SCIENTIFIC REPORTS

OF THE

Agricultural Research Institute, Pusa

1923-24

CALCUTTA: GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1924

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Scientific Reports of the Agricultural Research Institute, Pusa

(Including the Reports of the Imperial Dairy Expert, Physiological Chemist, and Secretary, Sugar Bureau)

1923-24

REPORT OF THE DIRECTOR.

(W. H. HARRISON, D.Sc.; AND W. MCRAE, D.Sc., F.L.S.)

I. CHARGE AND STAFF.

Charge. Dr. D. Clouston, C.I.E., held charge of the office of Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa, from 1st June to 2nd November, 1923, when the permanent incumbent, Mr. S. Milligan, returned from leave. On Mr. Milligan again availing himself of leave from 10th March, 1924, Dr. Clouston returned to officiate, but he also left on leave for 3 months and 25 days on 29th June, 1924, since when Dr. W. H. Harrison has been acting in the post.

The post of Joint Director was held by Dr. W. H. Harrison up to 28th June, 1924, when, on his appointment as Agricultural Adviser, Dr. W. McRae took over charge.

Staff. Mr. A. Howard, C.I.E., Imperial Economic Botanist, and Mrs. G. L. C. Howard, Second Imperial Economic Botanist, proceeded on leave for 7 months and 10 days and 7 months and 16 days from 17th March and 11th March, 1924, respectively. Dr. F. J. F. Shaw, Second Imperial Mycologist, officiated as Imperial Economic Botanist upto 17th April, 1924, when, on his departure on

leave, the Section was placed in charge of Maulvi Abdur Rahman Khan.

On the appointment of Dr. W. H. Harrison as Agricultural Adviser, Mr. J. N. Mukerji was appointed to officiate as Imperial Agricultural Chemist from 29th June, 1924.

The services of Mr. G. S. Henderson were placed at the disposal of the Government of Bihar and Orissa from 14th April, and Mr. Arjan Singh officiated as Imperial Agriculturist from 14th April to 4th June, 1924, when he made over charge of that post to Mr. M. Wynne Sayer.

Mr. C. M. Hutchinson, C.I.E., Imperial Agricultural Bacteriologist, was on leave for 22 days from 26th April, 1924.

On the expiry of leave, Mr. J. H. Walton resumed charge of the post of Assistant Bacteriologist on 11th February, 1924, relieving Mr. N. V. Joshi who reverted as First Assistant to Imperial Agricultural Bacteriologist.

Dr. J. Sen, Supernumerary Agricultural Chemist, was on leave for four months and one day from 1st November, 1923. On 15th April, 1924, he then went to the Forest Research Institute and College, Dehra-Dun, to take up the officiating appointment of Forest Chemist.

As the result of the recommendations of the Inchcape Committee, the posts of Supernumerary Mycologist, Supernumerary Entomologist and Assistant Bacteriologist (Industrial Branch) were abolished, and the Physiological Chemist was transferred to the newly established Imperial Institute of Animal Husbandry and Dairying at Bangalore.

II. Research.

The main aim of the research work carried out at the Institute is to establish principles which can be put into general practice. The Institute deals as a rule with problems of general or All-India importance or with problems which cannot be studied conveniently by Provincial Depart-

ments. The more important work of the year under report is summarized below :—

Botanical Section. Wheat, tobacco, gram, barley, oats, linseed, safflower and *Hibiscus* are the principal crops towards the improvement of which the energies of this Section are specially directed. The improved varieties of wheat originally selected at Pusa have received such wide recognition that they are now grown in an area which is estimated to approximate 2 million acres. They are not, however, quite acceptable in localities where the crop is liable to damage by animals and birds. A new series of bearded wheats have been evolved, some of which have not only been found to compare well in yield with the older selections in various parts of the country but their milling and baking qualities have also been reported exceedingly satisfactory in tests carried out in England. Some of the pure cultures of oats and barley under test are equally promising. A detailed investigation into the biology, taxonomy and economic aspects of the Indian linseed crop has resulted in the isolation of at least three types which give better yields than the mixtures at present grown on the alluvium. The research into the inheritance of characters in *Nicotiana rustica* and also into the phenomena of parthenogenesis and parthenocarpy in *Nicotiana Tabacum* has reached a stage when it has been possible to publish the results hitherto obtained. Another paper brought out during the year explains the colour in *Hibiscus Sabdariffa* and attributes the various colours which exist to the interplay of 24 different factors. Experiments made during the year have shown that sulphur can be a substitute for superphosphate in improving the efficiency of green-manure in Pusa soil.

Chemical Section. The study of the movements of nitrates in the soil and sub-soil has now been carried through two complete years comprising one very good and one very bad monsoon period. Observations made during both years tend to the same conclusion that the distribution of nitrates through the sub-soil is determined by climatic

factors and the physical character of the sub-soil layers and that the growth of the crop in turn depends to a considerable extent on the distribution of nitrate. Further experiments on the windrowing of sugarcane indicate that windrowed canes deteriorate on the incidence of rain owing to the quick passage of water through the nodes of somewhat dried canes, causing a translocation of the inverting enzymes from the nodes into the internodes. Sugar-beet, grown on a field scale during the year, gave promise of extending the working season of sugar factories operating in Bihar by at least two months and a half, provided irrigation facilities are at hand. The investigation into the different methods of tobacco-curing has shown that rack-curing is more effective than ground-curing in reducing the "volatile-nicotine" which gives an undesirable sharpness and pungency to the smoke from certain types of tobacco. Work on the determination of available phosphoric acid in calcareous soils was extended to soils obtained outside Pusa, and it was confirmed that the potassium carbonate method was a decided improvement on the existing citric acid method. Adsorption of moisture by soil and the effect of application of nitrate to wheat are the other important investigations in progress.

Bacteriological Section. Further observations on the conditions under which fixation of nitrogen by non-symbiotic organisms takes place have shown that bonemeal gives higher fixation figures than the mineral phosphates and that nitrogen fixation is increased by the addition of rotted organic matter to the soil. Fermented rice straw when compared with cattle manure has been found not only to increase greatly yields of maize but also of the succeeding oat crop. The nitrification of bone manures, which is ordinarily a very slow process in most Indian soils, was studied, and it was found that rapid and complete nitrification of this refractory material could be obtained by previous fermentation before applying to the soil. A compost of bone dust, sulphur and sand inoculated with a mixed culture of sulphur-oxidizing bacteria was found to

contain citrate-soluble phosphoric acid to the amount of 94 per cent. of its original content after a period of 23 weeks' fermentation. A wide-spread disease of the betel-vine plantations reported from Bengal is under investigation. The intensive nature of the bacterial infection suggests the burning of the soil with the whole of the plants and other appurtenances as the only possible and immediate remedy, the alternative being a prolonged period of rotation and fallowing.

Mycological Section. Progress was made in elucidating the factors governing the pigeon-pea wilt problem and in interpreting the data given by the existing field experiments. That the amount of wilt due to seed-borne spores is small has been proved by experiment. It has also been ascertained that the disease "extends" to a distance of nine feet in a season. The existing field plots having been found inadequate for ascertaining the relation between the incidence of disease and different manures, a new series has been laid down to test the influence of superphosphate and green-manure on the wilt. Work on the identity of the fungus causing stem rot in jute was brought to a conclusion. The fungus which has been identified in Japan as *Macrophoma Corchori* appears to be identical with that which has been worked with in this country as *Rhizoctonia Solani*, while cultures of the sclerotial stage sent to America have been pronounced to be identical with *Sclerotium bataticola*. The incidence of *M. Corchori* has been found to be largely determined by the amount of potash available for the plant. A set of field experiments has been designed in which different plots of jute are receiving different manurial treatment. The behaviour of *Fusarium udum* to phosphate and of *M. Corchori* to potash was studied in liquid culture media of known chemical composition to determine the relationship of the fungi to the various concentrations of these chemicals, as field work has indicated that in the one case phosphate favours the disease while in the other phosphate inhibits it. In actual practice the treatment of oat seed

with a 0·25 per cent. solution of formalin has been found to be an effective preventive against smut of oats.

Entomological Section. The investigation on borers in sugarcane and other gramineous plants was continued and large numbers of pests were reared in the insectory, but no new species were found. The fruit pests of Kashmir were specially studied from May to October 1923, and a report submitted to the Durbar. Work on pathological entomology was continued with special reference to veterinary entomology. The life-histories of various species of Tabanidæ have been worked out, and the transmission of rinderpest by means of *Stegomyia* and *Musca domestica* is being investigated in collaboration with the Director of the Muktesar Laboratory. Considerable progress has been made with the proposed book dealing with the insect pests of domesticated animals for the use of veterinary officers and colleges. Consideration of the data on the distribution and transmission of *Kala-azar* has led the Imperial Entomologist to suggest species of *Culicoides* as vectors of this disease.

Agricultural Section. The permanent experiments being carried out in collaboration with other Sections of the Institute were continued. Although a record deficiency in monsoon rains and the total failure of winter rains seriously affected the yield of grain crops, the enterprising irrigation policy initiated some years ago rendered it possible to maintain a herd of over 370 head of cattle on a green fodder ration throughout the year.

Both the pure Montgomery and the cross-bred Ayrshire-Montgomery sections of the cattle herd are to an increasing extent showing justification of the lines of work hitherto pursued. The average yield of the graded-up Montgomery cow is almost double of what it was ten years ago, while it has been definitely established that though all crosses further from the first appear to vary to almost any extent, the cross-breds are superior not only in milk yield but also in shorter dry period. It is gratifying to report that we have this year in milk a half-bred, Laura by name,

what promises to be a second Alibi. The fact that we have had 93 half-breds between these two prodigies gives some idea of the years of patient work required to tackle the cattle problem successfully.

Imperial Dairy Expert. With the transfer of the Bangalore, Wellington and Karnal dairy farms to this department, the scope of the activities of the Imperial Dairy Expert has been considerably developed. It has been decided to run Karnal as a breeding farm for indigenous breeds, specially Thar-Parkar and Hariana. The original herd taken over at Bangalore is altogether cross-bred, but for teaching and demonstration purposes a small herd of Sindhi cows and Murra buffaloes will be maintained there in future. Wellington will remain a branch of Bangalore and will be utilized for breeding pure bred Ayrshire bulls required for cross-breeding. The technical equipment of these farms has been largely extended, and this department can now teach the farming and cattle-breeding side of dairying as well as it can be done in many European countries. The Imperial Dairy Expert continued to interest himself in the milk supply of large cities like Calcutta and Bombay, and he also did much in stimulating an interest in cattle-breeding and dairying by delivering lectures illustrated by cinema films.

Animal Nutrition. The transfer of the Physiological Chemist to the newly established Imperial Institute of Animal Husbandry and Dairying at Bangalore in the middle of the year necessitated the discontinuance of the experiments initiated at Pusa. During the latter half of the year the laboratory and nutrition-stalls at Bangalore have been fitted up completely, and it will now be possible to undertake nutrition experiments in collaboration with Provincial Departments.

Sugar Bureau. As the result of thorough testing both in the field and in the factory, the selected Coimbatore canes 210, 213 and 214 have completely established their superiority over the indigenous canes grown in North Bihar, and the 1,330 tons of seed-cane available at

Pusa for distribution met only a fraction of the demand. So well did the Coimbatore selections under growers' conditions withstand the severest test possible, provided by the abnormal climatic conditions which prevailed throughout the year, that the representative association of sugar factories has come forward to finance the testing of more varieties of Coimbatore canes until definite arrangements are made to carry on the work. Nearly 50 new seedlings are under test this year in the testing plots, and it is proposed to transfer some of the more promising ones to the farm of 143 acres placed by Government at the disposal of the association for these tests. The sugar cable service conducted by the Bureau on a self-supporting basis has proved of the greatest value to the trade.

III. Training.

Agricultural Research Institute, Pusa. As stated in last year's report, post-graduate courses in Agricultural Chemistry, Botany, Mycology, Agricultural Bacteriology and Entomology extending over two years and qualifying for appointments in the Indian Agricultural Service were started at Pusa from 1st November, 1923. There were 40 candidates for admission, of whom the educational qualifications of only 8 approached the standard required and they were asked to appear before a Selection Committee. Of the 7 who came for interview, three only were selected and of them one was advised to complete the M.Sc. course which he was taking at the time. The two who actually joined the Institute are undergoing training in Botany and Entomology respectively.

In addition to these, one student was admitted during the year to a special one-year course in Entomology, while six students who joined during the previous year continued to receive training in the following subjects: Botany 1, General Agriculture 1, Entomology 1, and Agricultural Bacteriology 3.

Seven students took short courses in Mycology (2), Entomology (3), and Lac-culture (2).

The Imperial Institute of Animal Husbandry and Dairying. The fifteen-month course in animal husbandry and dairying started on 2nd January, 1924, at Bangalore for training of Deputy Directors of Agriculture and Professors of Agriculture is being availed of by five students, *viz.*, two from Bombay and three from the Punjab. This course which was at first confined to officers of the Provincial Service who had put in at least two years' service is now open to all suitable candidates.

In connection with the working of the Bangalore Institute, Government have also instituted an Indian Diploma in Dairying on the lines of the British National Diploma in Dairying, to be granted to persons who have successfully completed a course of not less than two years' instruction at an institution recognized by the Imperial Institute. There were 190 applications for admission to this course which is open to Matriculates, of whom not more than 15 could be admitted for want of accommodation. The Allahabad Agricultural Institute of the American Presbyterian Mission is the only other institution recognized for teaching students for this diploma course.

IV. Publications.

Seven memoirs, ten bulletins, and seven other publications were issued during the year, while over 18 publications were in the press on 30th June, 1924.

Among the more important publications issued during the year were the Proceedings of four conferences, *viz.*, the Thirteenth Meeting of the Board of Agriculture in India and the Cattle Conference held at Bangalore in January 1924, the Fifth Entomological Meeting held at Pusa in February 1923, and the Second Conference of Veterinary Officers which met at Calcutta in February 1923.

"The Agricultural Journal of India," which is issued every two months, continues to maintain its popularity among the class of readers for which it is intended.

V. General Administration.

Buildings. The housing problem created in the Estate by the absolute cessation of building of quarters for the subordinate staff during the last 8 years will be eased to some extent by the construction of 12 clerks' quarters sanctioned during the year.

Library. In addition to the 1,831 periodicals, reports, books and reprints received in exchange, 649 new volumes were purchased during the year.

Hospital. Medical relief was afforded to 382 in-patients and 13,463 out-patients during the calendar year 1923 as against 312 and 13,544, respectively, in the previous year. The number of operations performed rose from 1,832 to 2,730, of which the "selected" ones were respectively 51 and 76.

During the last few years Pusa and the surrounding district has become a centre of *Kala-azar* infection, and the successful manner in which the disease is being treated by the Medical Officer, Mr. D. F. Michael, has considerably increased the prestige of the institution in the country-side.

VI. Accounts.

The total expenditure during the financial year ending 31st March, 1924, as shown below, was Rs. 7,06,557 as against Rs. 7,86,056 during the previous year.

	Rs.
General expenditure of the Institute, including the Agricultural Adviser's office . .	2,72,420
Botanical Section	65,959
Chemical Section	62,423
Bacteriological Section	58,956
Mycological Section	58,227
Entomological Section	74,104
Agricultural Section	1,14,468
Total .	7,06,557

The following are the principal items of expenditure under the annual grant of Rs. 8,000 placed at the disposal of the Agricultural Adviser for expenditure on special agricultural experiments :—

	Rs.
Experiments with fibre extracting plant . .	273
Purchase of one Keith fan for threshing work on the Botanical Area	475
Construction of the base of a tank and an engine shed for irrigation work at Pusa . . .	766
Purchase of plates for the batteries of the Power House, Pusa	4,482

The gross receipts during the year from sale of publications, farm produce, milk and other articles amounted to Rs. 36,421 as against Rs. 45,852 last year.

REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

(ABDUR RAHMAN KHAN, ASSISTANT-IN-CHARGE.)

I. INTRODUCTION.

Charge. Mr. A. Howard, C.I.E., M.A., Imperial Economic Botanist, held charge of the Section up to 16th March, 1924, when he proceeded on leave, and Dr. F. J. F. Shaw, A.R.C.S., F.L.S., was appointed to officiate till 16th April, 1924, when the charge was handed over to Maulvi Abdur Rahman Khan.

Training. Mr. Ilabonto Banerji, M.Sc., a post-graduate student in economic botany, was under training in this Section from November 1922 to September 1923 when he was selected by the Central Cotton Committee for a research studentship in cotton-breeding. Mr. Nand Lal Datt, M.Sc., was chosen by the Selection Committee for post-graduate training in economic botany and has been under training since November 1923.

II. INVESTIGATIONS.

Wheat. The dissemination of improved varieties of wheat has now reached a stage when it is no longer possible to state the area actually grown by the cultivators. In the last year's report it was mentioned that the total area under improved wheats in the United Provinces and the Punjab is now well into the second million acres. As the area is steadily increasing year by year, it is no longer possible to give more than approximate figures of acreage.

During the year under report, about 117 maunds * of seed of the selected varieties (as detailed below) was distributed. It was impossible to meet all demands for seed, and as usual some of the indents had to be cut down

* 1 maund=82·28 lb.

considerably while a number could not be complied with at all.

Variety of wheat	Quantity of seed distributed	
	md.	sr.
Pusa 4	53	30
Pusa 12	32	15
Pusa 6	9	26
Pusa 51	1	29
Pusa 52	8	20
Pusa 54	0	32
Pusa 55	2	10
Pusa 56	1	3
Pusa 57	2	0
Pusa 58	0	12
Pusa 59	2	12
Pusa 101	2	30
TOTAL	117	19

Pusa 4 is now well established in Australia and is regularly distributed by the Queensland Agricultural Department[1]. In Rhodesia the Agricultural Department reports that this variety is doing well.

An indent for 2,250 lb. of Pusa 6 was received from Portuguese Africa but only a portion of it could be supplied.

The new hybrid wheats have given promising results in various parts of the country where a bearded variety is desirable. During the year some of these were sent to England for milling and baking tests. The report is exceedingly satisfactory and will be published in due course.

Tobacco. Seed of Type 28 sufficient to grow 10,000 acres was grown this year at Pusa, out of which sufficient to sow 8,000 acres has been distributed. The 51 types of *N. Tabacum* and 20 types of *N. rustica* were also grown to maintain the cultures.

[1] *Queensland Agricultural Journal*, March 1922, p. 100.

A memoir has been published by Mrs. Howard on the inheritance of characters in *Nicotiana rustica*, and also another paper, by the same author in collaboration with Babu Kashi Ram, on the phenomena of parthenogenesis and parthenocarpy in *Nicotiana Tabacum*. No evidence was obtained that parthenogenesis develops with acclimatization. It was, however, found that large and vigorous plants gave a high percentage of parthenocarpic fruits, whereas poorly grown plants of the same variety gave none at all.

Oil seeds. The unit species of the Indian linseed crop were maintained in pure cultures. The classification of these unit species, which was completed last year, was verified and has been published. The biology, taxonomy and economic aspects of the linseed crop have been the subject of a memoir by Mrs. Howard and Maulvi Abdur Rahman Khan during the year under review. The authors point out that the economic value of any variety of linseed depends, not only on the percentage of oil in the seed, but also, on the yield of seed per acre. In the case of linseed, high yields of seed depend generally on the suitability of the root system to its environment and on the power of branching of the plant. It has been found that all types with *bold* seed belong to Peninsular India and will not thrive on the alluvium, except possibly in the Punjab. This is attributed to the fact that all these types, so far obtained, have a deep root system. Variety trials have been carried out at Pusa with types suitable to the alluvium and at least three have been produced which are superior to the local variety. The success of the preliminary trials carried out with these varieties leaves no doubt that the yield of linseed on the alluvium can be very considerably increased by the systematic distribution of these kinds. Experiments are in progress with the object of producing a large-seeded variety with a high yield of seed and a shallow root system. Such a type would be suitable for the alluvium of the United Provinces and Bihar.

