e.g.*, sugar-cane, etc. At Sakrand and other Government Farms in Sind, experimental work on the technique of green manuring and on the comparative value of different green manure crops has been completed. A simple standard technique for the preparation of compost from waste materials, crops residues, etc., has been evolved and found well-suited to Sind conditions. Comparative trials of different leguminous crops with reference to their effect on soil fertility have been carried out. Research work on the relationship between

different tillage methods and irrigation practices on the fertility of the soil are in progress. The economics of green manuring and of applications of inorganic manures on different crops are being studied. In the districts, demonstration plots to illustrate the cultivation of green manure crops and their effect on subsequent crops are arranged annually in both kharif and rabi seasons, on zamindari lands.

(c) *Water requirements of crops.*—There is no doubt that a decided tendency to over-irrigate crops is apparent throughout the Barrage tracts and that such over-irrigation is having an adverse effect on crop yields and on soil conditions. This tendency is an unfortunate legacy from the pre-Barrage days when cultivators were dependent upon the inundation of the river for water-supplies for their cultivated fields, a source of irrigation which was neither assured or perennial and which resulted in excessive use of irrigation when it was available. It is not yet fully realized by the bulk of the cultivators in Sind that irrigation can never take the place of efficient cultivation of the soil in crop production and that excess of irrigation water is, in many cases, more harmful to crops than deficiency, especially at certain critical periods of growth. The water requirements of the main crops grown in Sind, with the exception of rice, have been studied in great detail at the Agricultural Research Station, Sakrand. With the establishment of a Right Bank Research Station at Dokri, similar work on rice and on other crops, grown under Right Bank conditions, will be undertaken. A rice 'duty' experiment to determine the correct 'duty' of irrigation water for rice cultivation in the Fuleli Canal tract was recently carried out by the Agricultural Department on zamindari lands near Badin. The results of this experiment were most valuable and an extension of such experimental work in the districts on other major crops is most desirable. At present, excessive irrigation of cultivated crops is partly due to the cultivation of large areas of virgin land with low water-holding capacity and there is reason to believe that greater economy in irrigation will follow the development of cultivation and continued cropping after a number of years, as has taken place in certain irrigated tracts in the Punjab. At Sakrand, the water requirements of the main kharif crops, e.g., cotton, jowar, bajri, have been fully determined and found to be no greater than the irrigation provision made under the Llyod Barrage Project. The same work has been done on the main rabi crop, i.e., wheat and on rabi oil-seeds and similar evidence of sufficiency of irrigation water in the rabi season has been obtained. Very careful study has been made of irrigation conditions in the non-Barrage areas, especially Lower Sind (Karachi district) and the Agricultural Department has introduced new varieties of crops into these areas

which are more suited to existing conditions of irrigation supply than the local types. Experimental work on the technique of irrigation, *i. e.*, intervals between applications of irrigation, quantities to be applied at different stages of growth, optimum date for economical last irrigation, etc., has been completed in connection with cotton cultivation and is being carried out with other main crops. Definite results on the economic utilisation of early irrigation supply for crop sowings, both in the kharif and rabi seasons, have been obtained and are being demonstrated on Government Farms and in the districts in order to illustrate the advantage and importance of the full utilization of the perennial irrigation now available in the Barrage areas.

SECTION II—*contd.*

SOILS AND IRRIGATION.

Programme of development for next five-year period *i.e.*, 1936—1941.**(1) Large-scale experiment on kalar land reclamation.**

The Agricultural Department in Sind should undertake a large scale experimental project on the reclamation of an extensive area of *kalar* land (4,000-5,000 acres) in the Barrage tract, the reclamation work to be based upon the successful results obtained in experimental work on *kalar* reclamation at the Agricultural Research Station, Sakrand. The area for this experimental project should be situated in the Right Bank tract where extensive *kalar* lands are common.

The work of reclamation might be combined with mechanical cultivation of the site of the experiment.

(2) Programme of research work on kalar prevention and reclamation.

Further scientific research work on the prevention of *kalar* formation and on the reclamation of *kalar* lands should be duplicated at the Left Bank Research Station, *i.e.*, Sakrand, and at the Right Bank Research Station, *i.e.*, Dokri.

Special attention should be given to—

- (a) an intensive study of soil and sub-soil conditions prior to, during and after reclamation experiments ;
- (b) the reclamation of persistent patches of *kalar* land in otherwise fertile areas, with special reference to the effect of cultural methods, *e.g.*, repeated deep ploughings, with or without organic manuring ;
- (c) investigation of the risk of excessive formation of sodium carbonate on *kalar* lands, after or during reclamation, as a result of leaching, cropping or organic manuring, combined with a study of the soil complex of *kalar* and reclaimed areas under perennial irrigation ;
- (d) effect of the rise of sub-soil water table on the formation of *kalar* lands or the re-appearance of *kalar* in reclaimed areas ;
- (e) trials of salt resistant plants and crops in *kalar* areas with the object of studying the possibilities of their utilization in *kalar* land reclamation ;

(f) research into improved methods of cultivation which would (a) hasten the process of reclamation by leaching with irrigation water and (b) prevent the re-appearance of *kalar* under normal conditions of Barrage irrigation and cropping.

(3) Reclamation of kalar lands by establishment of forest plantations.

The Agricultural and Forest Departments in Sind should undertake experimental work on the possibilities of *kalar* land reclamation by the gradual establishment of forest plantations of salt resistant types of trees or undergrowth followed by the introduction of cropping with salt resistant crops until fertility is restored.

(4) Trials of reclamation methods evolved at Sakrand on zamindari lands in the districts.

In order to demonstrate methods of *kalar* land reclamation, which have proved successful at Sakrand in the districts, the Agricultural Department should organise *kalar* reclamation demonstrations on lands of selected zamindars who are willing to co-operate in such work. The additional irrigation supply necessary for such reclamation experiment should be made available free of charge by the Irrigation Department. Three such demonstration centres should be organised in *kalar* affected tracts and the demonstration continued over a number of years until reclamation is completed.

(5) Utilization of surplus irrigation water for kalar reclamation.

Until the full intensities of Barrage cultivation are reached, there must be a considerable surplus of irrigation water available in the Barrage Canals. This is particularly the case in the rabi season. Arrangements should be arrived at, in consultation with the Irrigation Department, for experimental work on the utilization of such surplus irrigation water for *kalar* reclamation in such areas where the 'leaching' method of reclamation holds out hopes of success on account of sub-soil and drainage conditions.

(6) Research work on problems connected with the maintenance of soil fertility.

In connection with future investigation of problems connected with the maintenance of soil fertility in Sind, scientific research work is necessary on—

(a) the relation between different systems of tillage and rotations on soil fertility and its maintenance under Barrage conditions of irrigation;

- (b) the correct utilization of fallows under Barrage intensities of cultivation in maintaining soil fertility ;
- (c) the technique of green manuring, especially in the rabi season, in order to increase and maintain soil fertility.
- (d) factors causing impoverishment of soils in Sind ;
- (e) the economics of inorganic manuring with green-manure crops, compost and other inorganic manures, *e.g.*, fish manure, crushed cakes, etc.

(7) Extension of the cultivation of green manure crops.