Nearly 30 maunds of seed of the promising types was grown this year for distribution, out of which 11 maunds of seed of Types 12 and 121 has already been issued. These types as usual have given heavier outturns than the local mixed crop.

Gram. The pure cultures of the 24 types were maintained. The following quantities of the selected types were distributed to various applicants.

Gram type	Quantity distributed	
	md.	sr.
6	1	20
9	2	0
17	8	18
18	2	10
20	0	12
25	4	10

Types 17 and 18 are now being extensively grown in the United Provinces.

Khesari (*Lathyrus sativus* L.). The unit species of this crop were isolated in connection with the lathyrism investigation. A tentative classification of these forms has been made which will be completed next year. The following four leguminous weeds were found mixed with *khesari* :—

(1) *Akta* (*Vicia sativa* L.).

(2) *Missia* (*Vicia hirsuta* Koch. Synops.).

(3) *Langra khesari* (*Lathyrus sphœricus* Retz.).

(4) *Pipra* (*Lathyrus aphaca* L.).

The seed of the above weeds has been multiplied and is available for the various experiments which are being conducted by Major Anderson, I.M.S., Central Research Institute, Kasauli, and by Dr. Simonsen, Forest Research Institute, Dehra Dun. Very interesting results have been obtained which will be published in due course.

Fibres. A stock of *Hibiscus cannabinus* Type 3 was maintained. The breeding work on Roselle was continued.

In the third number of a series of studies in Indian fibre plants, Mr. and Mrs. Howard have dealt with the inheritance of characters in *Hibiscus Sabdariffa* L. The paper explains the inheritance of colour in *H. Sabdariffa* and attributes the various colours which exist to the interplay of 24 different factors.

Barley. Some unit species of this crop have been isolated and their comparative study is in progress.

Oats. Some years ago a selection of early and promising cultures of oats was made. Their seed is being multiplied and some of the pure cultures are very promising.

Safflower. All the 24 types of this crop which were isolated some years ago are maintained year after year in pure cultures. In addition, many new types have also been selected.

Lucerne. In October 1922, an experiment was begun in the Botanical Area in order to compare the growth of lucerne on the ridges and on the flat bed system. Although the season favoured the ridges, the total yield of the beds exceeded that of ridges by over ten per cent. The bed system also saved the irrigation water by 25 per cent.

Improvement of the Botanical Area. At a plant-breeding station, where numerous varieties have to be dealt with, an efficient and quick arrangement for winnowing is essential. As large threshers and winnowing machines are unsuitable for winnowing small quantities of varieties, an attempt has been made to find an effective substitute which would also prove of use on small holdings. The winnowing difficulty, which becomes very troublesome in the absence of good west winds, has been solved by driving a Keith fan of suitable size by an ordinary bullock gear. This provides an effective artificial wind and reduces the labour very considerably. The use of these fans would solve one of the difficulties in threshing the wheat crop in North-West India.

The efficiency of green-manuring. As is well known, the efficiency of green-manuring at Pusa can be improved by the addition of small dressings of superphosphate. During the year experiments were made to ascertain the effect of small quantities of sulphur (10 lb. to the acre) on green-manuring with *sanai* (*Crotalaria juncea* L.). In the case of wheat it was found that the addition of sulphur gave a larger yield of seed and of total crop. Arrangements have been made to extend the work to Great Britain and to ascertain whether the real effect of superphosphate on root crops is an indirect one in improving the texture and whether similar results can be obtained by small quantities of sulphur.

III. Programme and Publications.

Programme for 1924-25. Investigations on the lines indicated in the annual reports and in the publications of the Section will be continued on the following crops—cereals, tobacco, fibre plants, pulses, oil seeds, fodder crops and fruit—and on soil aeration and root development.

Publications. The following papers were either printed or accepted for publication during the year under review :—

1. Report on Economic Botany for the Board of Scientific Advice, 1922-23.

2. Report on Agricultural Botany, 1923-24, for the Committee of the Privy Council for Scientific and Industrial Research.

3. Studies in Indian Tobaccos. No. 4. Parthenocarpy and Parthenogenesis in the varieties of *Nicotiana Tabacum* L., var. *Cuba* and var. *Mirodata*. *Mem. Dept. Agri. India, Bot. Ser.*, XIII, No. 1.

4. Studies in Indian Tobaccos. No. 5. The inheritance of characters in *Nicotiana rustica* L. *Mem. Dept. Agri. India, Bot. Ser.*, XIII, No. 1.

5. Studies in Indian Fibre Plants. No. 3. On the inheritance of characters in *Hibiscus Sabdariffa* L. *Mem. Dept. Agri. India, Bot. Ser.*, XIII, No. 3.

6. An improved method of lucerne cultivation, II. *Agri. Jour. of India*, 1924, p. 276.

7. The continuous growth of Java indigo in Pusa soil *Agri. Jour. of India*, 1924, p.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST.

(J. N. MUKERJI, B.A., B.Sc.)

I. ADMINISTRATION.

Dr. W. H. Harrison held charge of the Section until 28th June, 1924, when he took over the office of the Agricultural Adviser to the Government of India, and I assumed charge of the duties of Imperial Agricultural Chemist.

From 8th April, 1924, the services of Dr. J. Sen, Supernumerary Agricultural Chemist, have been temporarily placed under the Forest Department as Forest Chemist in the Forest Research Institute, Dehra Dun.

Mr. P. B. Sanyal officiated as First Assistant from 13th August to 13th October, 1923, during the absence of Mr. J. N. Mukerji on privilege leave.

II. METEOROLOGY AND DRAIN-GAUGES.

The usual meteorological and drain-gauge records were maintained. The crops and drainage waters from drain-gauges were examined in the usual manner.

III. GENERAL ANALYTICAL WORK AND ASSISTANCE GIVEN TO OTHER SECTIONS.

A. The following samples were analysed and reported upon during the year under report :—

Soils	2
Manures	26
Sugarcane	171
Sugar-beet	1
Milk	2,492
Butter	3
Waters	3
Olive fruit	1
Olive oil	1
Miscellaneous	6
TOTAL	2,706

The sample of sugar-beet and the sample of olive fruit and its oil were analysed at the request of the Agricultural Officer, North-West Frontier Province.

One sample of manure (bonemeal) was received from the Patiala State.

B. The following assistance was rendered to other Sections :—

Agricultural Section. Ten samples of manures, three of water and 2,492 samples of milk were analysed and reported upon.

Botanical Section. Two samples of soil and two of manures were reported upon.

Mycological Section. One sample of carbonate of soda and three samples of fungicides were examined; besides these, a gummy excretion caused by a disease on *cholam* (*Sorghum*) ears was examined and found to contain dextrine and maltose, two sugars which are the products of hydrolysis of starch by an enzyme.

Sugar Bureau. Reports upon nine samples of manures and 171 samples of sugarcane juice were submitted.

IV. Methods of Analysis.

Harper's method for estimation of nitrates in soils by the phenol-disulphonic acid method (*Jour. Indus. Eng. Chem.*, 1924, 16, 180-183) has been tested during the year. The method is a convenient one and is an improvement on the old phenol-disulphonic acid method, especially when the soil extract is coloured owing to the presence of organic matter and when the soil contains more than 15 parts of chlorides per million.

V. Research and Investigations.

Windrowing of sugarcane. Mr. Sanyal continued his investigations into the nature of the enzymes inducing deterioration of windrowed canes and the mechanism

through which their activities become effective. The experimental results hitherto obtained have indicated that sugarcane windrowed in the field immediately deteriorates on the incidence of rain. It has also been shown that the enzymes (invertase) inducing deterioration are localized in certain portions of the cane, particularly in the nodes, and normally do not affect the juice contained in the internodes. Rain falling on the somewhat dry windrowed cane may be absorbed and may bring about a translocation of these enzymes into the internodes, thus inducing deterioration. In order to test this conclusion in a more rigorous manner, a number of windrowed canes of almost the same size were divided into three equal portions. One portion was simply topped and cleaned. The second portion was topped, cleaned and the two ends and all the nodes were coated with wax; after being waxed the canes were weighed, kept dipped in water for 4 hours and exposed to a moist atmosphere for 18 hours, when they were weighed again. The third portion was treated exactly like the second, but instead of the nodes, the internodes were coated with wax in this case. A second set of similar experiment was repeated, where the canes were dipped in water for a longer period, *i.e.*, 16 hours instead of 4 hours. Analyses were made of these differently treated portions of windrowed canes and the results obtained are given in the table below.

Experiments showing the effect of the passage of water through nodes and internodes of windrowed cane on its composition.

	Description	Weight increased on wetting		In juice			Water entered on wetting
		From	To	Brix	Sucrose	Glucose	
		lb	lb		Per cent.	Per cent.	Per cent.
Exptt. I	3 canes windrowed for 11 days in shade.	..	..	20·75	17·14	1·53	..
	3 canes windrowed for 14 days in shade. Two ends and nodes coated with wax and wetted for 4 hours.	2 180	2 495	20·26	16·93	1·20	0·61

Experiments showing the effect of the passage of water through nodes and internodes of windrowed cane on its composition.—concld.

	Description	Weight increased on wetting		In juice			Water entered on wetting
		From	To	Brix	Sucrose	Glucose	
		lb	lb		Per cent	Per cent	Per cent
	3 canes windrowed for 14 days in shade. Two ends and internodes coated with wax and wetted for 4 hours.	2·580	2 640	19 78	16 51	1 89	2·38
Exptt. II	3 canes windrowed for 33 days in shade.	..	..	23 87	19 03	2 53	..
	3 canes windrowed for 33 days in shade. Two ends and nodes coated with wax and wetted for 16 hours	2 480	2 540	22 47	19 96	1·70	2·45
	3 canes windrowed for 33 days in shade. Two ends and internodes coated with wax and wetted for 16 hours	2 620	2 765	20 27	15 28	2 71	5 50

A comparison of the results obtained clearly shows that where the nodes were exposed to water more water was absorbed and the canes showed greater deterioration than when the internodes only were exposed, and that the longer the canes were wetted, the more was the absorption of water and the greater the deterioration. These results, therefore, support the conclusion previously arrived at that the windrowed canes deteriorate on the incidence of rain owing to the quick passage of water through the nodes of somewhat dried canes, causing a translocation of the inverting enzymes from the nodes into the internodes and thus inducing deterioration.

Sugar-beet. Field experiments on the possibility of growing sugar-beet in Bihar were carried out at Pusa by Mr. Sanyal during the year under review. Five plots of land, each $\frac{1}{8}$th of an acre, were selected and manured with either farmyard manure or superphosphate in addition to farmyard manure. Seeds were sown between 5th September, 1923, and 5th November, 1923, and the beet-roots were raised and tested from the middle of February to the

middle of May. The outturn of beet-roots from the several plots varied between 10·5 and 11·8 tons per acre and the percentage sucrose in the juice from 14·8 to 15·3. These results compare very favourably with the results obtained under more favourable climatic conditions and demonstrate that the crop can be carried in the ground for a period of about two months and a half from the end of February to the middle of May following the cane season. The growing of beet-root in Bihar, for the production of sugar, on land capable of being irrigated would, therefore, appear to be a feasible proposal worthy of further consideration.

The available phosphate of calcareous soils. It was reported last year that Dyer's citric acid method for the estimation of available phosphoric acid in case of calcareous soils is in effect an extraction by solvents of varied composition and therefore unreliable. Hence, with a view to find a suitable solvent for the estimation of available P_2O_5. of calcareous soils, Mr. Das tried a large number of solvents of divergent character, but in the vast majority of cases it was found that $CaCo_3$ exerted a markedly depressing effect upon the amount of P_2O_5 extracted. It was found, however, that extractions with solutions of alkaline carbonates were not so affected, and a 1 per cent. solution of potassium carbonate was the most suitable for general employment. Last year several soil samples from the Pusa Estate were submitted to the action of 1 per cent. K_2CO_3 solution, and the amounts of P_2O_5 extracted showed that in practically all the cases examined the method differentiated between manured and unmanured plots, whereas Dyer's citric acid method yielded irregular and misleading results.

In the year under review the method was extended to other calcareous soils and was examined more closely. It has been found that the underlying principle of the action of K_2CO_3solution on calcareous soils is that a reaction takes place with any dicalcic and such other acid phosphates as may be present in the soils, leading to the production of insoluble tricalcic phosphates and soluble potassium phos-

phate. Hence the amount of P_2O_5 found in the extract is an approximate measure of the available P_2O_5 of these soils. The method has a bearing on the differentiation of the various forms of phosphate compounds found in the soils, thus affording a rational explanation of the value of the method.

On the other hand, it has been found that the extraction of P_2O_5 by the K_2CO_3 solution follows the law of mass action, and consequently the proportion of P_2O_5 extracted at any time is a function of the total amount of P_2O_5 present in the soil, depending on the concentration of K_2CO_3 solution.

The method was applied to certain calcareous soils this year and the results obtained confirm the conclusion arrived at from last year's experiment.

Thus, the K_2CO_3 method is capable of measuring the probable fertility of highly calcareous soils in their relation to available phosphoric acid and appears to be a decided improvement on the existing citric acid method.

Effect of gypsum on the cropping of Pusa soils In continuation of experiments reported last year in connection with the study of the relationship of the combined application of superphosphate and green manures to calcareous soils, it was found, from the crop returns of the pot experiments for the year under review, that gypsum exerts a markedly depressing effect on the yield, thus supporting the conclusions arrived at in previous years.

Effect of superphosphate with green manure on calcareous soils. It is generally conceded that superphosphate gives the best cropping value in calcareous soils here when combined with green manure. Starting with this idea mono- and di-calcic phosphates were separately composted with lucerne, when it was found that inorganic phosphorous present in the above phosphates combines with the organic matter of lucerne and forms organic phosphorous compounds. It is probable that under the natural soil conditions phosphates in organic combination become [illegible]

able to plants and consequently contribute towards the better yield of crops as evidenced when superphosphate and green manure are applied together in fields. The greater availability and efficacy of organic phosphorous to plants compared to inorganic phosphatic fertilizers as used in ordinary farm practice is being studied.

Tobacco curing. Investigations into the effect of curing tobacco by the ground and rack-curing processes have been continued by Mr. Mukerji. The experimental results obtained in previous years have led to the conclusion that ground-cured tobacco invariably shows a higher nicotine content than rack-cured ones. It was thought probable that during the process of rack-curing, owing to the slow drying of the tobacco, a portion of the so-called " volatile nicotine," which gives an undesirable sharpness and pungency to the smoke from certain types of tobacco, is expelled.

In order to test the efficacy of rack-curing in removing a portion of the so-called " volatile nicotine," samples of tobacco cured by the ground and the rack processes were extracted with petroleum ether and ether successively (the petroleum ether dissolving the " volatile nicotine," and the ether, " the total nicotine,") and " volatile " and " fixed " nicotine determined in the extract. A brief summary of results obtained is given in the following table :—

Constituents	Sample No. 1		Sample No. 2	
	Ground cured	Rack cured	Ground cured	Rack cured
Volatile nicotine %	1·74	1·57	2·53	2·27
Fixed nicotine %	3·11	3·06	0 91	0 98

A comparison of the results obtained clearly shows that ground-cured tobacco gives a higher content of " volatile nicotine " than rack-cured ones—that is to say, rack-curing is more effective than ground-curing in reducing the " volatile nicotine."

Mechanism of the action of sulphur in destroying organism. The germicidal and fungicidal properties of sulphur are well known and the number of works on this subject is large, but there is a conflict of opinion as to the mode of action in the destruction of the organism. With a view to arrive at some definite conclusions, a systematic study on the nature of the action of sulphur was taken up by Mr. Ukil. It has been noticed that when CO_2-free moist air is aspirated through a column of flowers of sulphur, washed free of acid, the sulphur is oxidized to SO_2 at the rate of 1 part per 46,000 parts air. Even when flowers of sulphur are kept in a moist condition for any length of time, there is slow oxidation, and the more intimately it is mixed with water, the greater is the oxidation.

Since plants often give out CO_2 and since sulphur is sprinkled on plants in the open, where the temperature of action is high owing to the sun's rays, the oxidation of sulphur at a temperature of 45°C., in the presence of CO_2, in slightly acid media and in the presence of carbohydrates was studied. It has been found that the rate of oxidation of sulphur increases with the rise of temperature and the presence of CO_2. A slightly acid media helps the rate of oxidation, whereas carbohydrates retard it. The rate of oxidation under the above conditions varied from 1/21000 to 1/11500, a concentration much higher than what is supposed to destroy the organism effectively, and no formation of sulphuretted hydrogen was noticed.

Effects of application of nitrate to wheat. Field experiments to investigate the effect of application of nitrate to wheat plants at different stages of growth were continued. Year before last it was observed that the addition of nitrate eighteen weeks after sowing produced no effect. It was, therefore, decided to discontinue this application and to use the nitrate only at three stages, *viz.*, at sowing time and at intervals of six and twelve weeks after sowing.

In order to study the effect of the nitrate passing down to different depths, last year two sets of experiments were carried out, one where $\frac{1}{4}$ inch of irrigation water was used

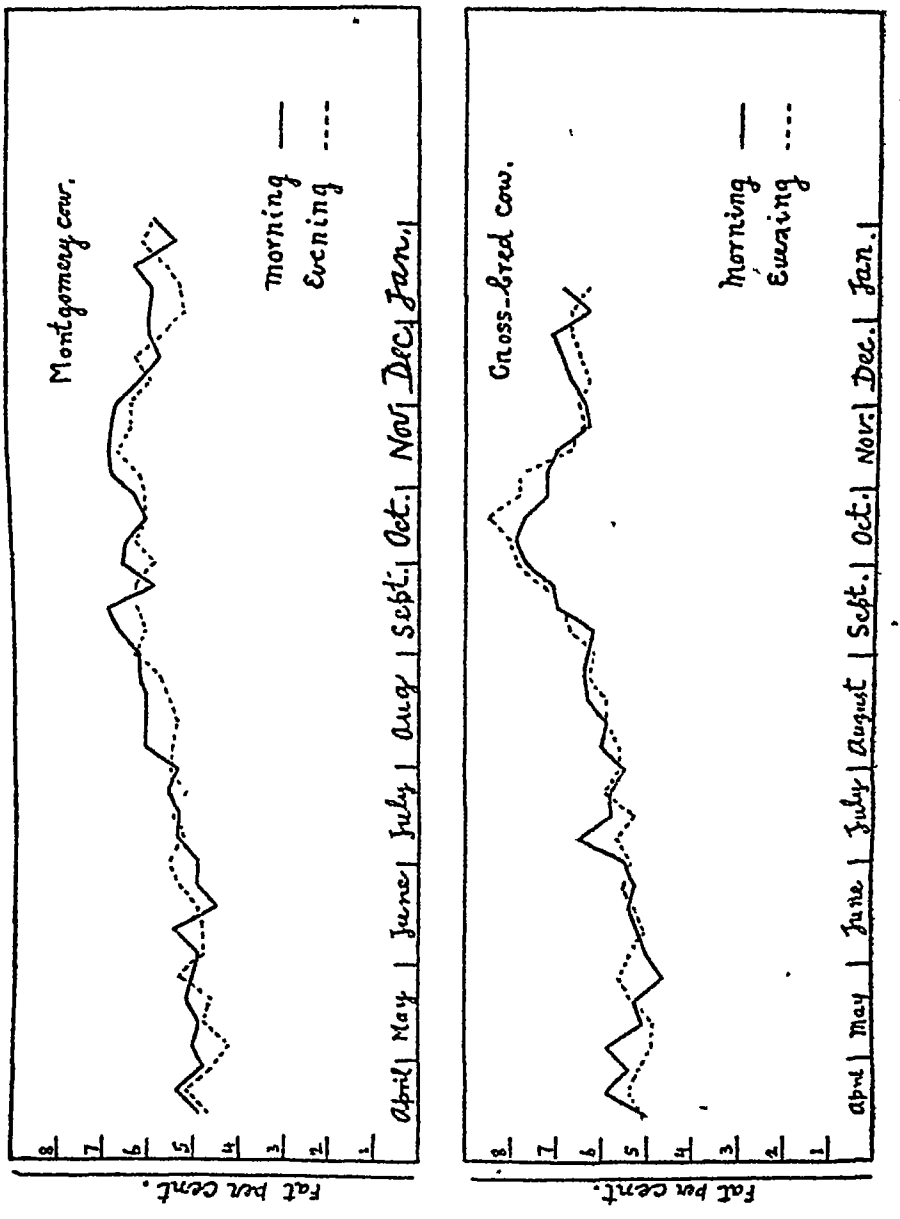
at the second and the third applications of nitrate and another where 2 inches of water were used each time. During the year under review, the experiment was repeated but instead of two inches of water, only ½ inch of water was used.

The results obtained in previous years and this year show that irrigation to the extent of 2 inches does not influence the nitrogen content of the wheat, the percentage of nitrogen in the wheat from unirrigated and unmanured plots being the same as the percentage from irrigated and unmanured plots of the same season. It is further noticed that the application of nitrate of soda, at any time up to 12 weeks after sowing, results in an increase of nitrogen in the grain.

Adsorption of moisture by soil. Dr. Sen continued his studies on the relation of the clay content of soils to their moisture adsorption. It has been found that the adsorption of moisture by a soil depends on the amount of clay contained in the soil, the relation between the two being of the nature of a log-log curve. The relation is, however, subject to a deviation due to the difference in temperature of observation, and in the character of the individual soils. The work may possibly prove to be of some value as a means of differentiating between varying types of soils.

Variations in the fat composition of the milk from selected cows. Samples of milk of four selected cows, two from the Montgomery breed and two from the cross-bred (Montgomery-Ayrshire), were daily examined twice for their fat content. The observation extended in each case throughout the lactation period. It was noticed that the percentage of fat varied from 3·0 to 7·5 in case of the two Montgomery and from 2·8 to 8·6 in the case of the two cross-bred cows, and that the variation between the morning and the evening milk of the same cow was from 3·0 to 7·0. It was also observed that there was a gradual rise in the fat content of each of these cows between the fifth and the seventh month of their lactation period followed by a slight fall towards the close. A chart showing the weekly

average fat percentage of morning and evening samples of one of each breed is attached to this report and shows the last point referred to above.



The movement of nitrates in the soil and sub-soil. As in previous years, the main energies of the Section have been directed towards this investigation; 1,404 samples of soil have been taken during the year and examined for their moisture and nitrate contents.

The report submitted last year carried the observation to the end of June when we had about 3 inches of rain and the nitrate was mostly at the surface within a depth of one foot. With more rain the nitrate was gradually washed down to the deeper sub-soil, and by the middle of September with a total rainfall of about 20 inches the nitrate passed into the layers 6—8 feet in the more open type soil column and down to sixth foot in case of those columns which contained heavy sub-soil layers.

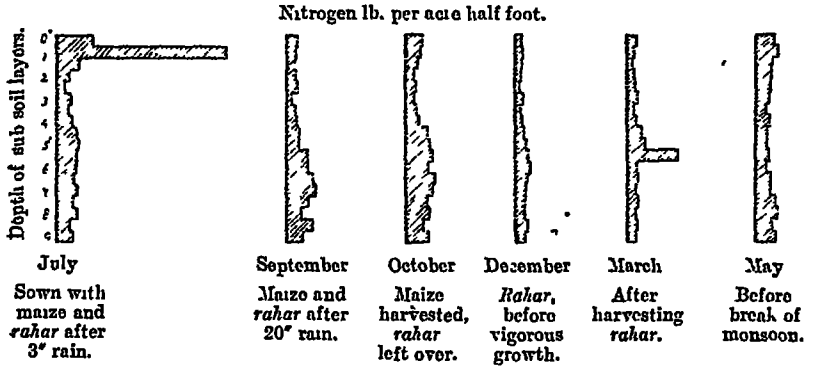
The rainfall during the year was abnormally low and, unlike the year previous, there had not been so much washing down of the nitrate into the layers below the depths to which boring had been taken. Still it was noticeable that the quantity of nitrate in the column had been considerably reduced and much nitrates had been carried into the deep sub-soil layers beyond the root range of crops. During the ensuing period of dry weather, nitrification occurred in the surface soil but the distribution and quantity in the sub-soil layers was not materially affected until the cold weather crop was fairly mature. It was noticeable that the crop throve well until by early December the nitrate in the soil layer was used up, and there was a check in the growth. In January, however, the growth revived and the crop put on a healthy appearance, and it was noticed that the nitrate in the lower layers was being utilized. The evidence obtained, however, was not in favour of any marked upward movement of nitrate.

The investigation, so far, shows and confirms previous year's observations that the distribution of nitrates through the sub-soil is determined by climatic factors and the physical character of the sub-soil layers, and the growth of the crop in turn depends to a considerable extent on this distribution of nitrate. The investigation has now been carried

through two complete years comprising one very good and very bad monsoon periods, and the results are now being collected and tabulated. Mechanical analysis of soils and sub-soils down to 9 feet of all the five plots under observation has been completed, and the analytical data obtained is expected to afford means of correlating the movement of nitrate and its concentration at various depths with the physical character of sub-soil layers.

The investigation has just been extended to a new series comprising (1) land permanently under pasture, (2) bare fallow land, (3) irrigated land, and (4) land under sugar-cane. The remarkable feature noticed hitherto has been the formation of nitrate in the surface layers, both in land under pasture and in bare fallow land, with the advent of monsoon and the washing down of the nitrate into the sub-soil layers 3½—4 feet in the pasture and to fifth foot in the fallow land after a heavy rainfall which totals to about 20 inches at the time of writing.

A diagram giving a few of the results obtained during the year under review forms the text-figure.



VI. Programme of work for 1924-25.

Major subjects.

(1) Continuation of the investigation into the amount and nature of drainage water from cropped and fallow land.

(2) The influence of manuring on the composition of crop.

(3) The estimation of the available P_2O_5 by means of *alkaline carbonate solution in calcareous and other types of* soils and its correlation with cropping value and manurial reaction.

(4) The movements of nitrates and water in Pusa soils.

(5) A study of the chemical and physical factors involved in combined applications of green manures and superphosphates.

(6) Further investigations into the possibility of sugar-beet cultivation in Bihar.

(7) Variations in the quality of the milk from selected cows.

Minor subjects.

(1) A comparison of the accuracy of various analytical methods.

(2) Analytical work for other Sections.

VII. Publications.

Harrison, W. H. . Report on Agricultural Chemistry, 1922-23, for the Board of Scientific Advice.

Harrison, W. H. . Report on Agricultural Chemistry, 1923-24, for the Committee of the Privy Council for Scientific and Industrial Research.

Mukerji, J. N. . Carbon-dioxide in Soil Gases. *Agri. Jour. India*, Vol. XIX, Part 2, 1924.

Sanyal, P. B. . A method for the accurate determination of carbonic acid present as carbonate in soil. *Pusa. Agri. Res. Inst. Bull.* 151.

REPORT OF THE IMPERIAL AGRICULTURAL BACTERIOLOGIST.

(C. M. HUTCHINSON, C.I.E., B.A.)

I. ADMINISTRATION.

I held charge of the Section during the year under report.

Mr. J. H. Walton, Assistant Bacteriologist, returned from combined leave and resumed his duties on 11th February, 1924.

Mr. N. V. Joshi, First Assistant, acted as Assistant Bacteriologist during the period Mr. J. H. Walton was on leave.

II. TRAINING.

Mr. K. R. Narayana Iyer, Agricultural Chemist, Travancore State, was under training in agricultural bacteriology in this Section from 4th April, 1923. He finished his course and was relieved from this Section on 7th April, 1924.

Mr. Sanyasi Raju, a private student from Coimbatore, was admitted in this Section to undergo a course of soil bacteriology from 7th October, 1922. He finished his course and was relieved on 29th May, 1924.

Mr. Ko Ko Gyi, Assistant to the Agricultural Chemist, Burma, is under training for a course of agricultural bacteriology from 14th October, 1922.

III. SOIL BIOLOGY.

Nitrogen fixation. Further observations of the conditions under which fixation of nitrogen by so-called non-symbiotic organisms takes place were carried out. Fixation of nitrogen requires a supply of phosphoric acid which can be furnished in the form of mineral phosphates either as rock phosphate, basic slag, superphosphate or pure tricalcic phosphate, or by bonemeal. The last named gives

higher fixation figures than the mineral phosphates; the acidity of superphosphate appears to be responsible for an adverse effect when using this source of P_2O_5.

Nitrogen fixation is increased by the addition of rotted organic matter (green manure—*Crotalaria juncea*) to the soil; this increase is not obtained if excess of organic matter is used, apparently owing to loss of nitrogen due to ammoniacal fermentation.

Field experiments were carried out to confirm previous laboratory and pot culture tests of the use of various substances found to increase the rate and amount of nitrogen fixation in soil measured in terms of fertilizing action on a crop. On maize the action of fermented and unfermented (rice) straw was compared with that of cattle manure, the fermented straw giving greatly increased yields as against cattle manure in equal quantities. Fermentation of the straw was carried out in the same manner as that previously recommended for green manures and gave a satisfactory product without any addition of nitrogenous compounds. The residual effect of the fermented straw, on the following oat crop, was again better than that got with cattle manure.

Sugarcane trash added to soil does not appreciably increase the rate of nitrogen fixation, but does so if previously treated with a bacterial inoculum in the form of a water extract of cow manure.

Rice dust as an organic manure is liable to very rapid ammoniacal fermentation with consequent nitrogen loss, so that as a promoter of nitrogen fixation allowance must be made for such loss and ammoniacal fermentation reduced by proper attention to water supply.

Nitrogen-fixing organisms in artificial culture gradually lose their nitrogen-fixing power; thus in 19 months as much as two-thirds of the original power was found to be lost in the case of azotobacter, various nodule (*radicicola*) organisms and certain aerobic manure organisms. Rejuvenation of the soil organisms could be obtained by ino-

culation into soil and subsequent recovery by plating after one month. The addition of mannite to the soil increased the rejuvenation effect with azotobacter, and rotted organic matter produced a similar increase with the manure organisms. The nodule organisms, however, showed but little recovery after incubation in soil and would probably require passage through appropriate host plants to secure this effect.

Nitrification. Further work was done by the First Assistant on the activation of the nitrification of cattle urine, and a practical method of conservation and use of this source of nitrogenous manure was elaborated; a description of this method was given in a paper read by the First Assistant at the Indian Science Congress at Bangalore, which will be shortly published in the " Agricultural Journal of India."

Studies of pure cultures of several strains of the nitrate-forming organism were made, and it was observed that this organism is capable of living and functioning in presence of large amounts of organic matter, provided the concentration of nitrite nitrogen is kept low. It has been found that in order to secure continued activity of the nitrate-forming organism in culture the concentration of nitrite in the culture medium should be kept at a level of 20 mg. nitrite nitrogen per 1,000 c.c. in place of the 200 mg. originally recommended by Winogradsky.

The nitrification of bone manures which is ordinarily a very slow process in most Indian soils was studied, and it was found that rapid and complete nitrification of this refractory material could be obtained by previous fermentation before applying to the soil, thus resembling the treatment of green manures and other organic residues recommended, as a result of work in this laboratory, some ten years since.

Green-manuring. The combined use of sann-hemp (*Crotalaria juncea*) as a green manure and a source of fibre was further studied, and it was found that cutting off and burying the tops of the plants in place of removing all the

leaves from the stem gave equally good manurial results; this method is recommended as involving less labour and expense, the latter not being more than Rs. 3 per acre with a yield of from 5 to 6 maunds of fibre.

Further work was done on the problem of the role of soil bacteria in the provision of available phosphate in the form of organic phosphorus compounds as a result of the interaction of green manures or other decomposing organic matter and phosphatic manures such as superphosphate. The marked influence of green manures upon the fertilizing power of super was referred to in my report on green-manuring experiments at Pusa, and the suggestion was made that the formation of organic phosphorus compounds as a result of bacterial action was a probable factor in this result. Experiments on a quantitative basis showed that bacteria in cultures, both pure and mixed, are able to take up large amounts of P_2O_5 from various sources, this phosphate being then stored in the form of organic compounds as part of the bacterial cell; this supply of P_2O_5 in the soil would probably persist in the organic form and as such remain relatively available as plant food. This line of enquiry must be carried much further before satisfactory conclusions can be drawn as to the practical quantitative aspects of this source of available phosphate in field soils.

Further quantitative studies of the decomposition of cellulose by aerobic symbiotic organisms were made with special reference to possible simultaneous nitrogen fixation by such organisms; these have not yet arrived at a stage for report.

The presence of urease in the nodules of various leguminous plants was demonstrated; this enzyme, however, was not found active in liquid cultures of the *radicicola* organisms but was so in solid cultures on soil extract mannite agar.

No urease was found in the roots of plants grown in sterile soil, whereas it was present in small amount in those of plants grown in normal soil. Further experiments sug-

gested the conclusion that urease is developed as a result of the reaction between the *radicicola* organisms and the root tissues of plants not necessarily legumes; some traces of the enzyme were also developed by the activity of such organisms as *B. subtilis* in contact with plant roots.

These observations are of interest in view of the possible future utilization of urea as a manure and the necessity of the presence of urease to make it available as a plant food.

Solubilization of mineral and other phosphates. Work on this subject, previously described and reported on both in my annual report for the previous year and in a paper published in the "Agricultural Journal of India" (Vol. XIX, Part I, 1924) was continued, with particular reference to the use of bonemeal as a source of phosphate. It was found that fermentation of bonemeal as a preliminary to nitrification of its content of organic nitrogen, although giving more rapid and complete nitrification than simple admixture with soil, as in field practice, yet involved some loss of nitrogen owing to the rapid ammoniacal fermentation produced. The addition of appropriate amounts of sulphur, however, to the compost gave nearly double the amount of nitrate, presumably as a result of nitrification of the ammonium sulphate formed by interaction with the oxidized sulphur.

A compost of bone dust, sulphur and sand inoculated with a mixed culture of sulphur-oxidizing bacteria was found to contain citrate-soluble phosphoric acid to the amount of 94 per cent. of its original content after a period of 23 weeks' fermentation.

It was found that an excess of sulphur as compared with phosphate (as bonemeal) in the compost was preferable to the reverse; thus by gradual addition of bonemeal to the compost better results were got than by gradual addition of sulphur, the total relative final amounts remaining the same.

The utilization of indigenous phosphates and of the sulphur composting method was made a subject for dis-

cussion at the meeting of the Board of Agriculture in Bangalore in February 1924.

IV. Dairy Bacteriology.

The bacteriological examination of the milk supplied by the Pusa farm was started in March and is being carried out regularly on not less than three samples each of morning and afternoon milk.

The methods adopted to secure cleanliness of utensils, cows, and milkers are so far successful that, in spite of the character of the milking shed, and the use of open top pails in the dusty days of the hot weather, samples of the afternoon milk, which is on sale within an hour of the commencement of milking, showed that customers were supplied with milk giving plate counts of bacteria as low as 2,500 per c.c., with no *B. coli* in 1/10 c.c., and counts as high as 10,000 per c.c. were the exception.

The counts of the samples taken from the morning supply were anything from fifty to a hundred times as great as those of the afternoon supply, owing to the fact that milking is finished by 2—3 A.M., on account of a portion having to be despatched by train, and the samples were taken at about 6 A.M., when customers were being supplied, and there are no means of keeping the milk cool.

Morning milk invariably gave higher counts than the milk of the afternoon before, which had been kept at 50° —60° F. for 24 hours, and the counts fluctuated with changes in the night temperatures.

Results up to the present indicate that the high temperature of the hot weather is, in that season, the chief influence causing excessively high counts in milk a few hours old, and that the provision of an efficient cooler would allow of the sale of milk of grade A quality.

V. Disease of Betel-Vine in Bengal.

A widespread disease of the betel-vine plantations in Bengal was referred to Pusa for examination and advice by the Director of Agriculture, Bengal. Diseased plants were

found to contain numerous bacteria in the water vessels of the stem: in order to test their possible pathogenicity it was necessary to grow betel-vines at Pusa for artificial inoculation after securing pure cultures from the diseased material. Two *pan baris* or plantations were made and planted in the experimental area of the Bacteriological Section, and after healthy growth of plants had been secured, inoculations from various cultures of bacteria isolated from diseased plants were carried out; results are still being awaited at the time of writing. I visited various plantations in the Howrah District suffering from disease, and made arrangements with the Deputy Director of Agriculture, Western Circle, Bengal, to carry out sterilization of the soil by burning with a view to removal of infection, which is apparently associated with the peculiar conditions obtaining in the plantations, resulting from the highly insanitary methods of treatment of the soil. The plants are grown closely crowded together, and when they reach a certain age, the creeping vines, which are trained on vertical supports, are pulled down and buried in the soil round the remaining root stock from which fresh shoots are then grown. Heavy dressings of organic manures, such as oil-cake, and of tank silt are applied; no rotation or fallowing is adopted, the vines being grown year after year on the same soil. Drainage is frequently defective and efficient tillage is similarly neglected. The p^H of the soil was found to be on the alkaline side of neutrality, providing highly favourable conditions, together with the high concentration of organic residues, for bacterial growth; a similar condition in the soil is known to be favourable to the spread and activities of *B. solanacearum* as a parasite of tobacco and tomatoes.

It is noteworthy that this disease in betel-vines, so far as I have been able to ascertain, is at present unknown in Bihar, where rotation and fallowing, and the proper drainage of the soil, are regularly practised by cultivators. Owing to the highly conservative character of the particular class who cultivate this crop in Bengal, it will pro-

bably be difficult to persuade them, even to save themselves from ruin, to adopt such a drastic measure as burning the soil and with it the whole of the plants and other appurtenances of the *pan boroj*, but in view of the condition of the soil and the probably intensive nature of the bacterial infection therein, this appears to me to be the only possible and immediate remedy, the alternative being a prolonged period of rotation and fallowing.

VI. E. C.

The appointment of a special chemist by the Government of Bihar and Orissa for the preparation of this antiseptic, with the use of the apparatus belonging to that Government at present installed in this laboratory, has permitted the extension of supplies to all the principal jails in the province as well as to various hospitals. Removal of part of the apparatus from Pusa to another centre is being arranged for together with installation of fresh apparatus at various others.

VII. Bed Bug as a possible carrier of Kala-azar.

Further work was done on the cytology of the bed bug (*Cimex hemipterus*) as a possible carrier of *Kala-azar*; this work was partly carried out in the laboratories of the Pasteur Institute at Shillong by kind permission of the Director, and with the help of Major Shortt, I.M.S., on special duty with the *Kala-azar* enquiry. A paper embodying my results has been submitted for publication by the Board of Medical Research.

VIII. Programme of work for 1924-25.

Major.

Soil biology—

This will include continuation of the work above reported on nitrogen fixation, nitrification, solubilization of indigenous phosphates, and the role of soil bacteria in modifying the supply of available phosphates to crops.

Training of students.

Industrial biology—

Work will be done on dairy bacteriology.

Minor.

Bacterial diseases of plants.
Biological analyses of soils.
Minor industrial researches.

IX. Publications.

Hutchinson, C. M. . An improved form of Kjeldahl apparatus. *Agri. Jour. of India*, Vol. XVIII, Pt. 4, July 1923.

,, The Utilization of Indigenous Phosphates in India. *Agri. Jour. of India*, Vol. XIX, Pt. 1, January 1924.

,, Report on Agricultural Bacteriology, 1922-23, for the Board of Scientific Advice.