Continued demonstrations of the cultivation of green manure crops are necessary in both the Barrage and non-Barrage areas of Sind and such work must form a permanent feature of the district demonstration work of the Agricultural Department in all districts. Special attention should be devoted to the demonstration of the cultivation of green manure crops, as inter-row crops with other money crops, *e.g.*, guar green manuring of cotton and suitable technique for such systems of green manuring should be tested on different types of crops and on different classes of soils in both the kharif and rabi seasons.

(8) Utilisation of waste materials for compost manufacture.

On the basis of the experimental work carried out at the Agricultural Research Station, Sakrand, a standard technique for the manufacture of compost from crop residues, waste organic materials, etc., has been evolved which could be given effect to in the preparation of organic manure in villages in Sind. The method should now be taken up by the Auxiliary and other farms, preparatory to demonstrating this technique in the districts.

(9) Research work on the water requirements of crops.

The Dokri Research Station, Right Bank, when established, should at once undertake scientific research work on the water requirements of the rice crop under Barrage conditions of irrigation.

Further scientific, research on the water requirements of crops in Sind should be concentrated upon—

- (a) determination of the water requirements of oil-seed crops, sugar-cane and vegetable crops, *e.g.*, potato and onion, under Barrage conditions of irrigation ;
- (b) the effect of varied numbers and intervals of irrigations on the yield of the wheat crop ;
- (c) investigation into the latest date for the irrigation of major crops in Sind in order to give economic returns

- (d) the efficient utilization of irrigation water, available in the short periods of inundation in non-Barrage tracts, in crop production;
 - (e) the effects of rotational irrigation on rice crop yields in the Barrage and non-Barrage tracts.
- (10) Provision of a sub-station for research into irrigation problems of crop production in the non-Barrage tracts of Sind.**

The Agricultural Department in Sind has no farm or sub-Station in the non-Barrage tracts of Sind for scientific investigation into irrigation of crops in such areas. Such sub-stations should be established in Karachi district, on the Fuleli Canals and at Ghotki (for the North Sind non-Barrage) tracts.

(11) Extension of 'duty' experiments on the irrigation of major crops.

Work should be undertaken to determine the correct 'duty' of irrigation in the production of the major crops, grown in the non-Barrage and Barrage areas of Sind, on zamindari lands and under zamindari conditions on the same lines as the 'duty' experiments on the rice crop in the Fuleli Canal tract, carried out in 1935

Agricultural Leaflets dealing with soils, irrigation and kindred subjects, already issued by the Agricultural Departments in Sind since 1930.

- No. 14.—“ Green Manuring.”
- No. 19.—“ Green Manuring of Cotton with Guar.”
- No. 23.—“ Calendar of Main Agricultural Operations at Agricultural Research Station, Sakrand.”
- No. 25.—“ Preparation of Lands formerly under Rice Cultivation, to render them suitable for Dry Crop Cultivation.”
- No. 35.—“ The Irrigation of Dry Crops in the Barrage areas.”
- No. 42.—“ An Experiment on Kalar Land Reclamation.”
- No. 43.—“ Irrigation and Cultivation of Rice Crop in Barrage areas of Sind.”
- No. 47.—“ A Practical Method of utilising Irrigation Water in October for growing Wheat Crop in Barrage areas.”
- No. 50.—“ A Note on the Irrigation of Field Crops in the Barrage and non-Barrage areas of Sind.”
- No. 51.—“ The Irrigation of the Cotton Crop in the Barrage areas of Sind.”

SECTION III.

DEMONSTRATION AND PROPAGANDA.

SUMMARY OF PRESENT POSITION.

The important task of introducing and extending the results of successful research work into general agricultural practice in the districts and of educating the cultivators to adopt improved methods and materials of agriculture, is carried out by the district staff of the Agricultural Department. As at present organised, the district demonstration and propaganda work of the Department is carried on under eleven territorial divisions, each in charge of an Inspector of Agriculture, in most cases assisted by one or two graduate or non-graduate assistants and a small staff of kamgars. Since 1931, the district work of the Agricultural Department in Sind has undergone considerable reorganization on the lines proposed by the Chief Agricultural Officer in a scheme submitted to, and approved by, Government in that year. The district officers and their staffs organise and carry out a definite programme of demonstrations and experiments on zamindars' lands in both the kharif and rabi seasons. On such 'demonstration plots', improved methods of tillage, the cultivation of improved or new varieties of crops, the use of improved agricultural implements, etc., are shown to the cultivators under their own conditions and on their own lands. In addition, the district staff of the Department organise local agricultural shows, collect indents for, and assist in the distribution of, pure seed of improved varieties of crops and give advice and assistance to cultivators in their agricultural problems and difficulties. During the year, village to village demonstrations of the working of improved agricultural implements are arranged for in the districts and meetings of zamindars, and their haris, are organised, generally at departmental demonstration plots for the purpose of conducting propaganda work towards the development of improved agriculture in the districts. Under the 'Village Uplift' scheme, the Agricultural Department has established implement and seed depots at eighteen centres in the districts. At these depots, improved agricultural implements are available for sale, hire or loan to cultivators and quantities of seed of improved crops are stocked for issue at concessionary rates in order to popularize these crops among the growers. In addition to the ordinary district staff maintained in each district of Sind for propaganda and demonstration work among the cultivators, a touring propaganda party has been organized which tours throughout the districts in the cold weather season. This party is equipped with a portable magic lantern and slides illustrating the work of the Agricultural Department in agricultural improvement and with small exhibits of seeds of improved varieties of

crops, manures, etc. Since 1931, six Government Auxiliary Demonstration Farms have been established in the Barrage areas, at Oderolal (362 acres), Lundo (448 acres) and Pad Idan (307 acres) in the Left Bank tract and at Dadu (585 acres), Nasirabad (311 acres) and Shahdaddkot (180 acres) in the Right Bank tract. These 'Auxiliary' Farms are worked by *haris* under departmental supervision, *i.e.*, on the *batai* system, and are utilized to demonstrate, under zamindari conditions, the results of large scale introduction of agricultural improvements, resulting from successful research work of the Agricultural Department at Sakrand and at other research centres. They have also been developed as training centres for zamindars and *haris* in improved methods of cultivation and as depots for stocking improved seed implements, etc., for distribution in the districts. At all such Farms and Research Stations of the Agricultural Department, organised "Farmers' Weeks" are held twice annually, once in the kharif and once in the rabi seasons, when the standing crops, methods of cultivation, etc., are fully demonstrated to all those attending such meetings. The North-Western Railway authorities have co-operated by agreeing to issue railway tickets at concessionary rates to agriculturists attending such "Farmers' Weeks" by rail from other centres in the districts. The Agricultural Department, since 1930, has issued 53 Agricultural Leaflets, dealing with Agricultural matters in Sind. These Leaflets, which are printed both in English and in the vernacular, are widely distributed in the districts by the propaganda and demonstration staff. Articles, dealing with items of agricultural improvement, etc., are frequently supplied by members of the staff of the Department to the 'Sind Co-operator' and to the local press. The work of the Agricultural Department in Sind in conducting demonstrations and propaganda towards the extension of agricultural improvements in the Province requires to be developed and extended very considerably in order to bring to the doors of the cultivators convincing evidence of the benefits which must accrue from the wholesale adoption of improved methods and materials of agriculture. For this purpose, it is essential to ensure the full co-operation of progressive zamindars, to organise the cultivators in order to facilitate extension of agricultural improvements and to review and revise, periodically and in detail, the progress and efficiency of all the activities of the Agricultural Department in the districts in the direction of demonstration and propaganda work.