,, Report on Agricultural Bacteriology, 1923-24, for the Committee of the Privy Council for Scientific and Industrial Research.

Walton, J. H. . . Indigo Experiments, 1922. I—The effect on produce when vat liquor is allowed to stand in the beating vat and beating is delayed; II—Effect of neutralizing the liquor with caustic soda before beating. *Indigo Publication* No. 12 (1923).

REPORT OF THE IMPERIAL MYCOLOGIST.

(W. McRae, D.Sc., F.L.S.)

I. Charge and Establishment.

I held charge of the Section throughout the year and Dr. F. J. F. Shaw was Second Imperial Mycologist. On 16th of March, Dr. Shaw left the Section to take up the acting appointment of Imperial Economic Botanist, and the post of Supernumerary Mycologist was abolished.

II. Training.

Mr. D. Rhind, the recently appointed Government Mycologist, Burma, worked in the laboratory from 5th November, 1923, to 25th January, 1924, to familiarize himself with Indian parasitic fungi as represented in the herbarium. During the same time, his assistant, Mr. L. N. Seth, B.Sc., received a training chiefly in laboratory methods. Mr. Bal Singh, B.Sc., a research student, was given an elementary training in diseases of fruit trees and their prevention during two periods amounting to two and a half months.

III. Diseases of Plants.

(1) *Cereals.* Mr. Mitra's work on the genus *Helminthosporium* was continued. Three species, *H. sativum*, *H. teres*, and *H. gramineum*, have been determined on *Hordeum sativum*, and two, *H. sativum* and an undescribed species, on *Triticum vulgare*. Under *H. teres* has been diagnosed what formerly was considered as a variety but now is definitely determined as *H. sativum*. The possible connection between *Helminthosporium* and a foot rot of wheat was investigated but so far inoculation experiments have not given conclusive results. A species of *Helminthosporium* on *Zingiber officinale* has been brought into culture and is being investigated. Frequently it does a

small amount of damage but this year it adversely affected the crop very considerably. In inoculation experiments it readily infects wheat, barley and oats.

(2) *Cucurbitaceæ*. The study of *Pythium* on various species of Cucurbitaceæ was continued. In addition to the strains got last year, two have been isolated from *Cucumis sativa* and *Trichosanthes dioica* respectively. All the strains appear to be of one species belonging to the gracile group and closely related to *P. Butleri*.

(3) *Jute*. Dr. Shaw's work on the identity of the fungus causing stem rot in jute was brought to a conclusion. The fungus which has been identified in Japan as *Macrophoma Corchori* appears to be identical with that which has been worked with in this country as *Rhizoctonia Solani* Kühn. The pycnidial stage of this fungus appears to be restricted to the jute plant and never occurs in artificial culture. Cultures on artificial media, using the spores from a pycnidium as inoculum, always give the sclerotial stage. Cultures of this sclerotial stage were sent to America and were there pronounced to be identical with *Sclerotium bataticola* Taub. The systematic position of the fungus is more fully discussed in a paper dealing with this disease.

The physiological work commenced last year on diseases of jute was continued. Since the incidence of stem rot (*Macrophoma Corchori* Saw.) is largely determined by the amount of potash available for the plant, the research was designed to test the growth of the causal fungus in culture media containing varying quantities of potassium. A series of experiments was arranged in which the fungus would be grown in liquid culture media and the resulting growth made in a certain fixed time, filtered off and estimated by weighing. In this new line of work unforeseen difficulties of experiment and manipulation rendered progress very slow in the initial stages. The standard medium employed was a modification of Richard's Solution in which the monobasic potassium acid phosphate was

replaced by the corresponding salt of calcium. This solution then had the following composition :—

Potassium nitrate (KNO_3)	1 grm.
Calcium phosphate monobasic ($Ca H_2 (PO_4)_2$) .	0·5 ,,
Magnesium sulphate ($MgSO_4$) . . .	0·25 ,,
Saccharose	3·43 ,,
Water	100 c.c.

Such a solution proved to be too acid for the growth of the fungus, and it was therefore necessary to bring this medium, and all other media used, to a certain fixed hydrogen-ion concentration by means of an indicator and the addition of lime water to the solution.

Each culture consisted of 50 c.c. of the medium in a 200 c.c. flask, and each culture was infected from a glucose-agar slant which was 48 hours old. All cultures were kept in darkness at 34-35° C. In the early cultures it was found that there were very wide differences in the weight of fungus produced by the individuals of a number of cultures on the same medium. This was, in part, traced to inequalities in the amount of the inoculum and was, to a certain extent, eliminated by inoculating each flask with as large a piece of mycelium as possible and by putting up 18 cultures with the same medium at one time and taking the average of the weights of fungus produced. Each set of 18 cultures was repeated at least three times.

With the full culture solution of the above composition the averages of the weights of fungus produced in four sets of 18 cultures each were :—0·679, 0·684, 0·672, 0·696 grm. We may consider 0·684 grm. as being the normal weight of fungus produced in 50 c.c. of this medium at 34° C. in a certain fixed time. This period was fixed at 8 days, it having been determined that after 8 days there was no further increase in growth.

In a second experiment the solution was changed by substituting calcium nitrate for potassium nitrate; this solution therefore was completely free from potassium. This substitution caused a difficulty as a precipitate was

thrown down on sterilization. It was therefore necessary to prepare a separate solution of calcium nitrate and add it to the remaining ingredients in the cold, after sterilization. The averages of the weights of fungus produced in three sets, each of 18 cultures, in this medium were:—0·190, 0·185, 0·179 grm. A very appreciable growth of the fungus had therefore resulted in the absence of potassium. Spectroscopic examination both of the original solution and of the filtrate after removing the fungus failed to show the presence of potassium.

In a third experiment half the quantity of potassium nitrate was used, the balance of nitrate being made up by the addition of calcium nitrate. The average of the weights of fungus produced in five sets of 18 cultures were:—0 753, 0·728, 0·698, 0·702, 0·713 grm. With the reduced quantity of potassium, therefore, a slightly higher weight of fungus was produced.

This research will be carried on during the following year. In addition to the main line of investigation, several promising side lines, such as staling and variations in the rate of growth, due to some property innate in the organism, will be investigated.

In conjunction with the culture work with the fungus a set of field experiments has been started. In these experiments different plots of jute will receive different manurial treatment. During the year under review jute was grown in six new plots with a manurial treatment to test the uniformity and comparability of these plots before the introduction of any varying factor.

(4) *Rahar*. Progress was made in elucidating the factors governing the *rahar* (*Cajanus indicus*) wilt problem and in interpreting the data given by existing field experiments. That the amount of *rahar* wilt due to seed-borne spores is small was proved by experiment. Seed sufficient for one acre of a selection susceptible to wilt was treated with two per cent. formalin for twenty minutes to kill spores adhering to the seed, while seed for another acre

was untreated. The plants were regularly spaced in the plots. In the first case two plants became wilted or 0·04 per cent. of the plants in the plot, while in the second case 66 became wilted or 1·4 per cent. The soil was presumably free from *Fusarium udum* as *rahar*, the only known host plant of this fungus in Pusa, had not been grown in the plots since 1908. This shows that a small amount of wilt in a season comes from new infection of the soil by spores brought with the seed. Again in searching for spores on the seed great difficulty is found in securing them quite apart from the tediousness of the process.

The distance to which the disease " extends " in a season is nine feet. A plot on which *rahar* had not been grown and to which no manure had been given for over ten years was divided into two. One half was infected and the other was not. A piece of *rahar* stem three inches long containing living fungus was buried two inches below the surface in alternate inter-rows between every four plants. Each row contained thirty-two plants with an interval of 2·5 feet between each plant. Of 320 plants in the infected plot, 294 wilted, *i.e.*, 92 per cent. Of the twenty-five plants that were not wilted, twenty-three produced seed which was collected plant by plant, and this will be tested in the coming season for possible resistance to wilt. Of 352 plants in the uninfected plot, twenty-nine were wilted and were adjacent to the infected plot, while a group of four plants were wilted and were situated at the edge of the plot farthest from the infected plot. The record shows that plants gradually wilted from the infected plot towards the interior of the uninfected plot. This indicates that the plants in the uninfected plot were infected from the infected plot by means of their roots extending into the infected plot to the source of infection (a buried piece of *rahar* stem) and extending to plants infected from that source. Roots of twelve wilted plants washed out during the season were found to extend to a maximum distance of 6·5 feet from the stem. The distance of the far-

thest wilted plant in the group adjacent to the infected plot was nine feet from a source of infection. Thus only an intermediate plant was required to step this distance though as a matter of fact there were two wilted plants in the interval. The isolated group of four wilted plants most probably became infected accidentally from some other source unknown.

Applying this observation to the thirteen plots in South Pungarbi field all of which are laterally contiguous and each of which is 19·5 feet broad and has nine rows of plants, we see that six rows in each plot are subject to the influence of the presence of the fungus in adjacent plots. This experiment as designed does not and cannot show the influence of the various chemicals on the incidence of *rahar* wilt. It therefore practically becomes a comparison between the influence exerted by the presence or absence of green manure on highly infected land that has had a dressing of superphosphate without indicating what influence, if any, superphosphate may have.

When this series of plots was begun the land was highly infected artificially and most of the plants died. In the next *rahar* season the death rate was also high and in the third it was about the same, *viz.*, 95 per cent. We know that on unmanured highly infected land the death rate may be 92 per cent. So that the death rate on the superphosphate plots may not be due to the presence of superphosphate but to high infection that has continued for three successive seasons. Taken as a single-plot comparison between the presence and absence of green-manure on highly infected land that has had a dressing of superphosphate, we see that green-manure has a depressing effect on wilt, for whereas the no-green-manure plot has 95 per cent. wilted, the green-manure plot has only 70 per cent.

The fact that the South Pungarbi plots are unsuitable for testing the influence of various chemicals on the incidence of wilt on *rahar* does not affect their value with

regard to the other crops, maize and oats, in the rotation. A new series of thirty plots have been laid down, each 51 by 156 feet with an interval of seventeen feet between each plot. In the first year the land is being tested by sowing disinfected seed of a susceptible selection and marking the position of wilted plants. Subsequently the plots will be arranged to test the influence of superphosphate and green-manure on the wilt. Four plots of a quarter of an acre each free from the wilt fungus, as tested this year with a susceptible selection of *rahar*, have been chosen from among several tested this year. They are being paired, superphosphate at the rate of 4 cwt. per acre against no superphosphate, and each plot is being infected along a line down the middle to observe the rate of extension during probably three or four years. The record of the incidence of wilt on the Permanent Manurials is consonant with that given in last year's report. *Rahar* as a leguminous crop will henceforth cease to form part of the crop rotation.

From observation made this season it does not appear that there is any difference in the root system of plants in the superphosphate plots as compared with those in the no-manure plots. All plants examined had deep roots and shallow roots and the latter were not more developed on the superphosphate plots. Attention will still be paid to this point as its definite solution has considerable bearing on the problem, for the first infected root is nearly always a surface root. The moisture-content of the soil down to 2 feet was found for all the 16 plots in the Permanent Manurials during December when the plants were wilting in greatest numbers, but the number of wilted plants were not correlated with the moisture-content of the plots. The hydrogen-ion concentration of the soil in the various plots up to 2 feet in depth was fairly uniform.

The physiological work begun last year to test the effect on the growth of *Fusarium udum* of various concentrations of phosphate in liquid culture media was continued on

lines similar to that on jute just mentioned and need not be further noted here.

(5) *Gram wilt.* Pot culture experiments carried out with the 12 strains of *Fusaria* isolated from wilted gram plants from various parts of India did not yield any definite results. In two cases there was infection but the disease did not progress. The reasons for the failure of the experiment may be that (1) the local variety of the gram used in the experiment may be immune to the disease—and there is some independent evidence of this—or (2) climatic conditions. *Fusarium Lycopersici, Fusarium Lini, Fusarium Conglutinans* require a comparatively high soil temperature for successful infections. The minimum temperature required for these fungi to infect plants is 21° C., 15° C. and 17° C. respectively and the optimum is about 280° C. for all three. It has been found in *F. Lycopersici* that even with the optimum soil temperature the disease did not progress if the air temperature is kept at 17° C. and the disease is inhibited below 21° C. and above 33° C. In Burma the mean minimum temperature during the months of January and February, the period when the disease appears in the field, varies from 18° C. to 24·5° C. The minimum air temperature in Pusa for the same period is 9° C. to 13° C., and the soil temperature at 6 inches below the surface for the same period varies from 14·7 to 17·5° C. Considering the temperature data of the different *Fusaria* in conjunction with the low temperature of Pusa, one is inclined to conclude that no successful infections can be secured unless the temperature is controlled. The absence of gram wilt generally in the crop round Pusa is in accordance with such a view. It is only in the month of March we get the suitable temperature but the crop is almost ready for harvest by that time. Further work will be continued with the Burmese variety of gram which is susceptible to the disease.

(6) *Sugary disease of jowar* (*Sorghum*). Several attempts were made to cultivate this fungus (*Sphacelia*

Sorghi) on artificial media but none succeeded. The spores germinate in water and produce secondary conidia but soon die.

(7) A beginning was made in the study of disease of berseem (*Trifolium alexandrinum*), and a species of each of *Rhizoctonia*, *Fusarium*, *Vermicularia* and *Cercospora* has been isolated.

(8) In conjunction with the Imperial Agriculturist, seed oats for 102 acres were treated with 0·25 per cent. formalin. The seed was kept in bags in the solution for ten minutes, stacked in the bags for four hours, then spread out and dried. One hundred and twenty-four acres were sown with untreated seed. In the treated field there was not a single smutted ear-head, while in the untreated field there was 1·5 per cent. of smutted ear-heads.

(9) From arecanut palms affected by a bud-rot a species of *Thielaviopsis* was isolated in several localities. Cultures of this fungus, however, did not cause infection when tried in Dacca and Sylhet.

(10) The fungus *Metarrhizium anisopliæ* Sor. (*Penicillium anisopliæ* (Sor.) Vuilleman) was found attacking rhinoceros beetle grubs (*Oryctes rhinoceros*) growing in cages in Burma. The fungus was brought into pure culture, and inoculation experiments carried out in the laboratory on living grubs gave cent per cent. infection. The grubs become paralysed in 20 days and gradually died. On the grub's body, the fungus forms white patches which finally become dark green and powdery chains of spores collect into small flakes. Tried in manure-heaps it was not found very efficient in killing the grubs in the heaps, but a better knowledge of the habits of the grub may lead to more certain results.

IV. Systematic work.

Two hundred specimens from within and outside India were added to the herbarium. Two hundred and ninety-

six specimens of fungi on various host plants were prepared and sent to the Imperial Bureau of Mycology for final identification. Three hundred and eighty specimens and 20 cultures were supplied to workers in various parts of the world and specimens were sent to Imperial Bureau of Mycology, London, for an exhibit in British Empire Exhibition.

V. Programme of work for 1924-25.

(1) *Research work.* New diseases of Indian crops that come to the notice of the Section will be investigated. The following crops and diseases will receive special attention.

(*a*) Diseases of cereals.

(*b*) Diseases of sugarcane.

(*c*) Diseases of jute.

(*d*) Diseases of *rahar*.

(*e*) Diseases of grain.

(2) *Systematic work.* This will be carried out in conjunction with the Imperial Bureau of Mycology in London. Steps will be taken to print supplements to the list of specimens in the Pusa herbarium for the assistance of the Provincial sections of mycology.

(3) *Training.* Students and assistants will receive training on the lines indicated in the prospectus.

(4) *Routine work.* Advice and assistance as require will be given to other departments and the general public.

VI. Publications.

McRae, W. . . Report on Mycology, 1922-23, for the Board of Scientific Advice.

McRae, W. . . Report on Mycology, 1923-24, for the Committee of the Privy Council for Scientific and Industrial Research.

McRae, W. . . I. History of the Operations against Bud-rot of Palms in Southern India.

II. Inoculation experiments with *Phytophthora palmivora* Butl. on *Borassus flabellifer* Linn. and *Cocos nucifera*. *Mem. Dept. Agri. India, Bot. Ser.*, Vol. XII, No. 2.

Shaw, F. J. F. . Studies in diseases of the Jute plant. (2) *Macrophoma Corchori* Saw. *Mem. Dept. of Agri. India, Bot. Ser.*, Vol. XIII, No. 6. (*In the press.*)

REPORT OF THE IMPERIAL ENTOMOLOGIST.

(T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.)

I. Administration.

The Imperial Entomologist held charge of the Section throughout the year. Mr. G. P. Pillai was appointed temporarily from 16th February 1924 to act as Assistant *vice* Mr. D. Nowroji on leave.

II. Training.

Mr. F. D. Peries, a student deputed by the Ceylon Government, was under training in Agricultural Entomology throughout the year. Mr. S. S. Mukherji, M.Sc., was admitted as a post-graduate student from 1st November 1923. Mr. T. V. Venkatakrishna, L.Ag., was admitted from 6th February 1924 for a twelve-month's course in Agricultural Entomology. Sardar Bal Singh, sent by the Punjab Government, was given a month's special course of Fruit Pests from 11th September 1923 and attended again for a few days in December. Mr. A. B. Misra, M.Sc., worked in the laboratory on Systematic Entomology for three months from 1st May 1924. Mr. H. D. Nangpal, M.Sc., was deputed by the Central Cotton Committee to study Cotton Pests for two months from the beginning of June 1924. Two other students were also put through the short practical course in Lac-culture. Eight students in all were therefore under training during the year.

III. Insect Pests.

Continuous observation was made throughout the year on the crops grown on the Pusa Estate, with special reference to sugarcane and other Gramineæ, and large numbers of pests were reared in the Insectary, but no new cane-

borers were found. The following pests were especially noted during the year :—

Caterpillar pests on sugar-beet included *Diacrisia obliqua*, *Amsacta lineola*, *Prodenia litura*, *Psara bipunctalis* and an unidentified Pyralid.

Euproctis subfasciata larvæ on cabbage-leaves, an unusual foodplant.

Termites attacking sugarcane, roses, cauliflower seedlings.

Scirpophaga xanthogastrella boring sugarcane.

Monophlebus contrahens on peach, plum and mango. There was a decided increase this year, after a great reduction in numbers five years since.

Pseudococcus virgatus on rose, violet.

Aulacophora abdominalis on melons and gourds.

Hypera spp. on lucerne.

Crocidolomia binotalis and *Hellula undalis* on cabbage, knolkohl, and cauliflower seedlings.

The study of Fruit Pests was continued, the Fruit Pests of Kashmir being specially studied from May to October 1923 by the Imperial Entomologist and Mr. G. R. Dutt, who have submitted to the Kashmir State Government reports on the San José Scale and other Fruit Pests and these reports will presumably be published by the Kashmir State. Numerous specimens were received from various correspondents during the year but do not call for any special comment.

Pathological Entomology. Work under this heading has been continued mainly with reference to Veterinary Entomology in which connection materials are still being collected for a book dealing with the Insect Pests of Domesticated Animals in India. Three hundred and fifty copies of a circular regarding Warble-Flies were sent out to Veterinary Officers in Northern India and a few lots of specimens were received in response; from these it appears that the Warble-Fly attacking cattle in India is *Hypoderma*

lineatum, and not *H. bovis*, as was supposed hitherto. The Muscid and Calliphorine Flies sent to Major Patton for identification have not yet been returned and the want of proper identifications in these groups has delayed this section of the work. We are indebted to Mr. C. M. Inglis for procuring and sending us a small collection of Mallophaga taken from Indian Birds. Consideration of the *data* on the distribution and transmission of *Kala-azar* has led me to suggest species of *Culicoides* as probable vectors of this disease; in this connection I visited the endemic and non-endemic areas in Calcutta and pointed out probable breeding places to Major Knowles, who has since reared out examples of *Culicoides* which examination has shown to be *C. oxystoma*, Kieff., and a second species which is apparently *C. macrostoma*, Kieff. Mr. S. K. Sen has worked at Muktesar on the transmission of rinderpest by means of *Stegomyia* and *Musca domestica;* an account of this work will appear in connection with other work done at Muktesar on rinderpest.