SECTION III—*contd.*

DEMONSTRATION AND PROPAGANDA SECTION.

Programme of Development for next five-year period *i.e.*, 1936-41.

(1) Formation of District Agricultural Committees.

In order to ensure closer co-operation between the non-officials in the districts and the district demonstration and propaganda work of the Agricultural Department and to bring such work into more direct relationship with the actual requirements of the cultivators, a District Agricultural Committee should be formed in each district charge of the Agricultural Department. These Committees should consist of (a) the Deputy Chief Agricultural Officer concerned (Chairman), the Inspector of Agriculture of the district, one Revenue Department Officer nominated by the Collector, one Irrigation Department Officer nominated by the Superintending Engineer and one Zamindar from each taluka in the district, nominated by the Chief Agricultural Officer in Sind. These District Agricultural Committees should meet at least twice annually, in January and in August, to discuss and submit proposals for the programme of district demonstration and propaganda work to be undertaken in their districts by the Agricultural Department in the following kharif and rabi seasons respectively. The Chairman will be responsible for maintaining detailed records of such meetings which will be forwarded to the Chief Agricultural Officer in Sind and to the Collector and Superintending Engineer concerned.

(2) Revised arrangements for (a) demonstration and (b) experimental plots, to be organised on zamindari lands in the districts.

The programmes of work to be carried out on plots on zamindari lands in the districts each kharif and rabi season should, in future, be prepared in two sections (a) demonstration plots and (b) experimental plots.

Experimental plots should be situated on lands which are taken on temporary lease by the Department from the land-owner or on private land under agreement between the Department and the land-owner, the latter to receive compensation in the event of the experiment being unsuccessful and for such extra labour as may be involved in the conduct of the experiment. Standard forms for such agreements should be prepared for use in the districts

Demonstration plots should be situated on the lands of private zamindars. No assessment should be levied on such demonstration plots, laid out under the direction of the Agricultural Department,

in co-operation with the land-owner, the cost of this concession to Government in any one district charge of the Agricultural Department not to exceed Rs. 1,000 per annum, *i.e.*, in both kharif and rabi seasons.

N.B.—The maximum cost to Government on account of this concession will be only Rs. 11,000 per annum, whereas it would enable the Agricultural Department to extend very considerably the range and intensity of its district demonstration work and to distribute such demonstration plots over much larger areas than at present. The concession of freedom from assessment on a plot used for demonstration purposes by the Agricultural Department should only be granted to the zamindar, on whose land the plot is situated, on certificate from the Deputy Chief Agricultural Officer concerned that he (the zamindar) has co-operated fully with the Department in the demonstration plot work.

(3) Establishment of sub-stations for district experimental work.

During the next five years period, arrangements should be made to establish small sub-stations for district experimental work at suitable centres in the districts, especially in areas where no Government Farm has yet been situated. Areas, where such sub-stations (16—32 acres) are most urgently required are:—

Karachi district, Fuleli Canal area, Eastern Nara district, Southern Jamrao tract, Sukkur district, Upper Sind Frontier district.

(4) Classification of agricultural improvements for demonstration and experiment on zamindari lands in the districts.

Agricultural improvements to be demonstrated, and experiments to be conducted, on zamindari lands in the districts should be classified as major demonstrations or experiments and minor demonstrations or experiments. Major demonstrations or experiments should include items of all Sind importance, *e.g.*, green manuring demonstrations, drilling *versus* broadcasting experiments, etc., and should be carried out in all districts under similar conditions of layout, area, etc., so as to give comparable results from a number of centres. Minor demonstrations or experiments are such as are of mainly local importance, *e.g.*, transplanting *versus* broadcasting of rice in Eastern Nara tract, and may be designed in accordance with local requirements only. Composite reports on all major demonstrations and experiments in the districts should be prepared annually on the basis of results obtained in all districts.

(5) Inspection of district demonstration and experimental plots in the districts.

Every demonstration and experimental plot or zamindari lands in a district must be inspected by a graduate or non-graduate member of the district staff at least once per month and a report on the progress of the demonstration or experiment submitted monthly to the Deputy Chief Agricultural Officer concerned. The Inspector of Agriculture of a district must inspect each demonstration or experimental plot under his charge (a) as soon as possible after it has been laid out, or crop sown and (b) just before conclusion of the demonstration or experiment, *i.e.*, at harvesting. All results from demonstration or experimental plots must be checked and certified by a graduate or non-graduate assistant.

(6) Organization of meetings of zamindars and haris at demonstration plots in the districts.

Arrangements should be made in co-operation with the local officers of the Revenue and Irrigation Departments in the districts, to organize meetings of zamindars at departmental demonstration plots on zamindari lands at such times as the purposes for which the demonstration plot was laid down, can be most effectively brought to their notice. The Inspector of Agriculture of each district will maintain a register for the demonstration plots in his charge showing the number, dates and approximate attendance of such zamindars meetings at each demonstration plot during the kharif or rabi season.

(7) Programme of demonstration of working of improved agricultural implements in the districts.

The District Agricultural Committees shall draw up definite programmes for the demonstration of improved agricultural implements in their districts for (a) the kharif and (b) the rabi season, annually. The programmes should set-down the number and names of each village or deh in which a demonstration of agricultural implements is to be held during the season and should allocate the conduct of these implement demonstrations to the graduate or non-graduate members of the district staff.

(8) Provision of bullocks and improved bullock-cart for district staff.

Arrangements should be made to provide selected Inspectors of Agriculture in the districts with a pair of bullocks and an improved (Cumming) all-steel bullock-cart for transport of improved agricultural implements for demonstration work on demonstration plots, etc., in order to compare the efficiency and economy of such a

measure in comparison with the present system of hiring bullocks and transport when required for district work. Preference should be given to districts where facilities, *e.g.*, Government Farm or sub-station, exist at the headquarters of the Inspector of Agriculture for the housing and maintenance of the bullocks.

(9) Introduction of system of awards, *e.g.*, afrinamas, lungis, &c., to cultivators, taking a prominent part in the adoption of agricultural improvements recommended by the Agricultural Department.

In each district charge of the Agricultural Department, provision should be made for the annual award of an afrinama, lungi, etc., to one cultivator (*hari*) in each taluka who has taken the most prominent part in the introduction on his own holding and in his own agricultural practice, of improvements recommended by the Agricultural Department. Such awards should be made on the occasion of a *darbar* or district agricultural show.

(10) Conditions for issue of improved agricultural implements from "Village Uplift" implement and seed depots.

For the first year, *i.e.*, 1936-37, implements stocked at the "Village Uplift" implement depots maintained by the Agricultural Department, should be issued free of charge to cultivators for a period not exceeding 14 days to any single individual. A deposit of Re. 1 per cheap implement, *e.g.*, ploughs, inter-cultivators, etc., and of Rs. 10 per costly implement, *e.g.*, winnower, clod-crusher, etc. should be taken from the cultivator, to whom the implement is issued at the time of issue and refunded to him when the implement is returned in good condition within the specified time.

(11) Programme of District Agricultural Shows.

At least one District Agricultural Show should be organised and held in each district charge of the Agricultural Department in Sind annually. At the January meeting of the District Agricultural Committee, the programme for District Agricultural Shows for the following financial year should be drawn up, showing number of District Shows proposed, approximate dates and centres where they will be held. As far as possible, such District Agricultural Shows should be organised to coincide with local fairs, etc.

(12) Preliminary arrangements for an All-Sind Provincial Agricultural Show.

An All-Sind Provincial Agricultural Show should be held within the next five years. A Committee should be formed to select site and make preliminary arrangements for finance, organization, etc.

(13) Reorganization of work and equipment of touring propaganda party.

The touring propaganda party of the Agricultural Department should be continued for propaganda and demonstration work in the district each cold weather season in accordance with a definite programme which should be drawn up for the next five-years period.

The possibility of equipping the party with a cinema outfit and suitable cinema films illustrating agricultural improvements in Sind should be investigated.

(14) Introduction of a series of simple vernacular leaflets on agricultural subjects.

In addition to the Agricultural Leaflets, at present published by the Agricultural Department in Sind in vernacular and English, a new series of simple vernacular pamphlets, in dialogue form, suitable for acting or reciting aloud at gatherings of *haris* and illiterate cultivators should be commenced. Such pamphlets should each illustrate one important item of agricultural improvement and should be drafted in very simple and every-day terms which can readily be understood and appreciated by an illiterate audience.

(15) Preparation of posters illustrating items of agricultural improvement for propaganda use in the districts.

In view of the success which has attended the preparation and display of the propaganda poster, "It pays to grow cotton on the Right Bank", steps should be taken to extend this form of propaganda and, to begin with, suitable posters to illustrate

- (a) results of good, as compared with careless picking of cotton,
- (b) benefit of cultivating 'rust' resistant varieties of wheat,
- (c) benefits of transplanting rice in comparison with broadcasting,
- (d) economy in use of irrigation water,

should be prepared for propaganda purposes.

The assistance of the Publicity Officer of the Indian Central Cotton Committee, should be applied for in connection with this work.

(16) Improvement of existing series of Agricultural Leaflets issued by the Agricultural Department.

The existing series of Agricultural Leaflets, issued from time to time by the Agricultural Department, should be continued and, wherever practicable and useful, such Leaflets should contain illustrations, sketches, etc.

The first fifty Leaflets issued should be made available in book form at as low a cost as possible.

When Agricultural Leaflets are issued in future, advance copies should be supplied to the press for review or publication *in extenso*. All such leaflets should be translated at once into Sindhi and the most efficient methods of getting such translations done should be investigated.

An Agricultural Hand-book for Sind should be prepared.

(17) Provision of trained non-graduate assistants and kamgars for demonstration and propaganda work in the districts.

In future, all vacancies for non-graduate assistants and kamgars for district propaganda and demonstration work should be filled by appointment from the corresponding cadres employed on Government Research Stations and Auxiliary Farms and not by direct recruitment. Direct recruitment to posts of non-graduate assistants and kamgars should only take place on Government Research Stations and Farms where suitable training in improved methods of agriculture can be given to new entrants into the Department.

(18) Future organization of cultivators in the interests of the development of improved agriculture.

The organization of cultivators in 'Taluka Development Associations' has not proved successful in Sind owing to (a) the unit of organization, *i.e.*, the taluka, being too large, (b) unstable financial conditions of such Associations and (c) concentration of management in taluka headquarters, *i.e.*, in towns and lack of real contact with the cultivators in the districts.

A Sub-Committee should be appointed to consider the whole question of the future organization of the cultivators in Sind in the interests of the development of improved agriculture, special attention being paid to (a) the unit of organization to be adopted and (b) financial provision and stability.

(19) Work to be undertaken by district staff of the Agricultural Department in following up the distribution of pure seed of improved crops to cultivators.

When the distribution of the seed of a new crop or of an improved crop variety has been completed in any season, kharif or rabi, a list of the cultivators to whom such seed has been supplied, should be prepared by the distributing agency, *e.g.*, Cotton Seed Distribution Committee, Botanist in Sind, &c., and copy supplied to each Inspector of Agriculture in the districts. The district staff will then arrange to visit such growers of departmental seed in their own districts, whenever possible, and ascertain the progress of his crop and his views on the seed obtained from the Department in comparison with local seed. An effort should be made by the district staff to record annually the extension of the area under new or improved varieties of crops in the districts.

(20) Organization of District Agricultural Surveys.

Arrangements should be made to carry out agricultural surveys in the districts on matters of agricultural importance with the objects of (a) ascertaining the correct position with regard to such matters and (b) obtaining a standard whereby future development can be measured.

To begin with, an agricultural survey on 'Fodder Crops in Sind' should be undertaken on a definite plan by the district staff in their respective districts.

(21) Establishment of an Agricultural Museum in Sind.

The establishment of an Agricultural Museum in Sind for samples of all crops grown in the districts and of improved varieties thereof, soil monoliths, indigenous and improved agricultural implements, etc., would be extremely valuable for propaganda purposes. Such a Museum would be suitably situated near the Lloyd Barrage at Sukkur in the offices at the Left Bank entrance to the Barrage itself.

Agricultural Leaflets, dealing with Demonstration and Propaganda already issued by the Agricultural Department in Sind, since 1930.

No. 1.—"The Agricultural Department in Sind—(2nd Edition No. 24)".

No. 8.—"Agricultural Propaganda by Touring Parties".

SECTION IV.

AGRICULTURAL ENGINEERING.

SUMMARY OF PRESENT POSITION.

(a) *Improvement of indigenous agricultural implements and design of new agricultural implements for use in Sind.*—Prior to the opening of the Lloyd Barrage and Canal Systems in Sind, the work of the Agricultural Department in Sind on the improvement and design of agricultural implements was extremely limited. The main success in this direction was the evolution of the “Sircar” or Egyptian plough which is now widely known and used by the cultivators. Large numbers of this type of plough, which is an improvement on the ordinary Sind *deshi* plough, are manufactured in the villages by local *mistries*. The Cooper No. 25 (Meston type) plough and the Hyderabad plough were also introduced into Sind and distributed in smaller numbers, especially in Middle and East Sind. There was no extension of other types of agricultural implements to any appreciable extent. Practically no work was carried out on the design of new agricultural implements or on the improvement of *deshi* implements. Certain types of foreign agricultural implements were imported, but owing to their high cost and unsuitability to Sind conditions, did not extend in use among the cultivators. After the opening of the Lloyd Barrage and Canal Systems, a step forward was made by the design and manufacture of the ‘Jenkins’ clod crusher in 1932. This implement was designed by Mr. B. B. Desai, Cotton Breeder in Sind, and its manufacture was undertaken by Messrs. Herman and Mohatta, Karachi. The price of this improved implement is Rs. 75 and about 400 have been distributed in the districts. It is a useful cultivating implement and is also used with great effectiveness for threshing the wheat crop. With the establishment of the Agricultural Engineering Section of the Agricultural Department in Sind in 1934, and the organization of an Agricultural Engineering Workshop at Mirpurkhas, the Agricultural Engineer (Mr. J. Cumming) commenced work on the design of agricultural implements, suitable for Sind conditions. Since September 1935, he has evolved, and is now manufacturing for distribution, the undernoted improved agricultural implements which are becoming very popular with the cultivators:—

- (1) Winnowing machines, large and small types (Rs. 246 and Rs. 150.)
- (2) All-steel bullock cart (Rs. 150).
- (3) Intercultivator (Rs. 11).