Mr. P. V. Isaac, Second Entomologist, has continued his work on Tabanidæ and has worked out the life-histories of *Tabanus crassus*, Wlk., *T. bicallosus*, Ric., *T. tenens*, Wlk. (=*striatus*, auct. *nec* Fb.), *T. rubidus*, Wied. (=*albimedius*, Wlk.), *T. nemocallosus*, Ric., and *T. striatus*, Fb. (=*hilaris*, Wlk.). From a study of the larval habits and morphology of *T. tenens*, he has been able to show that Tabanid larvæ introduce their mandibles into their prey and suck the juices through a mandibular orifice, whence a canal runs through the mandible into the head and opens into a pharyngeal pouch, the true mouth being rudimentary and non-functional.

Work on the local mosquito-fauna has been continued. Owing to the presence of small fish and aquatic bugs few larvæ seem to breed successfully in the rice-fields around Pusa, those obtained being *Anopheles fuliginosus*, *A. sinensis*, *Culex vishnui* and *Chaoborus manillensis*. The mosquitos found breeding in wells in the Estate were *Culex fatigans*, *C. vishnui*, and *Anopheles rossii*. Some observa-

tions were made on the life-history of *Mucidus scatophagoides*, which is only seen on the wing about July, a large number of eggs is laid in confinement but none of them hatched although kept in water for several months, but if the eggs are opened artificially at the end of this time the larva is found to be still alive, emerges and develops normally, if supplied with other mosquito larvæ as food; it seems probable (although this remains to be proved) that the eggs are deposited normally in situations in which they become thoroughly desiccated and so remain until hatched by the first monsoon rains.

IV. Bees and Lac.

Bees. Advice and suggestions regarding Apiculture were given to numerous inquirers in different parts of India. Standard pattern hives were also made and supplied. As previously remarked, the subject of Apiculture in India requires the services of a whole-time expert if work is to be taken up seriously, as it should be.

Lac. The emergence of larvæ took place at Pusa on 12th October 1923 and 30th June 1924. On account of the unusually fierce heat this year, the June crop was adversely affected and the outturn very poor. Brood-lac was supplied to the Director of Agriculture, Ceylon; the Entomological Assistant, Konkan; Assistant Professor of Entomology, Poona; the Professor of Bio-chemistry, Indian Institute of Science, Bangalore; and the Executive Officer, Cantonment, Ahmadnagar. The Principal, Technological Institute, Cawnpore, wanted to carry on work on Lac dye, and 10 lb. of Ber stick-lac were despatched to him for the work.

Two show cases on Lac-culture were prepared for the Indian Lac Association for Research, Calcutta, and permanent mounts depicting the life-history of the lac insect were sent to Angelo Brothers, Calcutta.

Work on *Eublemma amabilis* was continued from last year. Its seasonal appearance and extent of parasitization were studied during the October-June season. Hitherto

search for its alternative hosts has not been successful, though *Eublemma* sp. (near *trifasciata*) was again bred from *P. corymbatus* on cotton shoots. The study of the parasites has also been taken up. An Encyrtid has been found to parasitize the adult females of the June-July crop to a very large extent and is being studied. Hitherto only the females have been bred out, and it is believed that, in the absence of the males which have not been found as yet, agamogenesis occurs in the species under study.

Bulletin No. 142, published last year, has sold well and only a limited number of copies of the edition are available now. Hence material for the fourth revised edition of the original bulletin is being collected.

V. Insect Survey.

Steady progress has been made in additions to, and arrangement and identification of, the collection of insect specimens, which, as it expands, becomes constantly more valuable for present and future work, and which is increasingly taken advantage of by the Provincial Staffs and other workers on Indian Entomology for the identification of their material.

The collections are in good order but an unduly high proportion is still contained in store-boxes which have proved very unsatisfactory for the proper preservation of insect specimens in a climate such as that of Pusa. A small number of cabinets is being obtained but at the present rate of progress it will be many years before all our valuable, and in many cases irreplaceable, material is placed in secure storage.

A number of collections have been sent out during the year to various specialists for examination and identification, and our thanks are due to all who have assisted us in this way.

Several lots of Odonata have been sent to Major F. C. Fraser who has returned them named and is describing the novelties.

The small collection of named Ephemerids has been loaned to the Zoological Survey for study.

The Dermaptera are still with Mr. Morgan Hebard.

Further lots of Acrididæ have been sent to Mr. B. P. Uvarov, who is revising the Indian grasshoppers. The collection of Acrydidæ is still with Mr. Hebard, as are also the Blattidæ and Mantidæ.

In Coleoptera, specimens of the following families have been sent out:—Chrysomelidæ to Dr. H. Scott for Mr. Maulik for preparation of a *Fauna* volume; Cicindelidæ to Dr. Horn; Meloidæ to Mr. K. G. Blair, also for preparation of a *Fauna* volume; Paussidæ to Zoological Survey of India; Gyrinidæ to Herr Ochs (returned named).

Of the Neuroptera a further small supplementary collection, mainly from Kumaon and Kashmir, has been sent to Mr. Esben-Petersen, who still has the bulk of our collection.

In Hymenoptera, the Encyrtidæ are still with Senor Garcia Mercet. The whole of our named collection of Hymenoptera has now been transferred into cabinets.

In Lepidoptera a further large amount of material has recently been sent to Mr. E. Meyric, and of Geometridæ to Mr. L. B. Prout.

In Diptera, the bulk of our Muscidæ still remains with Major Patton, to whom further material requires to be forwarded. Major Austen has kindly named some of our Tabanidæ and later accessions will be sent on to him shortly. A part of our collection of Tripulidæ and other Nematocera has been sent to Mr. Edwards and further material will be sent.

Numerous collections of Indian Insects have been received during the year and named as far as possible. These included collections sent by the Forest Research Institute, the Provincial Departments of Agriculture, the Bombay Natural History Society and many correspondents.

VI. Catalogue of Indian Insects.

Rather slow but steady progress can be reported under this heading. Parts on Nitidulidæ and Trypetidæ are now

in the press. The card catalogues and *Fauna* volumes have been kept up to date by current literature and many parts of the catalogue are in such an advanced state that they only require to be copied out for printing.

In Coleoptera, catalogues of Staphylinidæ, Scolytidæ, Platypodidæ, Bostrychidæ, Lyctidæ, Brenthidæ are completed, and of Carabidæ, Cicindelidæ, Cerambycidæ, Anobiidæ are in progress.

In Diptera, the catalogue of Muscidæ is nearly ready for publication.

VII. Programme of work for 1924-25.

Major.

This will follow generally on the lines of work of the current year and will include general investigations of crop-pests and especially of the pests of sugarcane, rice and cotton, of fruit-trees and stored grain, and also work on insect pests of domestic animals.

Minor.

Results in various lines require to be written up and published as far as possible; in particular, it is hoped to complete and issue a book on Veterinary Entomology in India. Work and experiments in Lac-culture will be continued and new insecticides and insecticidal methods tested as occasion arises. Systematic work will be carried out with our resources and the help of specialist correspondents. The Catalogue of Indian Insects will be proceeded with. Advice and assistance will be given as far as possible to Provincial Departments and to all inquirers on entomological subjects.

VIII. Publications.

The following publications, either prepared by the Pusa staff or founded in whole or in part on material sent from

Pusa, have actually been issued during the year ended 30th June 1924 :—

Bose, B. B. . . Life-history of *Danais limniace*, Cram., and its parasite. (*Rept. Fifth Entl. Meeting*, pp. 280-287, t. 26; May 1924.)

Fletcher, T. Bainbrigge. List of Publications on Indian Entomology, 1922. (*Pusa Bull.* 147; December 1923.)

" Lepidoptera of the Siju Cave, Garo Hills, Assam. Pyralidæ. (*Rec. Ind. Mus.*, XXVI, 113; January 1924.)

" The American Cotton Boll-weevil, a menace to India. (*Rept. Fifth Ent. Meeting*, pp. 58-64; May 1924.)

" Carbon Bisulphide not efficacious as a Mosquito larvacide. (*tom. cit.*, pp. 226-227.)

" Co-operation in Indian Entomology. (*tom. cit.*, pp. 382-387.)

" Publicity for Entomology in India. (*tom. cit.*, pp. 388-390.)

" Intestinal Coleoptera. (*Ind. Med. Gaz.*, LIX, 296-297; June 1924.)

Meyrick, E. . . Exotic Microlepidoptera, Vol. II, pt. 20 (March 1923); Vol. III, pts. 1 (June 1923) and 2 (July 1923).

Misra, C. S. . . The Citrus White-fly, *Dialeurodes citri*, in India and its parasites, together with the life-history of *Aleyrodes ricini*, n. sp. (*Report Fifth Entl. Meeting*, pp. 129-135; May 1924.)

" A preliminary account of the Tachardiphagous Moth *Eublemma amabilis*. (*tom. cit.*, pp. 238-247.)

" Observations on some Rhynchota from North India. (*tom. cit.*, pp. 300-317, tt. 29-30.)

" A list of Coccidæ in the Pusa Collection. (*tom. cit.*, pp. 345-351.)

Rohwer, S. A. . . Notes on Saw-flies, with descriptions of new genera and species. (*Proc. U. S. Nat. Mus.*, LIX, pp. 83-109; June 1921; recd. October 1923.)

Sen, S. K. . . . Observations on the Bionomics of *Aëdes* (*Stegomyia*) *albopicta*. (*Rept. Fifth Entl. Meeting, pp.* 215-225, *t.* 16; May 1924.)

Weld, C. J. . . Studies on Chalcid-flies of the sub-family Leucospidinæ, with descriptions of new species. (*Proc. U. S. Nat. Mus.*, LXI, Art. 6, pp. 1-42, 4 figs; June 1922; recd. October 1923.)

White, R. Senior . Notes on Indian Muscidæ: 1, Calliphorinæ Testaceæ; 2, Rhiniinæ (*Ind. Agr. Ent. Mem.*, VIII, No. 4; July 1923.)

A Revision of the Sub-family Sarcophaginæ in the Oriental Region. (*Rec. Ind. Mus.*, XXVI, pt. 3; May 1924.)

REPORT OF THE IMPERIAL AGRICULTURIST.

(WYNNE SAYER, B.A.)

I. CHARGE.

Mr. G. S. Henderson, N.D.A., N.D.D., held charge of the Agricultural Section except from 3rd April to 2nd November, 1923, when he was on leave on average pay, and from 14th April, 1924, to the end of the year when he was on deputation to Bihar Government as Director of Agriculture. During his absence I officiated as Imperial Agriculturist except for a period from 14th April to 4th June, 1924, when Bhai Arjun Singh, L.Ag., acted as Imperial Agriculturist.

Khan Saheb Mahamad Ikramuddin, Assistant to the Imperial Agriculturist, who was on privilege leave combined with furlough for six months from 15th March, 1923, retired from Government service with effect from 15th September, 1923, on expiry of leave. Bhai Arjun Singh, L.Ag., First Farm Overseer, was appointed acting Assistant to the Imperial Agriculturist with effect from 15th March, 1923.

Mr. L. S. Joseph, G.B.V.C., Cattle Superintendent, remained in charge of the Cattle Section throughout the year.

II. TRAINING.

Mr. T. V. Krishna Swami Rao, a private student from Madras, who was admitted to a two-year course in general agriculture on 31st July, 1922, completed his training on 5th April, 1924.

III. FARM CULTIVATION.

The year under report was marked by a record deficiency in rainfall, the farm receiving only 24·88 inches compared with 65·78 in the previous year. This was the lowest rain-

fall for the last fifteen years and its effect on all agricultural operations was considerable.

The regular monsoon commenced on 24th June with a fall of 1·4 inches and the *kharif* sowings (400 acres) were completed on the six following days. The monsoon rains were distributed into small showers which matured the *kharif* crops well and it was possible to harvest a crop from all the arable land. On the whole the season was very favourable for maize, *arhar* (*Cajanus indicus*) and gram but it was not suitable for oats and wheat, the yield of which was reduced by 50 per cent. on account of the total failure of winter rains. The rainfall figures are given below :—

Month	Rainfall in inches
June 1923	2·98
July	6·64
August	8·87
September	5·01
October	0·98
November	...
December	0·01
January 1924	0·03
February	0·22
March	...
April	0 01
May	0·13
TOTAL	24·88

The general fertility experiment on the lines mentioned in the previous years' reports was continued. The outturn

figures of this experiment are given in the following table :—

TABLE I.

Yield from 13 fields (413 acres) for 12 years.

Year	Annual rainfall	Oats and other cereals	Maize	Pulses	Total grain	Green stuff for fodder and silage
	Inches	mds.	mds	mds.	mds.	mds.
1912-13 . .	41·26	2,210	522	894	3,626	16,301
1913-14 . .	61·74	1,997	200	1,100	3,297	11,513
1914-15 . .	54·88	1,749	534	704	2,987	14,427
1915-16 . .	51·37	2,669	884	701	4,254	36,903
1916-17 . .	59·67	2,897	670	932	4,499	31,071
1917-18 . .	45·54	2,376	1,276	1,010	4,662	30,893
1918-19 . .	60·19	3,386	559	1,037	4,982	30,735
1919-20 . .	32·73	2,479	1,004	719	4,202	31,624
1920-21 . .	44·33	2,542	766	1,073	4,381	33,359
1921-22 . .	39·82	3,754	1,267	1,132	6,153	34,492
1922-23 . .	65·78	3,752	496	941	5,189	23,021
1923-24 .	24·88	2,448	988	1,100	4,536	29,146

The permanent manurial and rotational plots were continued as before. The details and results for the year under report are as follows :—

TABLE II.

Results of permanent manurial plots for the year 1923-24.

Plot No.	Treatment	A Series			B Series		
		Maize	Oats	Peas	Maize	Athar	Barley
		lb	lb.	lb.	lb.	lb.	lb
1	No manure	936	146	.	331	1,121	.
2	Farmyard manure to supply 10 lb. nitrogen per acre	1,166	302	..	454	1,160	. ..
3	Farmyard manure to supply 20 lb. nitrogen per acre.	1,180	318	..	724	1,039	..
4	Farmyard manure to supply 30 lb nitrogen per acre.	1,574	335	..	780	620	..
5	Rape cake to supply 20 lb nitrogen per acre	1,072	137	..	576	811	..
6	Sulphate of ammonia to supply 20 lb nitrogen per acre.	376	359	..	86	1,121	..
7	Sulphate of potash to supply potash as in F. Y. M No. 3.	423	211	..	97	866	..
8	Superphosphate to supply P_2O_5 as in F. Y. M. No. 3.	939	318	..	536	542	..
9	Sulphate of potash to supply potash as in F. Y. M. No 3 Superphosphate to supply P_2O_5 as in F. Y. M. No. 3	936	310	..	587	651	..
10	Sulphate of ammonia to supply nitrogen as in F. Y. M. No. 3 Sulphate of potash to supply potash as in F. Y. M No. 3 and superphosphate to supply P_2O_5 as in F. Y. M. No 3.	1,001	302	..	802	727	..
11	No manure or leguminous crop .	322	203	..	330	..	240
12	Green manure in a cereal rotation .	..	343	..	598	..	304
13	Deep rooted leguminous crop in a cereal rotation.	268	261	..	140	854	..
14	One deep, one shallow-rooted leguminous in the rotation.	272	248	29	203	920	..
15	Leguminous crop and green manure in the rotation.	..	281	..	850	573	.
16	Green manure and superphosphate to supply P_2O_5 as in F. Y. M. No. 3.	..	544	..	1,521	704	..

Leguminous crops. The results achieved by growing a number of leguminous crops mentioned in previous reports during several successive years have established the superiority of the following both for green fodder and grain.

Guar (*Cyamopsis psoralioides*) is rapid growing, a fair yielder of green fodder and grain and much relished by cattle.

Math (*Phaseolus aconitifolius*) is a bit slower than *guar* in growing but is ready for soiling just after *guar* is finished. It is a high yielder both for fodder and grain. Sown mixed with maize, it makes excellent green fodder and silage, and when allowed to ripen after removing maize cobs from stalks, it yielded an average of 8 maunds grain per acre, and made a very good dry fodder when chopped up with dry maize stalks. It is the most suitable legume to be grown mixed with maize in place of *arhar*.

Val (*Dolichos lablab*) was grown in the past for grain only and yield was not very good. Its value as green fodder was always ignored in the past. It has now been found out that if sown in the month of September after cutting maize for green fodder or silage, it will give a fair yield of grain and then if left after plucking the pods will supply a good amount of succulent green fodder in the driest months of May and June. It was noticed that the growth was very luxuriant in spite of an exceptionally dry season. The trial was on ¼-acre plot only and the figures obtained are as follows :—

Date of sowing	Date of harvesting	Grain per acre	Green fodder per acre
		mds.	mds.
11th September 1923	1st February 1924	7	...
11th September 1923	6th June 1924 .	...	250

It is being tried this year on a large scale.

Eight varieties and selected strains of gram were tested both on ¼-acre plots and on a field scale.

The yields of these varieties are as follows :—

Variety	Grain per acre
	lb
No. 16 (Farm selected)	1,102
No. 17 ,, ,, . . .	1,230
No. 3 ,, ,, ...	1,236

Variety	Grain per acre. lb.
No. 11 (Farm selected)	961
No. 6 (Pusa)	1,113
No. 17 ,, ...	1,784
No. 23 ,, ...	920
No. 25 ,, ...	739

Investigations with imported oats. Seeds of New Zealand white oats, Scotch potato oats, Captain oats and New Ascot white oats which produced seed in previous seasons were sown in *rabi* 1923. No seeds were matured on account of the dry winter and short rainfall.

Green-manuring experiments. These were continued to test the residual values. The results and conclusions have been published by the Imperial Agricultural Bacteriologist. This experiment has now been closed.

Experiments to deal with the wilt disease of *arhar* were continued for the Imperial Mycologist.

A series of $\frac{1}{4}$-acre plots tested over a number of years are now ready for experimental purposes and are kept at the disposal of the Imperial Agronomist.

Clearing and levelling. About 35 acres of *dhab* land were cleared and levelled and added during the year to the irrigated area, making a total of 100 acres irrigated. Only 38 acres were sown under berseem as seed was not available for the whole area. Thirty-two acres, therefore, were sown with oats and Patna peas. Sowings of berseem and oats and peas were commenced in the middle of October and finished in the middle of November. The berseem was ready for grazing in the first week of December and cattle were put on the crop on 3rd December, 1923.

Berseem and oats and peas supplied full pasturage for the herd from 3rd December, 1923, to 9th May, 1924, and 1,592 maunds were available for cutting and feeding in the byres. One acre of average crop of berseem was cut

green in order to determine the actual yield of the crop. The details are as follows :—

Date of sowing	Date of cutting	Weight in mds.
18th October 1923 . .	1st cutting on 3rd December 1923 .	36
	2nd cutting on 9th January 1924 .	56
	3rd cutting on 16th February 1924 .	112
	4th cutting on 23rd March 1924 .	264
	TOTAL .	468

It was then kept for seed. No seed was produced. The total area of 100 acres was then sown with maize and *math* mixed from middle of February to 4th June, 1924. The maize crop was ready for feeding and *math* for grazing on 9th May, 1924, when berseem finished. This supplied total green fodder for the whole stock (500) up to 25th July, 1924. *Math* after the removal of maize took the place of berseem and cattle were pastured on it till 12th July, 1924, when the whole area was flooded; 4,000 maunds of green maize were turned into silage before flooding.

It is thus perfectly clear that during the season under report the herd has been practically maintained on the irrigated area, which now enables us to carry a greater head of stock on the farm than was ever possible before.