The manufacture of these improved implements is in progress at the Agricultural Engineering Workshop at Mirpurkhas and they are being widely demonstrated in the districts.

(b) *Mechanical cultivation in Sind.*—Prior to March 1935, the Agricultural Department in Sind had experimented with various types of kerosine tractors on Government Farms and in the districts. The types of tractors used in this work were the Cletrac, Austin, Fordson and International. No departmental organization existed for the economical and rapid execution of repairs or for the supply of spare parts, when required. In 1931 the Burmah Shell Co., (India), Ltd., undertook tractor-ploughing of the new areas under the 'Six Farm Scheme' on contract with the Agricultural Department. Owing to the absence of the organization mentioned above, this work proved unduly expensive. With the establishment of the Agricultural Engineering Section of the Department in Sind in 1934, a series of tractor trials was organised at Tando Jam in March 1935, at which five different types of tractors, three kerosine and two crude oil (Diesel engine) competed. On the basis of the results of these trials, the Agricultural Department purchased a Caterpillar 35 Diesel tractor for the purpose of obtaining reliable data on the economics of mechanical cultivation in the Province. The total cost of the tractor and necessary tillage implements was approximately Rs 18,000. This set has now been at work in the Thar Parkar district for a period of 12 months, has completed 230 actual working days and has afforded very valuable information regarding the costs, etc., of mechanical cultivation under Sind conditions. There have been no break-downs or need for spare parts during this period. The demand for tractor cultivation in Sind has increased considerably since the development of perennial irrigation under the Barrage and one departmental set is quite insufficient to meet the needs of zamindars. In the past, many zamindars have purchased tractor outfits for use on their own lands. In the absence of reliable advice, based on continuous experimental work, as to the type of tractor best suited for Sind conditions and without proper service for rapid repair work and replacement with spare parts when required, practically all such private enterprises have proved unsuccessful. With the appointment of an Agricultural Engineer for Sind, the establishment of an Agricultural Engineering Workshop at Mirpurkhas and the experience now gained in tractor cultivation, the Department is at last in a position to give this advice, assistance and service in mechanical cultivation to the zamindars.

(c) *Service to the public in matters relating to agricultural engineering.*—In 1930 the Agricultural Department in Sind was separated from the Agricultural Department in the Bombay Presidency, but the Chief Agricultural Officer was permitted to apply to the Agricultural Engineer, Bombay Presidency, for advice and assistance in agricultural engineering matters. This arrangement proved inadequate to meet the requirements in Sind for development in agricultural engineering, and in 1934 the Chief Agricultural

Officer and Mr. J. Cumming, Mechanical Engineer, Lloyd Barrage, submitted to Government a scheme for the development of an Agricultural Engineering Section of the Department in Sind. The scheme was approved and was put into effect under the direction of Mr. Cumming, appointed Acting Agricultural Engineer in Sind. One of the most important items in the scheme was the establishment and equipment of an Agricultural Engineering Workshop, at Mirpurkhas. With regard to this workshop, two alternative proposals were submitted in the scheme (a) that the workshop should be a research workshop only and (b) that the workshop should be a manufacturing as well as a research workshop, *i.e.*, that it should undertake the manufacture of improved agricultural implements for sale to the public in addition to research work on agricultural engineering problems. It was decided that the workshop should be purely a research workshop to begin with, but it has been found necessary, in practice, to carry out considerable manufacturing work there in addition, in order to meet the public demand for new and improved implements, repairs, replacements, etc. At present the workshop is fully employed in services to the public on agricultural engineering matters and the Agricultural Engineer and his staff receive very numerous requests for technical advice and assistance from zamindars. These requests largely deal with matters connected with the purchase and erection of power plants, pumping sets, the introduction of mechanical cultivation on private estates, tube wells and low level water lifts and repairs, etc., to existing agricultural machinery and plant.

SECTION IV—*contd.*

AGRICULTURAL ENGINEERING SECTION.

Programme of development for next five-year period, *i.e.*, 1936—1941.**(1) Programme of work in design of new implements.**

With reference to the design and introduction of new and improved agricultural implements, the Agricultural Engineering Section of the Agricultural Department in Sind should concentrate upon the production of the undernoted items:—

- (a) A suitable reaper or harvesting machine, bullock power, for harvesting the wheat crop, efficiently and economically.
- (b) An efficient threshing machine, bullock power, for wheat, rice and other cereal and pulse crops.
- (c) An implement which can be utilised for (a) constructing small field bunds and (b) levelling uneven lands.
- (d) A universal seed-drill, bullock power, which can be adopted for the sowing of all main kharif and rabi crops.
- (e) An effective implement for cutting or uprooting cotton stalks.
- (f) A portable machine for the purpose of applying insecticides, sprays, washes and dusts to fruit orchards and to field crops.
- (g) An implement which can be utilised efficiently for the collection of crop stubbles after ploughing.
- (h) A cheap and effective appliance for low lift of irrigation water, *i.e.*, lift of 2'-4', which can be worked by bullock or camel power.
- (i) A bullock power sugar-cane crusher for the small cane grower.
- (j) A small type improved bullock cart, costing Rs. 75—Rs. 100, for use in the Upper Sind tracts.

The primary aim in the design of these improved implements should be to combine efficiency in work, simplicity in construction and cheapness in cost.

(2) Plough trials and preparation of standard ploughs for Sind.

The Agricultural Engineering Section should arrange to organise and carry out a series of comprehensive and scientific field trials of all the types of ploughs now being used in Sind. On the basis of the results of these tests, steps should be taken to design and manufacture not more than three standard types of improved ploughs for general introduction into Sind by the Agricultural Department and suitable for (a) light lands, (b) heavy lands and (c) rice lands. The adaptation of these standard ploughs for ridging purposes, *i.e.*, by the attachment of suitably designed ridging boards, when required, should also be undertaken.

(3) Appointment of touring Mechanical Inspectors.

The Agricultural Engineering Section should undertake the instruction of the district staff of the Department, especially field kamgars, in the correct use and maintenance of all types of improved agricultural implements. For this purpose, two Travelling Inspectors who must be trained mechanics, should be added to the staff of the Agricultural Engineering Section and should tour in the districts to encourage and extend the introduction of improved agricultural implements and assist the cultivators in their proper use.

(4) Publication of note on economics of tractor cultivation in Sind.

After two years complete working of the departmental tractor and its ploughing and cultivating tackle have been completed, *i.e.*, after March 1937, the Agricultural Engineer in Sind should prepare and issue a detailed note on the economics of tractor cultivation in Sind on the basis of the results obtained.

(5) Extension of departmental tractor cultivation for zamindars on contract system.

The Agricultural Department in Sind should undertake the service maintenance and running of three tractor-ploughing and cultivating sets for the use of zamindars on the contract system in (a) Lower, (b) Middle and (c) Upper Sind, *i.e.*, two more sets in addition to the one at present being worked by the Department. These additional sets may be provided by such agencies as Co-operative Banks, District Local Boards, etc., if such bodies can be induced to co-operate in this work.

(6) Design of light double cable set for mechanical cultivation in Sind.

The Agricultural Engineer in Sind should continue his research work on the development of a light cable ploughing set with two small portable Diesel engines and suitable cultivating implements, specially designed for use in Sind. Such a plant should be designed and manufactured and, if successful after trials, be introduced in the districts. The total cost should not exceed Rs. 8,000 approximately. The main features of this plant must be simplicity and economy in working.

(7) Light tractor trials.

The Agricultural Engineering Section of the Department should organise and carry out a series of tractor trials with light tractors, *i.e.*, 20 H. P. and under and costing not more than Rs. 5,000 approximately with the object of determining the best types of such tractors for use on cultivated land and in subsidiary operations of agriculture, *e.g.*, drilling, interculturing, etc., and for belt work, *e.g.*, sugar-cane crushing, chaff cutting, small ginneries, etc.

(8) Course for tractor drivers and mechanics at Mirpurkhas.

The Agricultural Engineer in Sind should arrange to institute a practical course for tractor drivers and tractor mechanics at the Agricultural Engineering Workshop at Mirpurkhas. The course should last at least one year, half the period to be spent in the workshop and half with departmental tractors in the field.

(9) Organization of Government Workshop, Mirpurkhas, as a manufacturing workshop.

During the next five years, the Agricultural Engineering Workshop, Mirpurkhas, should be definitely constituted as a manufacturing workshop in accordance with the proposals contained in the scheme for the development of agricultural engineering in Sind originally submitted to Government by the Chief Agricultural Officer in 1934. This step will considerably facilitate the introduction of improved agricultural implements in Sind without any additional cost to Government.

(10) Investigation of mechanical means of improving land levels, water-courses, etc.

The Agricultural Engineer in Sind should examine all possibilities of assisting cultivators in (a) the levelling of their lands and (b) the improvement of water-courses, etc., by simple mechanical methods which could be placed at the disposal of cultivators.

(11) Publication of agricultural engineering Leaflets.

The results of all tests and trials of new implements, etc., conducted by the Agricultural Engineering Section, descriptive notes of such implements and instructions for their correct working and maintenance should be published in leaflet form, in English and vernacular, as soon as possible for the information of the cultivators

(12) Services in agricultural engineering to the public.

In order to encourage the development of the use of mechanical plant for agricultural purposes in Sind during the next five years, the Agricultural Engineering Section should undertake the preparation of plans, estimates, lay-outs, etc., of agricultural engineering projects on behalf of zamindars free of cost. Erection of plants, repairs, replacements, etc., should be undertaken when the charges involved are met by the zamindar concerned. The sinking of small tube wells, *i.e.*, up to 8" diameter, should be undertaken by the Agricultural Engineering Section at the land-owner's cost. The staff of the Agricultural Engineering Section will require to be increased by the addition of a draughtsman and a boring mistry to enable the work mentioned above to be undertaken.

Agricultural Leaflets, dealing with Agricultural Engineering and kindred subjects, already issued by the Agricultural Department in Sind since 1930.

No. 5—"The Hyderabad Plough."

No. 17—"The Egyptian (Sircar) Plough."

No. 21—"The Cooper No. 25 (Meston type) Plough."

No. 33—"The Three-coultered Rabi Seed Drill."

No. 45—"The 'Jenkins' Clod-breaker."

SECTION V.

HORTICULTURE.

SUMMARY OF PRESENT POSITION.

(a) *Research work on horticulture.*—The Government Fruit Farm, Mirpurkhas, is the main centre for horticultural research work of the Agricultural Department in Sind. Experimental and research work has been carried on to determine the best methods for the establishment and maintenance of fruit orchards in Sind, to investigate the optimum seasons for horticultural operations, *e.g.*, budding, grafting, etc., to study the irrigational requirements of fruit and vegetable crops and to solve problems connected with the cultivation, manuring and care of fruit trees under Sind conditions. In addition, considerable work has been done on the introduction and acclimatization of desirable varieties of fruit trees from other countries of the world and from other fruit-growing tracts of India. In this connection, the introduction of different citrus varieties from Iraq, Palestine, California, Phillipine Islands and South Africa and of superior mango varieties from Bombay and Madras Presidencies and from the United Provinces, are recent developments. Investigations are in progress on the best methods of trellising and pruning grape vines. Scientific research work on the control of fungoid diseases and insect pests of the common fruit tree varieties of Sind is in progress at the Fruit Farm. No experimental work has yet been undertaken upon the preservation of fruit and vegetable products or on the manufacture and storage of tinned or bottled fruits, juices, etc. Since the opening of the Lloyd Barrage and Canal Systems, there has been a marked increase in the interest taken in fruit and vegetable farming and an extension of scientific research work on horticultural problems in Sind is very necessary. The Agricultural Department has recently opened a Fruit Sub-Station for North Sind at Larkana, in co-operation with Mr. S. S. Tolani, M.L.C.

(b) *District demonstration and propaganda work in connection with the development of horticulture.*—One of the main functions of the Government Fruit Farm, Mirpurkhas, is the production of large quantities of improved fruit tree stock and their distribution to fruit growers in the districts. The demand for such seedling, budded and grafted stock plants has increased tremendously since the opening of the Lloyd Barrage, *i.e.*, during the past five years. In 1929-30, the issue of such material to the public was negligible (worth Rs. 19) whereas, during the past three years, *i.e.*, 1932-35, an average number of about 20,000 improved varieties of fruit tree stock have been issued annually to fruit growers. Recently in 1934-35, a Fruit Sub-Station

has been opened at Larkana to serve the North Sind districts where fruit-growing is making extensive progress under Barrage conditions of irrigation. At most district agricultural shows, organised by the Agricultural Department in Sind, a horticultural section is organised and numerous Agricultural Leaflets on horticultural subjects have been issued by the Department. Twelve subsidiary demonstration orchards and nurseries have been established in the districts on the lands of zamindars, selected for this purpose. Small demonstration fruit gardens have been laid down at all Government Research Stations and Auxiliary Farms. The Horticulturist and his staff are constantly employed in district propaganda and demonstration, *e.g.*, spraying of orchards with insecticides against insect pests, and in responding to application for advice and assistance from fruit growers. In recent years, a beginning was made at the Government Fruit Farm, Mirpurkhas, in the training of *malis* for service with private owners of orchards and vegetable gardens. Trained *malis*, on the staff of the Fruit Farm, are lent, for short periods of time to give practical assistance to cultivators in horticultural development on their own lands.

SECTION V—contd.**HORTICULTURAL SECTION.****Programme of development for next five-year period, i.e., 1936—1941.****(1) Trial of foreign fruit tree varieties in Sind.**

Steps will be taken to obtain detailed information from all fruit-growing countries, where climatic, soil and irrigation conditions approximate to those prevailing in Sind, regarding the best varieties of fruit trees in cultivation, and specimens of these varieties will be imported and tested on the Government Fruit Farm at Mirpurkhas and Larkana to determine their suitability for extension under Sind conditions. The best and most successful of fruit tree varieties, already imported and tested at the Fruit Farm, will be cultivated on half-acre plots at the Farm for investigation of their economic possibilities.

(2) Detailed programme of scientific research work in horticulture.