There is practically no pasture land now and cattle are, therefore, grazed on cultivated crops only. The following crops were grazed during the year :—

	Acres	
Cow peas	9·5	Time of grazing August to October.
Guar	54·5	
Math	2·5	
Soybeans	23·0	
Urid	2·0	
Velvet beans . . .	43·5	

	Acres	
Barley	12·9	December to May.
Oats	6·2	
Oats and peas . . .	13·3	
Berseem	38·0	
Val	15·0	November.

Four grazings were taken off berseem.

In addition to this, the total production of the harvested crop was as under in comparison with previous two years :—

TABLE III.

Total farm produce for the last three years.

Year	Rainfall in inches	Grain	Green fodder	REMARKS
		mds.	mds.	
1921-22 . . .	39·82	7,060	41,925	Dry fodder is calculated as double the quantity of grain.
1922-23 . . .	65·78	6,560	32,952	
1923-24 . . .	24·88	5,656	43,822	

IV. MACHINERY.

(*a*) *The steam tackle* worked during the year for 120 days of 10 actual hours. Working costs and analysis for different operations are shown in the following two comparative statements :—

TABLE IV.

Showing cost of working steam tackle for last five seasons.

Particulars	1919-20	1920-21	1921-22	1922-23	1923-24
	No. of working days 126	No. of working days 131	No. of working days 114	No. of working days 112	No. of working days 120
	Rs	Rs	Rs.	Rs.	Rs
Labour	1,200	1,450	1,243	1,278	1,317
Fuel	1,623	2,140	1,622	1,461	1,819
Oil	633	588	412	483	483
Miscellaneous stores, etc., and renewals	1,196	1,764	1,783	2,137	614
TOTAL .	4,652	5,942	5,060	5,362	4,233

TABLE V.

Showing the above cost divided into different operations per acre for the last five years.

Particulars	1919-20			1920-21			1921-22			1922-23			1923-24		
	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work
	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres
Ploughing . . .	401·5	1·8	7·5	115	6	7 5	211 5	5 6	7·8	375 0	5 71	8 34	371 0	4 00	7 06
Disc harrowing . . .	582 0	1·7	20 5	633	2 5	17·5	112 0	2 6	16 5	470 0	2 81	16 50	534 5	2 43	11 46
Drubbing	488 0	1 6	22 0	180	2 0	22 0	600 5	2 0	21·3	507 0	2 25	21 00	491 0	1 8	19 55
Rolling	533 0	1 6	23 0	783	1 8	25 0	285 0	2 0	21 0	331 5	2 06	23 00	127 5	1 45	24·28
TOTAL .	2,007·5	..	..	1,911	..	..	1,560 0	..	..	1,683 5	..	..	1,530 0	..	..

(*b*) *Austin and Fordson motor tractors* were used on the farm for lighter operations such as disc harrowing and cultivating in busy time only. They were also used in belt pulley work for chopping up green fodder, etc. Their usefulness is still considerably impaired by the delay in obtaining spares.

V. Cattle.

The total stock in both herds stood as under during the year under report:—

Montgomery	232
Cross-bred (all classes)	138

The year brought no outbreak of any serious contagious disease. The cattle kept condition excellently throughout the year despite the short rainfall, and the milk herd showed no drop in yield. This most satisfactory state of things is due to the enterprising irrigation policy adopted and carried through by the permanent incumbent of the post, which has entirely separated the herd from the fodder difficulties formerly experienced through a portion of the year.

Six statements are attached showing: (1) Livestock, (2) Milk yield, (3) Milk disposal, (4) Receipts from sale of milk and other dairy products, (5) Fodder and concentrated food consumed, (6) Milk and dry percentage through the herd. These statements will be referred to in this report.

The grading up of the Montgomery herd was continued and the heifers now coming in show the results of this policy. The yield is steadily increasing and the general average mounting, both signs of progress and justification of the lines being worked on. Ayrshire-Montgomery crossing experiments continued and though all crosses further than the first cross appear to vary to almost any extent, yet one or two factors seem to be appearing, which may give a line on future work, but as is the case with all cattle-breeding work, it will be a matter of years.

An Ayrshire bull is being used on the poor class Montgomery cows outside the grade group. He has served some thirty cows and appears a good stock getter. His constitution and milk pedigree are excellent and I have great hopes for his stock.

We have this year in Laura No. 98, a half-bred got by Lessnessock, what promises to be a second Alibi. She has calved and started with a yield of 32 lb. It is gratifying to see this result as we have had 93 half-breds between these two prodigies—a long wait.

It is, however, regrettable to notice that the percentage of cows reverting or standing out of calf is larger than previously. It all points to the fact that the possible effects of outbreaks of contagious disease centre here. If such is the case, it will be a matter for serious consideration in the future.

The following cows from the Montgomery and cross-bred herds closed their lactations during the year under report :—

1.	Montgomery cow	.	Joogni	No. 142	5,777	lb.	in	10	months.
2.	„ „	.	Sumati	No. 202	5,211	„	„	„	„
3.	„ „	.	Milapi	No. 263	5,092	„	„	„	„
4.	„ „	.	Kamli	No. 312	6,817	„	„	„	„
5.	Montgomery-Ayrshire cow.		Pansy	No. 4	7,026	„	„	„	„
6.	„ „	.	Daisy	No. 5	8,013	„	„	„	„
7.	„ „	.	Nelly	No. 13	8,126	„	„	„	„

Some of the young Montgomery half-bred and double-cross cows that have come in milk are very promising, but the figures of their first performances are not available as they have not closed their lactation.

From the tables and statements the average yield per cow per day can be seen. This stands at a figure of 14·3 lb. for June and represents a figure well worth watching as it is on this average that the value of the herd is judged. The subsequent tables show the total yield of 386,000 odd pounds of milk in the year and the consumption of concentrated food and green fodder. The statement showing the

milk and dry percentage of the herd makes interesting reading and shows clearly that the cross-breds are superior not only in milk yield but also in a shorter dry period, while the Montgomeries milked without calf show a distinct superiority over those milked with calf when it is remembered that every dead calf means a dry cow in the second section which is not the case in the first.

In short the Pusa herd is well on the way to solve the problem of dairying in India—a problem which entails not solely the keeping and milking of the cow but also the feeding of it throughout the year according to its milk yield.

TABLE VI.

Showing the number of live-stock as it stood on the 1st of July 1924.

Serial No.	Breed	Description of cattle	Number of animals as stood on the 1st July, 1923	INCREASE			DECREASE			TOTAL	REMARKS
				By birth	By transfer	By purchase	By death	By transfer	By sale		
1	Montgomery cattle . .	Bull . .	7	..	..	..	..	..	..	7	
2	Ditto . .	Cow . .	86	..	(a) 12	..	2	..	2	94	
3	Ditto . .	Young male stock.	32	35	..	(c) 6	8	..	(d) 12	53	
4	Ditto . .	Young female stock.	55	39	..	..	5	(a) 12	..	77	(a) Transferred to adult stock (c) Taken back from the farm.
5	Progeny of Montgomery cow and Ayrshire bull.	Bull . .	1	..	..	..	..	..	1	3	(d) Sent to the farm.
6	Ditto .	Cow . .	36	..	(a) 6	..	..	..	..	42	
7	Ditto .	Young male stock.	3	..	..	..	..	..	(d) 2	1	
8	Ditto .	Young female stock.	17	..	..	..	..	(a) 6	..	11	
9	Progeny of ¾-bred cow and Ayrshire bull	Cow . .	4	..	..	..	..	..	1	3	
10	Progeny of Montgomery cow and ¼-bred bull.	Cow . .	4	..	..	..	..	.	1	3	
11	Progeny of ¾-bred cow and ¼-bred bull	Young male stock	..	2	..	..	..	..	(d) 2	..	
12	Ditto .	Young female stock	1	2	..	..	..	..	..	3	
13	Progeny of ¾-bred cow and ¼-bred bull.	Bull . .	2	..	..	..	..	..	..	2	
14	Ditto .	Cow . .	4	..	(a) 8	..	.	..	2	10	
15	Ditto .	Young male stock.	4	10	..	..	3	..	(f) 13	7	(f) Out of 13 bull calves 9 were sent to the farm.

TABLE VI—*concld.*

Showing the number of live-stock as it stood on the 1st of July 1924—concld.

Serial No.	Breed [illegible]	Description of cattle	Number of animals as stood on the 1st July, 1923	INCREASE			DECREASE			TOTAL	REMARKS
				By birth	By transfer	By purchase	By death	By transfer	By sale		
16	Progeny of ¾-bred cow and ¾ bred bull.	Young stock female	33	16	..		5	(a) 8	1	35	(a) Transferred to adult stock.
17	Progeny of ¾-bred cow and ¾ bred bull	Young stock male	..	1	..	..	1		.	..	
18	Ditto .	Young stock female	1	..	..	..	..	.		1	
19	Progeny of ¾ bred cow and Montgomery bull.	Young stock female	1	..	..	..	..		..	1	
20	Progeny of double cross cow and Ayrshire bull.	Young stock male	1	..	..	..	..	..	(d) 1	..	(d) Sent to the farm.
21	Progeny of double cross cow and ¾-bred bull.	Young stock female	2	1	..	..	..	..	..	3	
22	Progeny of double cross cow and double cross bull.	Young stock male	..	3	..	..	1	..	..	2	
23	Ditto .	Young stock female	..	6	..	..	1	..	1	4	
24	Progeny of Montgomery cow and Holstein bull.	Young stock male	..	..	..	1	..	..	..	1	
25	Ditto .	Young stock female	2	..	..	..	..	..	..	2	
26	Montgomery bull for cartling.	..	1	..	..	..	..	..	..	1	
27	Ayrshire cattle. . .	Bull . .	..	..	..	1	..	..	..	1	
28	Cross-bred bullocks . .	.	2	..	(f) 2	.	..	..	..	4	(f) Taken from the farm.
29	Mule	..	..	..	(f) 1	1	..	..	..	2	(f) Taken from the Estate Office
	.		302	121	29	9	26	26	30	373	

TABLE VII.

Showing the milk yield (in lb.) of cows during 1923-24.

Month	ACTUAL YIELD OF			AVERAGE YIELD PER DAY AND PER COW PER DAY					
				CROSS-BRED COW		MONT. COW		TOTAL	
	Cross-bred cows	Mont. cows	TOTAL	Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day
July 1923	14,057	15,736	29,793	453	13 3	508	9 6	961	11·1
August	14,012	14,730	29,642	181	13·7	175	9 5	956	11·2
September	14,230	12,848	27,078	474	12 5	428	9 3	902	10·7
October	16,084	12,583	28,667	519	13 0	406	9 2	925	11 0
November	14,601	10,901	25,502	487	12 5	366	8 7	853	10 5
December	16,287	10,892	27,179	525	11 6	351	9 2	876	11 8
January 1924	16,843	13,844	30,687	543	16 0	446	10 9	990	13 2
February	17,028	14,436	31,464	587	17 8	497	12·1	1,085	14 6
March	21,520	15,919	37,439	694	19 8	513	12 5	1,207	15·9
April	22,076	16,502	38,578	736	18·8	550	12 8	1,286	15 6
May	22,660	18,771	41,431	731	18 2	606	12 9	1,336	15·3
June	19,465	19,356	38,821	649	17·1	645	12·4	1,294	14 3

TABLE

Showing disposal of milk, cream

Month	Milk yield in lb.	MILK DISPOSAL IN LB.										
		SOLD AT THE RATE OF					ISSUED FOR					
		10 lb. per rupee	12 lb per rupee	*6 seers per rupee	16 lb per rupee	Total	Cream	Calf	Analysis	Ghee	Medicine	Total
		lb.	lb.	lb.	lb.	lb	lb.	lb.	lb	lb.	lb.	lb.
July 1923 .	29,703	2,072	1,025½	3,020	15,672½	23,270	1,310	4,782½	62	160	10	6,333½
August . .	29,612	2,614	3,177½	2,875	14,329	22,995½	1,444	4,007½	62	..	14	6,427½
September .	27,078	2,614	2,352	2,100	13,250	20,415	667	5,536	60	16	15	6,294
October . .	28,667	2,380	2,195	1,050	13,766	20,291	1,453	6,796	38	..	12	8,299
November .	25,502	2,000	964	1,220	12,158	16,432	1,074	7,017½	53	..	6	9,050½
December .	27,179	4,120	..	..	13,134½	17,254½	2,693	7,073½	47	..	1½	9,815
January 1924.	30,697	5,260	..	..	14,691½	19,951½	2,142	8,441½	46½	..	2	10,632
February .	31,464	6,130	..	..	14,822	20,952	2,427	7,896½	49	71	1	10,444½
March . .	37,439	8,069	..	..	17,019	25,088	2,095½	8,074	62	150½	25½	11,310½
April . .	38,573	9,830	..	..	18,257	28,087	1,831½	6,412	53	..	18½	10,315
May . .	41,131	14,770	..	..	17,038½	31,808½	1,299	8,051	62	..	1	9,413
June . .	38,821	12,054	..	..	18,193½	31,147½	1,205	6 214	63	..	5	7,577
TOTAL .	386,371	78,193	10,614	11,255	183,240½	278,302½	21,531	83,202	657½	406½	111½	105,911½

* 40 seers

VIII.

and ghee during 1923-24.

Milk disposal in lb.			Cream obtained and sold at the rate of				Ghee obtained and sold at the rate of 12 oz per rupee	Butter obtained and sold at the rate of 20 oz. per rupee
Shortage	Thrown	Grand Total	10 oz per rupee	12 oz. per rupee	16 oz per rupee	Total		
lb.	lb.	lb.	oz.	oz.	oz.	oz.	oz.	oz.
130½	50	20,703	..	18	1,430	1,457	48	84
124½	94½	20,612	..	30	1,537	1,567	..	..
188½	180½	27,078	..	36	633	669	6	..
47½	29½	28,607	..	24	1,668	1,692	..	..
54½	55	25,592	..	..	2,346½	2,346½	..	..
53½	50	27,179	184	..	2,971	3,155	..	..
60½	43	30,687	336	..	2,209	2,545	..	..
49½	18	31,401	16	..	2,778	2,794	..	..
80½	60	37,430	112	..	2,987	3,099	10	..
90½	85½	38,578	8	..	2,038	2,046	80	..
84½	125	41,431	50	..	1,427	1,483	..	..
57	30½	38,821	16	..	1,561	1,577	..	..
1,021½	845½	336,371	728	108	23,594½	24,430½	153	84

=82½ lb.

TABLE IX.

Showing receipts from sale of milk, other dairy products, cattle, etc., during 1923-24.

Demand	Amount			Collection	Amount		
	Rs.	A.	P.		Rs.	A.	P.
1. Customers' bills outstanding on 1-7-23 .	2,754	14	0	1. Amount realized .	20,286	3	7
2. Sales for the year—				2. Amount written off .	0	1	0
(a) *Milk*							
73,483 lb. @ 10 lb. per rupee . . .	7,348	4	0	3. Customers' bills outstanding on 30-6-24	4,452	9	11
10,611 lb. @ 12 lb. per rupee . . .	884	8	0				
1,81,210½ lb. @ 16 lb. per rupee . .	11,452	8	0				
11,255 lb. @ 0 sr per rupee	911	13	0				
(b) *Cream*							
728 oz. @ 10 oz. per rupee . . .	72	12	9				
108 oz. @ 12 oz. per rupee . . .	9	0	0				
23,591½ oz. @ 16 oz. per rupee . . .	1,474	10	0				
(c) *Butter.*							
84 oz. @ 20 oz. per rupee	4	3	0				
(d) *Ghee.*							
153 oz. @ 12 oz. per rupee . . .	12	12	0				
(e) *Cattle.*							
*16 Cattle . . .	899	0	0				
(f) *Miscellaneous.*							
22 sr. sheep wool @ 2 srs. per rupee .	11	0	0				
1,428 lb. separated milk @ 3 pies per lb. .	22	5	0				
	25,787	11	6				
Less incidental charges for carriage, etc. . .	1,048	13	0				
TOTAL .	24,738	14	6	TOTAL .	24,738	14	6

* Out of 16 animals shown as sold, 3 were sold in the year 1922-23, and the cost amounting to Rs. 299 8-0 was realized this year.

TABLE X.

Showing the concentrated food and fodder consumed by the breeding herd during 1923-24.

Months	Cereal grains	Chuni	Oil-cake	Salt	Bhusa	Green fodder	Silage	REMARKS
	mds.	mds.	mds.	mds.	mds.	mds.	mds.	
July 1923	236½	69	60½	9½	226½	2,157½	..	
August	240½	68½	54	9½	157½	2,037	..	
September	224½	67½	55	8	121	1,792½	..	
October	220½	60½	59½	8½	122	1,399	..	
November	247½	46½	69	9	234	32½	2,581	
December	237½	66½	87	9½	652½	106½	2,405	
January 1924 . . .	273½	82½	85½	11	739	276½	1,255	
February	269½	79	77½	9½	514½	488	722	
March	317½	101	96½	11½	438½	1,051	303	
April	318½	110½	101	12	462	201½	1,272	
May	315½	147	105½	13	385½	855	1,151½	
June	262½	190½	103	12	163½	2,166	351½	
TOTAL .	3,163½	1,189½	953½	123	4,216	12,558½	10,040½	

TABLE XI.

Showing the percentage of cows in milk and dry during the year 1923-24.

	CROSS BRED COWS				MONTGOMERY COWS MILKED WITHOUT CALF				MONTGOMERY COWS MILKED WITH CALF			
	Total No of cows	In milk	Dry	Percentage in milk	Total No of cows	In milk	Dry	Percentage in milk	Total No. of cows	In milk	Dry	Percentage in milk
July 1923	48	34	14	70 8	61	11	20	67 2	27	12	15	44 4
August	50	35	15	70 0	61	38	23	62 3	27	12	15	44 4
September	53	38	15	71·7	61	35	26	57 4	27	11	16	40 7
October	53	40	13	75 5	60	34	26	56 6	27	10	17	37 0
November	52	39	13	75 0	59	33	26	55 9	27	9	18	33 3
December	53	30	17	67 9	60	29	31	48 3	27	9	18	33 3
January 1924 . . .	52	34	18	65 4	61	28	33	45 9	27	13	14	48·1
February	52	33	19	63 4	63	28	35	44 4	27	13	14	48·1
March	54	35	19	64 8	64	28	36	43 7	27	13	14	48 1
April	55	39	16	70 9	65	29	36	44 6	27	14	13	51 8
May	54	40	14	74 1	60	32	34	48 5	27	15	12	55 5
June	58	38	20	65 5	67	37	30	55 2	27	15	12	55 5

VI. Programme of work for 1924-25.

1. (*a*) Practical treatment of pedigree dairy herd of Indian cattle and pedigree dairy herd of Montgomery-Ayrshire cattle.

(*b*) Continuance of experiments with regard to fixing a type of Montgomery-Ayrshire most suitable to Indian conditions.

2. Practical treatment of a 1,200-acre mixed farm with particular attention to profitable modern machinery and the financial results of the work.

The bulk of the produce of the Pusa Farm is used for the maintenance of the dairy herd. The rotation adopted aims at the upkeep of the fertility of the land along with supply of concentrated food and long fodder and a constant supply of green fodder throughout the year. Included in the above is the study on a practical scale of:—

(*a*) Rotations.
(*b*) Crops for fodder, seed and silage.
(*c*) Implements and machinery.
(*d*) Technique of cultural operations.

3. Continuation of collection of data and results regarding the costs and capabilities of the steam-ploughing tackle on estates of this size.

4. Experiments with various types of motor tractors and ploughs for collection of data and working costs and for determination of most suitable types of tractors and implements for India. Also collaboration with manufacturers regarding the manufacturing and introduction of improvements in standard types to suit Indian conditions.