Scientific research work in horticulture should be concentrated upon—

- (a) the irrigational requirements of fruit tree orchards in Sind;
- (b) suitable manurial treatments for orchards and vegetable gardens;
- (c) systems of pruning and root pruning for fruit production;
- (d) the technique of nursery production;
- (e) control and preventive measures against major insect pests and fungoid diseases of fruit trees and vegetable crops;
- (f) the picking and handling of fruit.

This experimental work should be conducted on similar lines at three centres, i.e., at Mirpurkhas (Government Fruit Farm), at Larkana (Fruit Sub-Station) and at Tharushah (where a new fruit Sub-Station should be established). The Horticulturist in Sind should submit a special report annually on the progress made and the results obtained from each of these lines of research and investigation, which should be published as an Agricultural Leaflet for the information of fruit and vegetable growers.

(3) Investigation of subsidiary industries to horticulture.

Preliminary experimental work should be undertaken at the Government Fruit Farm, Mirpurkhas, on the possibilities of establishing subsidiary industries based upon horticulture, *e.g.*, bottling of fruit juices, drying of vegetables and fruits, preparation of vegetable sauces, tinning of fruits and vegetables, etc., in Sind.

(4) Establishment of sub-station for date palm research.

A sub-station for investigation into date palm cultivation should be opened in North Sind, preferably at Sukkur or Shikarpur. The best varieties of dates should be imported from Mesopotamia, Arabia and Egypt and tested under North Sind conditions with a view to the extension of suitable types in the North Sind talukas. At this sub-station, research work on the cultivation, propagation and treatment of date palms should be undertaken.

(5) Establishment of Lower Sind sub-station for vegetable research.

In co-operation with the Sind Provincial Co-operative Bank, Ltd., who is willing to provide land and other facilities, a sub-station for scientific research on vegetable, especially potato cultivation, and for fruit cultivation, *e.g.*, banana, papaya, &c., should be opened at Malir, Karachi. Trials of different varieties of potato should be conducted at this sub-station and research carried on upon methods of storage of seed potatoes from one season to the next. In Karachi, storage methods by refrigeration should be investigated as facilities for such work are available there.

(6) Programme for distribution of improved fruit tree stock.

During the next five-year period, *i.e.*, 1936—1941, arrangements should be made to produce and to distribute 30,000 improved fruit tree stocks per annum rising to 50,000 per annum at the end of the five-year period. The stock should consist of improved varieties of citrus, mangoes, grapes and miscellaneous fruit trees.

(7) Subsidiary nursery at Agricultural Research Station, Sakrand.

A subsidiary nursery for the production of improved fruit tree stock should be opened at the Agricultural Research Station, Sakrand.

(8) Programme for establishment of district demonstration orchards.

At present, there are 12 demonstration fruit orchards on zamindari lands in Sind. During the next five years, a total number of 80 such demonstration centres for horticulture should be organized, at least one in each taluka of Sind. Increase should take place at the rate of 12 demonstration orchards per annum. Each such demonstration orchard should be 4—5 acres in area and, in selecting sites, preference should be given to small fruit growers who reside on their own lands. These demonstration orchards will be in charge of the Inspectors of Agriculture in the districts and will be visited at least twice annually by the Horticulturist in Sind or his senior staff. Stock plants will be supplied free of charge for the purpose of establishing such demonstration orchards.

(9) Records of horticultural development in Sind.

A record should be kept of the annual increase under (a) fruit tree cultivation and (b) vegetable garden cultivation in Sind, separately, in order to watch the progress of horticulture in the province.

(10) Establishment of a Sind Fruit-growers Association.

Steps should be taken, within the next five-year period, to establish a Fruit Growers' Association in Sind on a co-operative basis in order to extend and promote horticulture in the districts.

(11) Organization of Horticultural Shows.

Two horticultural shows should be organised annually, one in the kharif and one in the rabi season. (This may be done after the formation of a Fruit Growers Association in Sind has been accomplished.)

(12) Training of malis at the Government Fruit Farm, Mirpurkhas.

A twelve months course in practical horticulture should be commenced at the Government Fruit Farm, Mirpurkhas, for the production of trained *malis*. All District Local Boards in Sind should be invited to send two nominees each for this course of training and to award such nominees an annual training grant of Rs. 180 each. On the completion of the course, the Department of Agriculture will award a Diploma in Horticulture to successful students. The Horticulturist in Sind should maintain a register of employers requiring men trained in improved horticultural methods at the Government Fruit Farm, Mirpurkhas.

(13) Appointment of Horticultural District Kamgars.

Three horticultural kamgars should be appointed on the staff of the Horticulturist in Sind and stationed at the Government Fruit Farm, or sub-stations at Mirpurkhas, Larkana and Tharushah (or Sakrand). These kamgars should be utilised for district propaganda in horticulture and for the training of the ordinary subordinate district staff of the Department in improved horticulture methods, etc.

(14) Maintenance of spraying outfits, etc., for district work against fruit and vegetable pests and diseases.

At all implement depots of the Agricultural Department in Sind, outfits for spraying or dusting fruit and vegetable crops against insects pests or fungoid diseases should be maintained, together with a supply of common insecticides and fungicides on a maximum and minimum schedule. A reserve stock of such insecticides or fungicides should be held at the Fruit Farms at Mirpurkhas and Larkana.

District kamgars of the Agricultural Department should be trained in the proper use of such equipment and after such training, an entry should be made in their service books that they are capable of carrying out spraying or dusting operations on fruit and vegetable crops.

(15) Horticultural section at District Agricultural Shows.

A Horticultural Section should be organised at all district shows or large demonstrations held by the Agricultural Department in the districts. Standard sets of horticultural exhibits, *e.g.*, improved horticultural implements, insecticides, posters, leaflets, etc., should be maintained at Mirpurkhas and Larkana for the purpose of such Horticultural Sections at district shows or demonstrations.

(16) Preparation of text-book on Horticulture.

The Horticulturist should undertake the preparation of a text-book on 'Horticulture in Sind' for educative and propaganda purposes. The text-book should be concise, simple and in Sindhi for the use of fruit-growers in the districts,

Agricultural Leaflets dealing with Horticulture and kindred subjects already issued by the Agricultural Department in Sind since 1930.

- No. 6—"The Red Pumpkin Beetle."
No. 9—"The Propagation of Plants by (a) Seed and (b) Cuttings."
No. 10—"The Propagation of Plants by Layering."
No. 11—"The Propagation of Plants by Grafting".
No. 12—"The Propagation of Plants by Budding".
No. 15—"Potato Cultivation in Sind."
No. 20—"The Establishment of a Fruit Tree Orchard."
No. 28—"The Protection of Fruit Trees from Frost."
No. 40—"Mahlo disease in mango gardens in Sind and its Treatment."

SECTION VI.

ANIMAL HUSBANDRY.

SUMMARY OF PRESENT POSITION.

In Sind, there are three important breeds of cattle, *viz.*, the Sindhi (Red Karachi), the Thar Parkar and the Bhagnari. The first-named of these is essentially a dairy breed, the second is useful both for dairy and draught purposes, *i.e.*, 'dual purpose' and the third is solely a draught breed. The Sindhi and Thar Parkar breeds are found in Lower and East Sind, the former being bred in the hilly tracts near Karachi and the latter in the desert areas of Thar Parkar district. The Bhagnari breed is a North Sind breed whose home is near the river Nari on the borders of British Baluchistan. With regard to buffaloes, the Sind Murrah type is common in the riveraine tracts of the Province and in rice-growing areas. In Sind, the buffalo is almost entirely used for milk production and seldom for draught purposes. There are two important breeds of sheep, *viz.*, the 'Dumba' or fat-tailed sheep and the ordinary Sindhi type. The Dumba breed is usually found in the North Sind areas and in the Kohistan tract of Karachi districts. The Sindhi sheep are distributed throughout the Province. Both breeds of sheep are valuable for wool and mutton production and itinerant herds are utilised for manuring cultivated lands. There are several types of goats in the Province, the Burri breed being specially noted for the quality of its milk. With reference to poultry, the Aseel breed is the most notable, being largely used for table purposes. Ordinary *deshi* poultry are to be found in all villages.

With reference to the improvement of live-stock in Sind, practically no action is at present being taken by Government. In 1920, the Willingdon Cattle Farm was established at Malir, near Karachi, for scientific breeding and improvement of the Sindhi (Red Karachi) breed of cattle. A very fine herd of this breed was built up there but, in 1931, the Farm was closed down on account of financial stringency and the best animals were transferred to the Government Fruit Farm, Mirpurkhas, for maintenance. The work at the Willingdon Cattle Farm was directed towards scientific breeding for improved milk performance and early maturity. At present, the herd at the Government Fruit Farm, Mirpurkhas, consists of approximately 75 animals. A few young bulls of this breed have been given out in the districts on the 'Premium Bull System'. A scheme for the extension of improved Thar Parkar cattle in the Barrage areas of Sind was prepared by the Chief

Agricultural Officer and is still under the consideration of Government. A small herd of Sind Murrah buffaloes has been established at the Agricultural Research Station, Sakrand, but no scientific work on buffalo-breeding is in progress. No efforts have been made in the direction of the scientific improvement of sheep, goats or poultry in the Province. The Agricultural Department in Sind has no Live-Stock Officer and no Live-Stock Section has been organised.

SECTION VI—*contd.*

ANIMAL HUSBANDRY SECTION.

Programme of development for next five-year programme, i.e., 1936—1941.**(1) Appointment of Live-Stock Officer for Sind.**

A Live Stock Officer should be appointed on the staff of the Agricultural Department in Sind.

(2) Programme of scientific research work in animal husbandry—Preparation of schemes,

Scientific research work on the improvement of the valuable indigenous breeds of cattle in Sind should be recommenced with the main objects of (a) improvement of milk yields, (b) early maturity and (c) improvement of bullocks for draught purposes. The measures to be adopted for this purpose should be:—

For the Sindhi (Red Karachi) breed.—The Willingdon Cattle Farm, Malir, should be re-opened and utilised, in combination with the old Government Farm at Landhi, for the scientific improvement of the Sindhi (Red Karachi) breed of cattle. The Sindhi herd of cattle, now being maintained at the Government Fruit Farm, Mirpurkhas, could, with few additions, be utilised as foundation stock for this purpose.

For the Thar Parkar breed.—A small breeding herd of Thar Parkar cattle should be established at the extended Agricultural Research Station, Sakrand, and scientific breeding work commenced for the development of this breed as 'dual purpose' animals suitable for extension in the Barrage areas of Sind. In view of the urgency for cattle improvement in the Barrage areas, the scheme, prepared by the Chief Agricultural Officer in Sind, for the purpose and rearing of young male stock for breeding purposes in the Barrage areas, should be commenced as soon as possible.

For the Bhagnari breed.—A small breeding herd, consisting of 24 typical selected cows and 2 breeding bulls, of the Bhagnari breed should be established at the Right Bank Research Station, Dokri, for scientific breeding work on this breed.

For the Sind Murrah buffalo breed.—The herd of Sind Murrah buffaloes, at present stationed at the Agricultural Research Station, Sakrand, should be transferred to the Right Bank Research Station, Dokri, when established, for scientific breeding work towards improvement of milk yield and earlier maturity.

Detailed schemes and estimates for giving effect to these above noted proposals should be prepared and submitted to Government for consideration.

(3) Improvement of poultry at Auxiliary Farms.

At all Research Stations and Auxiliary Farms of the Agricultural Department in Sind, pens of selected deshi hens, White Leghorn cocks (24 birds in all) should be provided and three-quarter bred cockerels should be bred for distribution in the districts for the improvement of indigenous poultry.

(4) Investigation into nutritive value of fodders and concentrates in Sind.

The scientific staff of the Agricultural Department in Sind should undertake at the Central Research Stations, detailed investigations into the comparative nutritive values of the main fodder crops and concentrates available in bulk in Sind for live-stock. The results of these investigations should be published as soon as possible.

Experimental work to investigate the possibilities of the utilization of irrigation water in the *rabi* season for fodder production and the preservation of such fodder for use in times of scarcity of fodder supply, should be undertaken at the same centres.

(5) Organization of Cattle Fairs in Sind.

Cattle fairs should be organised to take place annually at definite centres in Sind for—

- | | | |
|-----------------------|-----|------------|
| (a) Karachi breed | ... | Malir, |
| (b) Thar Parkar breed | ... | Umerkot, |
| (c) Bhagnari breed | ... | Jacobabad, |

and propaganda work should be carried out to popularise such fairs among actual breeders by (a) Government purchase of approved young male stock and (b) award of cash prizes and certificates to successful competitors.

(6) Establishment of Herd Books.

The establishment of Herd Books for the Sindhi (Red Karachi) and the Thar Parkar breeds of cattle in Sind should be carried out in accordance with the scheme approved by the Advisory Committee of the Imperial Council of Agricultural Research.

(7) Investigation into possibilities of Co-operative Milk Producers' Associations.

An investigation should be carried out by the Agricultural and Co-operative Departments in Sind to determine the possibilities of the establishment of Co-operative Milk Producers' Associations in rural areas, and adjacent to centres of population in Sind, and suitable model bye-laws and working plans for such Associations should be prepared.

(8) Examination of methods of extending cultivation of leguminous fodder crops.

The Revenue and Agricultural Department in Sind should examine conjointly the possibility of the extension of the cultivation of leguminous fodder crops in the Barrage areas by such methods as rebates on assessment on such crops, and similar concessions.

(9) Scheme for co-operation with pinjrapoles in Sind in cattle improvement.

The Agricultural Department in Sind should prepare a scheme whereby pinjrapoles and gawshalas in the Province might co-operate in the work of cattle improvement. This scheme should be submitted to the controlling authorities of such institutions who should be invited to indicate their willingness to co-operate with the Department on the lines suggested.

(10) Availability of breeding bulls at Government Auxiliary Farms.

At each Auxiliary Farm in Sind, breeding bulls, of breeds suitable to the district, should be maintained and their services made available to the cultivators free or at a nominal charge. A register of the services of such departmental bulls should be maintained at the centres where they are situated.

Agricultural Leaflets dealing with Animal Husbandry and kindred subjects, already issued by the Agricultural Department in Sind since 1930.

No. 26.—“The Cultivation of Oats as a Green Fodder in the Rabi season.”

No. 37.—“Improved varieties of Jowar for Sind.”

No. 44.—“Fodder Crops suitable for cultivation in the Barrage areas of Sind.”