5. *Experimental work at Pusa.*

(*a*) Rotational experiments.
(*b*) Trial of new varieties of crops especially leguminous fodder crops and wheat varieties.
(*c*) Manurial experiments, especially seasonal and quantitative tests with phosphates.

(*d*) Trial of sugarcane varieties suitable for growth without irrigation, along with the Sugar Bureau.

6. Demonstrations, exhibitions and sales of surplus dairy stock, etc., will be held from time to time as occasion offers.

7. *Touring and Advisory.* Visits will be paid to provincial agricultural centres. This should tend to co-ordination of agricultural work.

REPORT OF THE IMPERIAL DAIRY EXPERT.

I.

(W. SMITH.)

I held the post of the Imperial Dairy Expert until 25th April, 1924, when I proceeded on leave and handed over charge to Mr. E. J. Bruen.

In accordance with the practice followed in last year's report the advisory work done may be classified as:—(*a*) Work done for Local Governments, Indian States, municipalities, etc.; (*b*) Advice given to the general public in India; (*c*) Information given to persons or Governments outside of India.

I. WORK DONE FOR LOCAL GOVERNMENTS, INDIAN STATES AND MUNICIPALITIES.

Madras. I visited Ootacamund on 23rd July and discussed with the Chairman of the Municipal Council there the proposed municipal dairy scheme. As the result of this conversation, an alternative proposal for the supply of dairy produce to the Ootacamund Municipality from the Wellington dairy farm was submitted to the Chairman of the municipality. Plans and particulars of a central milk depôt were sent with this proposal.

Bombay. The Deputy Director of Agriculture for Animal-breeding, Government of Bombay, was in correspondence with this office during the period in connection with cattle-breeding and dairying questions, and an almost continuous correspondence took place with the Special Milk Supply Officer of the Bombay Corporation concerning the various schemes submitted to him for dealing with the milk supply problem of that city.

On three occasions I visited the city of Bombay and discussed these matters with the City Commissioner, the

Medical Officer for Health, and the Special Milk Supply Officer, and towards the end of the period under review the Bombay Measures Committee of the Bombay Corporation had decided to adopt my recommendation to subsidize a public company which would undertake to supply milk to the city in accordance with modern methods under the supervision of the experts of the Corporation. With this end in view they had advertised in the daily papers for applications from approved concerns who would undertake supplies of dairy produce on these lines, and the evening before I sailed from India I had the opportunity of advising the Municipal Commissioner concerning the applications received.

Central Provinces. At the request of the Director of Agriculture, Central Provinces, I visited Nagpur in February at the time of the annual Agricultural Show there. I addressed a public meeting presided over by the Hon'ble the Minister of Agriculture in connection with the Show on the importance of the cattle-breeding and dairying question as it affected Indian agriculture. This lecture was largely attended by exhibitors at the Show and it was illustrated by cinematograph films. Later on advice was given to the Agricultural Department of this province concerning the reservation of grazing lands, etc.

Captain Alex Petrie, guardian to His Highness The Maharaja of Charkhar, was advised as to the adoption of a suitable cattle-breeding policy for his State.

United Provinces. A request by the Government of the United Provinces that their Agricultural College at Cawnpore should be recognized as being capable of teaching pupils for the Indian Diploma in Dairying was submitted for opinion by the Agricultural Adviser, who was informed that if the Cawnpore College installed the necessary plant and sent the officer in charge of their dairy section for a special course of instruction to the Bangalore Institute, Government might agree to this college being accepted as capable of teaching for the Indian Diploma in Dairying.

The Deputy Director of Agriculture in charge of Cattle-breeding Operations, United Provinces, was supplied with the building plans and machinery specifications for the modernization of his existing farms.

Bengal. In company with the Director of Agriculture, Bengal, I visited the Government farms at Dacca and Rangpur and inspected a number of suggested sites for a proposed Government dairy farm in the vicinity of Calcutta. Later a report on the Rangpur cattle farm and a detailed scheme with building plans, machinery specifications, etc., for the suggested experimental Government owned dairy farm were submitted.

One bull and five Thar-Parkar cows were selected by me at Karachi and shipped to the Rangpur farm, and plans of a suitable bull shed for Rangpur and various other details of technical information were supplied to the Bengal Agricultural Department from time to time.

Advice was given to the District Board, Pabna, as to dairy stud bulls, and a list of publications concerning cattle-breeding in India was furnished to the Director-General of Commercial Intelligence, Calcutta.

Bihar and Orissa. Eight Thar-Parkar cows were selected in Sind and sent to the Sabour farm of the Bihar and Orissa Agricultural Department and two Gowallas were also procured in the Punjab for this farm. A set of dairy building plans was furnished to the Deputy Director of Agriculture, North Bihar Range, for the proposed central farm near Sipaya.

Punjab. At the request of the Director of Agriculture, Punjab, arrangements were made for the supply of a pasteurizing and refrigerating plant to the Lyallpur Agricultural College, and I had the privilege, as in former years, of addressing the students of this college on matters connected with the cattle-breeding and dairying industry. General information respecting problems relative to cattle-breeding and management was given to the Professor of Agriculture, Lyallpur, and at the request of this officer a

note on the economic value of the goat was submitted to the Punjab Board of Economic Enquiry.

Assam. Advice as to the value of bulls supplied to this Government by other provinces was given.

Baroda State. Early in February, I visited Baroda to inspect the State Dairy and Cattle-breeding Farm at Makarpura, and at the request of the then Joint Prime Minister a report on the working and future policy of this farm was submitted to the Government of Baroda. Correspondence took place with the Department of Agriculture of this State throughout the year and necessary information on matters connected with cattle-breeding and dairying was supplied. When the Director of Agriculture, Baroda State, was in Bangalore in January 1924 for the meetings of the Board of Agriculture, I had a conference with him in connection with the utilization of the Makarpura farm for teaching students for the Dairy Diploma Course, and as a result of this conference proposals for equipping Makarpura farm for this purpose were submitted. The State authorities have postponed these proposals to a later date as they are unable to undertake this course at present.

Dewas Junior State. The Prime Minister of this State was in correspondence during the period in connection with the cattle-breeding problems of his State, the sending of delegates to the World's Dairy Congress in U. S. A., etc.

Dhar State. At the request of the Dewan, I visited Dhar State in August 1923. I attended a cattle show at Kholghat, and advised the State authorities to take up cattle-breeding and dairying propaganda in their State on three different phases of activity :—

(1) The establishment of a model dairy with special producing herds of the existing Palace Dairy at Dhar.

(2) The establishment of a cattle farm in a suitable district on which a herd of Malvi cattle would be maintained.

(3) The establishment of a cattle farm in the Nimari district on which a herd of Nimari cattle would be maintained.

On the occasion of the above-mentioned visit their dairy was also inspected and two buffalo bulls were purchased for the Bangalore farm and arrangements were made whereby one Ayrshire bull from Wellington farm was sold to the State. A copy each of Cattle-History-Sheet Book and Milk-Record Book was supplied for use in their dairy.

The officer-in-charge of the Palace Dairy, Dhar, was supplied with a copy of the form of Cattle Yard Report Book as used on military dairy farms.

Military Dairy Farms. During the period under report, I was frequently consulted by the Director of Military Farms at Army Headquarters and by the Assistant Directors of Military Dairy Farms at Rawal Pindi and Poona, concerning questions affecting the working of military dairies, cattle-breeding policy, etc.

II. Advice given to the general public in India.

This office was requested by Mr. Javerbhai Ramji of Bombay to compile for him a complete scheme for the establishment of a modern milk producing farm, but after consultation with the Deputy Director of Agriculture for Animal-breeding, Government of Bombay, this gentleman was advised not to proceed with his proposed scheme owing to the insufficient land available.

Advice was given to the Bombay Pinjrapole regarding the utilization of their organization for cattle-breeding and milk production.

At the request of the Superintendent of the Palace Dairy, Baroda, I inspected a large tract of land near Ahmedabad belonging to the trustees of an Indian temple at Bachusan, with a view to advising its proprietors as to its suitability for dairy farming purposes. The lands appeared to be more suitable for cotton growing than for

dairying on an extensive scale, and the proprietors were put into communication with the Managing Director of the British Cotton Growing Association, Khanewal, Punjab.

In company with the Deputy Director of Agriculture for Animal-breeding, Government of Bombay, I visited proposed dairy sites at Muland and Devnur near Bombay, and as a result of this visit, and in collaboration with the Deputy Director of Agriculture for Animal-breeding, Bombay, a complete scheme with plans, specifications, estimates of cost and of working expenses for the establishment of a modern dairy farm in conjunction with a cow protection organization were submitted to Mr. Motilal Kanji Kapadia, B.A., LL.B., managing trustee of the Nathalji Charity Fund, Bombay.

A pure bred Ayrshire bull was supplied from the Bangalore Institute to the Kokine dairy farm, Rangoon, Burma, and plans of a modern dairy cattle shed were supplied to the Department of Rural Reconstruction, Surul, Bombay.

A complete scheme for the establishment of an up-to-date condensed milk factory in the Punjab was supplied to Messrs. Syeds A. and M. Wazir Ali, provision merchants and army contractors, Lahore. In connection with this scheme I attended a conference in Simla with the Director of Agriculture, Punjab, a forest officer, and the promoters, at which the question of Messrs. Wazir Ali's obtaining sufficient lands in one of the new canal colonies was discussed and recommendations on this subject were made to the Director of Agriculture, Punjab.

Certain plant erected at the Dairy Farm of Mrs. Brown's syndicate near Lahore was inspected and reported on at the request of the purchasers, and a complete scheme, with building plans, machinery specifications, estimates of cost and of profit and loss accounts for the establishment of a model dairy for the supply of milk and butter to the Meerut Cantonment was supplied to Messrs. S. Rashid & Co., army contractors.

The Principal of the Allahabad Agricultural Institute belonging to the American Presbyterian Mission, Allahabad, applied to have that institution recognized as being capable of teaching for the Indian Dairy Diploma. I visited the Institute and advised that if certain building alterations were made, refrigerating machinery installed, and a competent dairy manager appointed, Government should recognize this college as being suitable for training dairy pupils to sit for the Indian Dairy Diploma. The authorities at this institution having complied with my recommendations, the Government of India sanctioned their accepting pupils for the new diploma.

In addition to the foregoing, specific advice and information on dairying or cattle-breeding matters was supplied to some fifty-five definite enquiries from Bengal, Delhi Province, Central India, Burma, Punjab, Bombay, Kashmir, Bhopal, Mysore, Madras, Bihar and Orissa, United Provinces, Central Provinces, Baroda, Baluchistan, Sind, and the Andaman Islands.

III. Information given to persons or Governments outside of India.

During the period 29 Sindhi cattle and 100 Sindhi goats were selected in Karachi and shipped to the order of the Government of Ceylon, and specific technical information regarding dairying and cattle-breeding in India was supplied to enquiries in United States of America, England, Italy, China, Checho-Slovakia, Federated Malay States, Japan and Siam.

IV. Bangalore, Wellington and Karnal Farms.

As mentioned in the concluding part of last year's report, on 1st July, 1923, I took over on behalf of the Imperial Department of Agriculture the military dairy farms at Karnal (Punjab), Bangalore and Wellington (Nilgiris). Within a few days of taking over these concerns they were visited by the Officiating Agricultural Adviser to Government and myself, and it was decided that Karnal should

be run as an experimental cattle-breeding farm, that Bangalore farm should form the nucleus of an Imperial Institute of Animal Husbandry and Dairying and that Wellington should remain a branch of Bangalore and serve as a feeder to that farm.

Karnal. To commence with a small herd of Thar-Parkar cattle, 61 cows and 2 bulls were purchased in Sind for the Karnal farm, as it was considered that this type of animal provided the most promising field for the development of the dual purpose class of ox which India so much needs. These animals since they were sent to Karnal have done well and give promise of producing, by careful selection and breeding, the type of cattle with milk and draught qualities so much in demand in many parts of the country.

In order to test the powers of resistance to Indian hot weather conditions of the famous dairy breed of Jersey cattle, 4 imported Jersey heifers in calf and 1 imported Jersey bull were purchased for the Karnal farm in the period, but these cattle showed no trace of their much vaunted ability to withstand tropical heat, and at the time of writing only one of these animals survives. The experiment has been a costly one for the farm, but it has clearly proved the question at issue, and it may be taken that this breed, like most other European breeds of dairy cattle, cannot survive in the plains in India. It is not intended to keep any imported breeds of cattle at Karnal in the future, but to concentrate on the breeding of the indigenous cattle of India. As soon as practicable, a herd of pure Hariana cattle will be established at Karnal to be developed on dual purpose lines.

The Director of Agriculture, Punjab, visited the Karnal farm in February 1924 with a view to see if his Government could obtain part of our area there to form an experimental farm for the Eastern Punjab. He was shown an area which could possibly be rented to him for this purpose, but it was pointed out to him that the matter was one which could only be decided by the Government of India as far as this department was concerned.

In order to be able to utilize the produce of the Karnal herd to the best possible advantage, and to demonstrate the possibilities of milk sterilization in bulk in India, a Mentor patent milk sterilizing plant has been installed and is now in working order.

The balance sheet, trading account, herd and crop statistics, produce statement and disposal of produce statement for the Karnal farm for the period ending 31st March, 1924, are attached (Appendices II—VIII).

Bangalore. In order to utilize to the best advantage the educational facilities which the Bangalore Institute would offer, and to meet a crying demand in the country, I asked the Government of India to sanction the granting by the Imperial Agricultural Department of a Diploma in Dairying on somewhat similar lines to that given in Great Britain by the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland and known as the National Diploma in Dairying (N. D. D.), this Diploma to be given by the Imperial Agricultural Department to students of the newly founded institute at Bangalore, or of any other approved teaching institution who had spent at least two years at such institution. Government agreed to these proposals and although it was advertised that only twelve pupils could be taken at Bangalore, over 190 signed and completed applications were received from all over the country. Fifteen of them were accepted and are now undergoing tuition at Bangalore. A copy of the syllabus of this course at Bangalore is attached (Appendix 1).

The Physiological Chemist and his assistant are co-operating with the dairy staff in teaching for this diploma, and I take this opportunity of placing on record my appreciation of the valuable assistance given by Mr. Warth in the organizing of this diploma course, and of his readiness to undertake the scientific part of the instruction.

The Bangalore farm being the site of the new Imperial Institute of Animal Husbandry and Dairying, it was deem-

ed necessary that the Physiological Chemist to Government should have his headquarters there instead of at Pusa as formerly, and consequently considerable building alterations and additions were made in order to provide hostel accommodation for the students and laboratory space for the Physiological Chemist and his staff. Extra plant, machinery and utensils had also to be secured to bring the farm up-to-date as a teaching institution. All these meant a substantial but unavoidable increase in capital expenditure as the attached accounts show.

The original herd taken over at Bangalore is altogether cross-bred, and for teaching and demonstration purposes a small pure bred herd of Sindhi cows and a few Murra buffaloes will be maintained in the future. At the same time, the cross-breeding policy of the late military dairy farm will be carried on for the present, this having proved to be the most profitable method of milk production in Bangalore.

The Bangalore farm is now fairly well equipped as a teaching institution of farm dairying, but more hostel accommodation is most urgently required. Many really first class applicants had to be turned away this year, and as India urgently requires trained dairy men it is hoped that hostel accommodation for the maximum number of students that the institute can teach will be provided at an early date.

The area available at Bangalore for fodder production is quite inadequate to produce anything like the requirements of the herd there, and if the late remount department lands at Hosur could be obtained for Bangalore, the farm would at all times be independent of the local fodder market which soars to enormous rates in scarce years. This is more important now with the farm than formerly, as in the past when local rates for fodder were excessive, the farm could always fall back on the local military grass farm for its requirements. This privilege, I believe, is now withdrawn and it is of paramount importance financially that the farm should produce its own fodder requirements.

The balance sheet, trading account, herd and crop statistics, produce statement, disposal of produce statement and statement of yields of milch cattle of the Bangalore farm are attached (Appendices IX—XVI).

Wellington. The system of cattle-breeding and cropping carried out by the military authorities has been maintained at the Wellington farm but prolonged pasteurization of all milk sold was introduced as yearly as possible after taking over. Four pure bred imported Ayrshire heifers were purchased for this farm as an experiment. So far they have done well, and it is hoped that in future pure bred Ayrshire bulls required for Bangalore can be bred and reared at Wellington.

The balance sheet, trading account, herd and crop statistics, produce statement, disposal of produce statement and statement of yields of milch cattle of the Wellington farm are attached (Appendices XVII—XXIV).

This department can now teach the farming and cattle-breeding side of dairying as well as many European countries.

The Superintendent of the Bangalore farm, Mr. F. E. Traynor, when he knew that he was to be called upon to teach students at Bangalore, immediately took leave and went to Europe to make a special study of modern cheese-making. This summer, Mr. A. Lamb, Superintendent of the Wellington dairy, has taken a special three months' course in cheese-making at the University Dairy Institute at Reading, and Mr. Gossip, Superintendent of the Karnal dairy, underwent a special course in cheese and butter-making at the Scottish Dairy Institute, Kilmarnock, Scotland, in 1921, so that our three senior superintendents are particularly well qualified for giving instruction in practical dairy work, and all the four farm superintendents have enthusiastically supported my efforts to transform these farms from mere milk-producing concerns into educational institutions.

The meetings of the Indian Science Congress and the Board of Agriculture were held in Bangalore in the period

now being reviewed; I attended both meetings. At the former, I read a paper on the economic aspect of the cattle-breeding problem in India, and at the latter meeting I acted as Secretary of the Cattle Conference.

Since the inception of the Imperial Institute of Animal Husbandry and Dairying at Bangalore, I have, with the permission of the Agricultural Adviser to Government, written a number of articles for the press describing the work of the Institute.

All the cattle suitable at the Bangalore and Wellington farms were inoculated against rinderpest by the serum-simultaneous method in February 1924. The results were very satisfactory and my thanks are due to the Director and staff of the Imperial Bacteriological Laboratory at Muktesar for so promptly and efficiently carrying out this work.

The supply of dairy produce to British troops and military hospitals at Bangalore and Wellington was continued throughout the period. Both these farms were regularly inspected by the military sanitary officers.

A suggestion was made to Government that certain lands should be acquired in Sind in order to establish a cattle farm for the preservation and development of the famous Bagnari breed of Baluchistan cattle.

A waggon of Thar-Parkar cows were selected and sent to the Imperial Bacteriologist at Bareilly and a waggon of Malvi bullocks were purchased and railed to the Secretary, Sugar Bureau, Pusa.

II.

(E. J. BRUEN.)

I took charge of the duties of Imperial Dairy Expert from Mr. Smith proceeding on leave on the afternoon of the 25th April, 1924. During this period, the teaching of animal husbandry was commenced at the Institute at Bangalore.

The following advisory work was performed in addition to the administration of the department :—

(1) The Professor of Agriculture, Agricultural College, Poona, was supplied with a machinery specification necessary for equipping the Agricultural Dairy at Poona, for training students for the Diploma course.

(2) The Deputy Director of Agriculture in charge of Cattle-breeding Operations, Muttra, was supplied with a note on cost of pasteurization, cooling and preparing milk for sale, and the cost of manufacturing butter as at the Bangalore Institute. Further, this officer was supplied with a note on the standard ration fed to calves at Bangalore.

(3) The Agricultural Adviser to Government was supplied with a note showing the cost of establishing a small butter factory at Bangalore. Later on, a note indicating the directions in which the Dairy Section could be extended was submitted to the Agricultural Adviser.

(4) At the request of the Officer in charge of the Government House Dairy at Poona, pedigrees of Sindhi bulls (property of the Governor of Bombay) available for sale were circulated to parties and persons interested in cattle-breeding.

(5) I visited Wellington from 26th to 28th May, 1924, for the inspection of the Dairy Institute there and at the same time the Ex-Officers' Farm at Lovedale was also visited.

APPENDIX I.

Syllabus of Studies for Dairy Manager's Course at the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

I. Animal Husbandry.

1. *Principles of Breeding*:—Heredity; Selection; Influence of sire and dam; Breeding systems; Mendellism.
2. *Feeds and Feeding*:—Functions of food; Food nutrients; Digestion of food; Food requirements; Feeding standards including balanced rations; Indian feeding stuffs.
3. *Dairy Farm Management*:—Cultivation of special fodder crops for dairy cattle feed; Irrigation; Rotation of crops; Dairy farm buildings (cattle sheds, godowns, calf pens, silos, milk recording rooms, and purely farm buildings).
4. *Dairy Cattle*:—Indian breeds of milch cows; Foreign breeds of milch cows; Indian breeds of milch buffaloes; Draught cattle (bullocks and buffaloes); The dual purpose animal; Calf rearing.
5. *Stock Judging*:—Handling and examination of the living animals to estimate age, milking qualities, draught qualities, value, etc.
6. *Diseases of Dairy Cattle*:—Signs of health and disease; Treatment of wounds and minor troubles; Contagious diseases; Prevention of disease.

II. Dairying.

1. *Dairy Buildings*:—Manager's residences; Dairy factory buildings; City dairies; Farm dairies; Drainage, ventilation and sanitation of dairy buildings.
2. *Milk Production Handling and Sale*:—Milking by hand; Milking by machine; Recording of milk yields; Milk pasteurising by different methods; Milk cooling; Milk bottling and distribution; Cold storage and rail transport of milk; Marketing dairy produce.
3. *Butter and Ghee Manufacture*:—Separation of milk by hand and power machines; Treatment of cream for butter making; Churning by hand and power; Working, salting, and making up; Packing, cold storage, and transport of butter; Ghee manufacture, packing and transport.
4. *Cheese Manufacture*:—Manufacture of Cheddar cheese; Curing hard cheese in cold storage; Manufacture and ripening of soft cheese.
5. *Utilization of Dairy By-Products*:—Casein manufacture; Whey butter; Dried and condensed milk, etc.

6. *Dairy Chemistry*:—Testing of new milk, separated milk, butter milk and whey by Gerber or Babcock and quantitative methods; Testing of butter, cheese and ghee for fat contents, moisture, salt, etc., etc.; Detection of preservatives in milk and dairy products; Detection of adulterants in milk and dairy products; Analysis of feeding stuffs and detection of adulteration of feeding stuffs.

7. *Dairy Bacteriology*:—Principles of cleanliness; Estimation of bacterial contents of dairy products air and water; Preparation of pure cultures for cream ripening and cheese manufacture.

8. *Dairy and Farm Engineering*:—Cultivating and harvesting implements and machines; Prime movers, steam boilers, steam engines, internal combustion engines and electric motors; Pumps and water raising apparatus; Farm yard machines, silage cutters, grinding mills.

Dairy Machinery:—Pasteurisers, milk pumps, coolers cream separators, churns, butterworkers, milk sterilising plant, ghee boiling plant, milk testers.

Refrigerating Machinery:—Principles of mechanical refrigeration compressor, condensers, evaporators, ice making systems, construction of cold storage rooms.

Milk Delivery Vehicles:—Their construction and maintenance.

9. *Principles of Co-operative Dairying.*

10. *Book-keeping and Records*:—Milk records, animal history records, pedigree records. Cultivation registers, commercial dairy book-keeping including preparation of trading accounts, balance sheets and costing systems.

APPENDIX II.

Balance Sheet of the Imperial Cattle Breeding Farm, Karnal, as at 31st March 1924.

Liabilities	Rs. A. P.	Rs. A. P.	Assets	Rs. A. P.	Rs. A. P.
			By Capital :—		
To Liabilities	3,110 10 0	..	Land	89,358 0 0	..
„ Government	2,70,197 11 6	2,73,038 5 6	Buildings	57,943 6 10	..
			Live stock { Dairy 36,226-8-10 / Drought 3,007 0 0 }	39,233 8 10	..
			Plant and furnishing . .	60,708 7 0	2,47,243 6 8
			By stock	30,329 5 0	..
			By cash in hand . . .	..	..
			By outstandings . . .	3,728 7 8	34,057 12 8
To Profit made up to previous year	..	..	By Loss sustained up to previous year.	..	..
„ Profit made in current year .	7,662 13 10	7,662 13 10	By Loss sustained in current year	..	..
TOTAL .	..	2,81,301 3 4	TOTAL .	..	2,81,301 3 4

APPENDIX III.

Capital Account of the Imperial Cattle Breeding Farm, Karnal, for the period 1st July 1923 to 31st March 1924.

Particulars	Land and improvements to land	Buildings and accessories	Live-stock		Plant, Machinery and implements	Total
			Dairy cattle	Draught animals		
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1. Opening balance on 1st July 1923	..	..	..	..	..	..
2. Taken over from M. D. F. Karnal on 1-7-23.	89,358 0 0	47,928 0 0	..	7,495 0 0	54,092 2 2	1,98,873 2 2
3. Purchases	..	9,563 15 10	41,145 2 0	175 0 0	25,644 1 0	76,528 2 10
4. Transfer from other Farms and Departments	..	1,418 7 0	..	..	..	1,418 7 0
5. Appreciation charges	..	..	..	..	..	..
6. Increase in value through re-valuation by biennial or other valuation committees.	..	..	690 0 0	..	..	690 0 0
7. Transfers from stock	..	..	..	..	..	..
Net increases (4+5+6)	..	..	690 0 0	..	..	690 0 0
Grand Total	89,358 0 0	58,910 8 10	41,835 2 0	7,670 0 0	79,736 3 2	2,77,509 12 0
1. Depreciation charges	..	531 8 0	..	228 0 0	2,810 8 2	3,573 0 2
2. Decrease in value through re-valuation by biennial or other valuation committees.	..	..	..	..	..	..
3. Casualties	..	..	5,608 9 2	400 0 0	..	6,008 9 2
4. Condemnations	..	..	..	4,035 0 0	..	4,035 0 0
5. Transfers to other Farms and Departments	..	..	..	..	16,217 4 0	16,217 4 0
6. Transfers to stock	..	432 8 0	..	..	..	432 8 0
Net reductions (1 to 6)	..	967 0 0	5,608 9 2	4,663 0 0	19,027 12 2	30,266 5 4
Closing balance on 31st March 1924	89,358 0 0	57,943 6 10	36,226 8 10	3,007 0 0	60,708 7 0	2,47,243 6 8

Dr. APPENDIX IV. Cr.

Trading Account of the Imperial Cattle Breeding Farm, Karnal, for the period 1st July 1923 to 31st March 1924.

	Particulars	Expenditure	Amount due by dairy at end of the period	Value of stocks at beginning of the period	Total (2+3+4)	Amount due by dairy at beginning of the period	Value of stocks at end of the period	Total deductions (6+7)	Net expenditure for the period (5—8)
	1	2	3	4	5	6	7	8	9
		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
	To Expenditure as per Cash Book under the revenue heads—								
Direct charges.	1. Grain and fodder . . .	2,475 0 0	15 4 0	31,153 14 6	31,604 3 0	..	22,023 8 9	22,023 8 9	10,080 10 3
	2. Rent and grazing . . .	..	..	..	..	..	..	..	..
	3. Purchase of dairy produce . .	..	..	..	..	..	..	..	..
	4. Ice, salt, acid, etc. . . .	362 12 0	1 1 0	359 2 1	723 2 1	..	173 7 0	173 7 0	549 11 1
	Accommodation.								
Standing charges.	5. Rent of hired buildings . .	..	..	..	..	..	..	..	..
	6. Repairs (Stores and Charges) .	1,275 5 9	1,751 0 6	639 11 5	3,266 10 8	..	1,372 14 9	1,372 14 9	1,893 11 11
	7. Rents and taxes	..	..	..	..	..	..	..	..
	8. Conservancy charges . . .	42 3 0	..	..	42 3 0	..	..	..	42 3 0
	Plant and Machinery.								
	9. Workshops, repairs, etc. (Stores and Charges).	571 3 9	3 5 0	4,692 14 7	5,267 7 4	..	3,824 9 0	3,824 9 0	1,442 13 10
	Production of Grain and Fodder.								
	10. Cultivation charges . . .	6,875 8 0	134 11 0	1,130 11 1	8,140 14 1	..	97 2 2	97 2 2	8,043 11 11

General.	*Fuel, light, water and misc. stores.*								
	11. Fuel, light, water, etc. . . .	406 8 3	22 3 0	2,101 6 4	2,023 1 7	..	951 9 2	951 9 2	1,071 8 5
	12. Durable articles costing Rs. 200 or less each.	332 12 0	..	420 1 8	702 13 8	..	631 6 4	631 6 4	101 7 4
	12-A. Medical Stores	175 14 2	3 2 0	668 4 0	847 1 2	..	614 0 1	614 0 1	232 11 1
Administration charges.	*Farm establishment and contingencies.*								
	13. Pay and allowances of European managers and students.	4,680 0 0	585 0 0	..	5,265 0 0	..	..	..	5,265 0 0
	14. Pay and allowances of Indian Establishments.	8,090 10 1	1,106 1 0	..	9,196 11 1	..	..	..	9,196 11 1
	15. Leave and superannuation allowances.	..	..	..	..	..	..	..	..
	16. Contingencies and miscellaneous charges. .	715 3 0	8 10 6	31 4 3	785 1 9	..	40 2 3	40 2 3	744 15 6
	17. Refund of coupons and deposits .	..	..	..	..	..	..	..	..
	Transportation charges.								
	18. Travelling allowance and outstation allowances.	968 11 0	209 8 0	..	1,178 3 0	..	..	..	1,178 3 0
	19. Rail charges	..	..	..	..	..	..	..	..
	20. Sea, mechanical transport and road charges.	..	..	..	..	..	..	..	..
	21. *Head Quarters and other yearly charges.*	..	..	..	..	..	..	..	..
	TOTAL .	27,011 11 6	3,140 10 0	41,580 5 11	72,032 11 5	..	30,329 5 0	30,329 5 0	41,703 6 5
	To net reductions in the value of Capital as per the attached Capital account . .								30,266 5 4
	To Profit made .								7,662 13 10
	GRAND TOTAL .								79,632 9 7

Dr. Cr.

Trading Account of the Imperial Cattle Breeding Farm, Karnal, for the period 1st July 1923 to 31st March 1924—concld.

Particulars	Receipts	Amount due to dairy at the end of the period	Total (11+12)	Amount due to dairy at beginning of the period	Net receipts for the period (13—14)
10	11	12	13	14	15
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
By receipts as per Cash Book under the revenue heads :—					
1. Dairy produce	838 2 11	1,012 7 0	1,850 9 11	....	1,850 9 11
2. Sale of skins	7 8 0	....	7 8 0	....	7 8 0
3. Grain and fodder	44,890 10 3	1,678 13 9	46,569 8 0	....	46,569 8 0
4. Piggery receipts	....	....	....	....	....
5. Miscellaneous receipts	9,061 12 8	347 3 0	9,408 15 8	....	9,408 15 8
By receipts as per cash Book under capital heads :—					
1. Land and improvements to land	....	....	....	....	....
2. Buildings and accessories	....	....	....	....	....
3. Live stock— Dairy cattle	....	....	....	....	....
4. Live stock— Draught animals	4,310 0 1	109 15 11	4,420 0 0	....	4,420 0 0
5. Plant, machinery and implements	16,106 0 0	580 0 0	16,686 0 0	....	16,686 0 0
TOTAL	75,214 1 11	3,728 7 8	78,942 9 7	....	78,942 0 7
By net increase (other than purchases and transfers from other farms and departments) in the value of Capital as per the attached Capital Account					690 0 0
By loss sustained					....
				GRAND TOTAL	79,632 9 7

APPENDIX V.

Statement showing the outturn of grain and fodder on the Imperial Cattle Breeding Farm, Karnal, during the 9 months ending 31st March 1924.

Description of grain and fodder.	Outturn in lb.
Gram seed	218,548
Anjan grass seed	120
Ziri seed (Rice with husk)	160,950
Oat seed	18,400
Toria seed	238
Wheat 8 A	141,680
Maize cobs	2,014
Feeding hay	193,948
Oat straw	32,000
Wheat *bhoosa*	197,100
Mixed *bhoosa*	149,200
Bedding hay	5,029
Gur	19,892

APPENDIX VI.

Produce Statement of the Imperial Cattle Breeding Farm, Karnal, for 9 months ending 31st March 1924.

Number of Government owned cows in milk each day multiplied by number of days in year	Average yield of Government owned cows in milk per day	Average percentage of cows herd in milk during year	Milk							
			Produced by Government owned herd	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lb. milk required to make 1 lb. butter	Manufactured
	lb.		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
In milk, 4,319 . . .	7·3	92·6	31,781	20,256	5,125	475-2	456-10	4,949-14	20·3	10
					Issued to Farm Stock	Water	Churned			
					lb.	lb. oz.	lb. oz.			
Dry, 344 . . .	..	..	..	..	100	7 2	25 10	...	..	..

APPENDIX VII.

Disposal of produce of the Imperial Cattle Breeding Farm, Karnal, for 9 months ending 31st March 1921.

New milk sold		Separated milk fed to farm stock	Cream		Butter sold to farm employees at 12 annas per lb.	Total receipts for dairy produce as shown in the Cash Book
To officers and civilians at 1 anna per lb.	To farm employees at 1 anna per lb.		Sold	Average price per lb.		
		lb. oz.	lb. oz.	Rs. A. P.	lb.	Rs. A. P.
15,299½ lb.	8151	4,919 14	156 10		10	838 2 11
@ 18½ lb. per rupee			As per follows:—			
			lb. oz.			
2,272 lb.			6 6	0 12 0		
@ 14 lb. per rupee.						
			450 4 on butter outturn, i.e., lb. oz. 119 8 Butter outturn.	1 0 0		
7,839 lb.						

APPENDIX VIII.

Herd Statistics of the Imperial Cattle Breeding Farm, Karnal, 1st July 1923—31st March 1924.

	Adult stock cows		Young stock cows				Calves cows				Draught cattle		
			Bulls		Heifers		Bulls		Heifers				
	Bulls	Cows	Imported	Country	Imported	Country	Imported	Country	Imported	Country	Cow Bullock	Cow Bullocks C. B.	Ponies.
Strength of herd on 1-7-23.	..	..	..	..	..	..	..	..	..	..	..	..	..
Taken over from M. D. F. Karnal on 1-7-23.	..	..	..	..	..	..	..	..	..	..	16	4	3
Born . . .	..	..	..	..	..	..	..	1	1	2	..	..	..
Purchased . .	2	61	1	1	1	1	..	27	..	25	..	..	1
Average price paid for animals purchased including freight.	..	..	..	..	..	..	..	..	..	..	..	..	..
Transferred from—													
Other Government dairies.	..	..	..	..	..	..	..	..	..	..	..	..	..
Young Stock . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Calves . . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Total .	2	61	1	1	1	1	..	28	1	27	46	4	4
Transferred to—													
Other Government dairies.	..	..	..	..	..	..	..	..	..	..	..	..	..
Adult stock . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Young stock . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Lost . . .	..	..	..	..	..	..	..	..	..	..	..	..	..
Died . . .	..	..	1	..	1	..	..	1	..	1	..	..	1
Sold . . .	..	..	..	..	..	..	..	..	..	..	30	..	1
Average price for animals sold.	..	..	..	..	..	..	..	..	..	..	..	..	..
Total .	..	..	1	..	1	..	..	1	..	1	30	..	2
Strength of herd 31st March 1924.	2	61	..	1	3	1	..	27	1	26	16	4	2

Note.—Animals to be considered as calves until 12 months old and thereafter to be classed as "young stock" and to be transferred to that heading.

APPENDIX IX.

Balance Sheet of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, as at 31st March 1924.

Liabilities						Assets					
	Rs.	A.	P.	Rs.	A.	P.		Rs.	A.	P.	Rs.	A.	P.
							By Capital :—						
To liabilities	14,689	13	4	..			Lands	22,053	0	0	..		
„ Government	3,34,748	4	4	3,49,438	1	8	Buildings	1,48,782	0	0	..		
							Live Stock—						
							Dairy	84,085	0	0	..		
							Draught	2,392	0	0	..		
							Plant and furnishing	42,679	0	0	3,00,891	0	0
							By Stock	41,610	12	7	..		
							By Cash in hand	287	13	10	..		
							By outstandings	15,178	4	11	57,076	15	4
To Profit made up to previous year	..			..			By Loss sustained up to previous year	..			..		
„ Profit made in current year	8,529	13	8	8,529	13	8	By Loss sustained in current year	..			..		
TOTAL	3,57,967	15	4	3,57,967	15	4	TOTAL	3,57,967	15	4	3,57,967	15	4

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APPENDIX X.

Capital Account of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the period from 1st July 1923 to 31st March 1924.

Particulars	Land and improvements to land	Buildings and accessories	Live stock		Plant, Machinery and implements	Total
			Dairy cattle	Draught animals		
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs A P
1. Opening balance on 1st July 1923 . .	22,953 0 0	1,36,773 0 0	52,857 0 0	3,097 0 0	27,102 0 0	2,42,782 0 0
2. Purchases	..	13,065 11 8	25,414 7 3	..	17,662 6 4	56,742 9 3
3. Transfers from other Farms and Departments	..	..	450 0 0	..	900 0 0	1,350 0 0
4. Appreciation charges	..	..	..	..	..	..
5. Increase in value through re-valuation by biennial or other valuation committees.	..	..	18,285 0 0	..	..	18,285 0 0
6. Transfers from stock	..	174 9 0	..	..	..	174 9 0
Net increases (4+5+6)	..	174 9 0	18,285 0 0	..	..	18,459 9 0
GRAND TOTAL .	22,953 0 0	1,50,613 4 8	97,006 7 3	3,097 0 0	45,664 6 4	3,19,334 2 3
1. Depreciation charges	..	1,831 4 8	..	..	2,551 6 4	4,382 11 0
2. Decrease in value through re-valuation by biennial or other valuation committees.	..	..	1,022 14 9	171 0 0	..	2,096 14 9
3. Casualties	..	..	4,232 4 0	172 0 0	..	4,404 4 0
4. Condemnations	..	..	2,998 0 0	59 0 0	..	3,057 0 0
5. Transfers to other farms and Departments .	..	..	4,068 4 6	..	434 0 0	4,502 4 6
6. Transfers to stock	..	..	..	..	..	..
Net reductions (1 to 6)	..	1,831 4 8	12,921 7 3	705 0 0	2,985 6 4	18,443 2 3
Closing balance .	22,953 0 0	1,48,782 0 0	84,085 0 0	2,392 0 0	42,679 0 0	3,00,891 0 0

APPENDIX XI.

Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for 9 months ending 31st March, 1924.

	ADULT STOCK				YOUNG STOCK				CALVES				DRAUGHT CATTLE			
	Cows		Buffaloes		Cows		Buffaloes		Cows		Buffaloes		Bulls or Bullocks		Buffaloes	
	Bulls	Cows	Bulls	Cows	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Cow bullocks	Buffalo bullocks	Mules	Ponies
Number in herd on 1st July 1923.	5	125	..	..	6	71	..	..	6	37	..	..	25	2	2	11
Born during the period from 1st July 1923 to 31st March 1924.	..	..	..	..	..	..	..	.	43	18	..	..	..	..	..	..
Purchased during the period from 1st July 1923 to 31st March 1924.	3	20	2	6	..	1	2	..	12	7	2	2	..	..	..	..
Heifers transferred to milking herd.	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calves transferred to heading "Young Stock."	..	..	..	..	4	24	..	..	..	..	..	..	..	..	..	..
Young stock transferred to heading "bullocks."	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	.
TOTAL .	8	160	2	6	10	96	2	..	61	92	2	2	30	2	2	11
Transferred to other Farms and departments.	..	8	1	..	..	8	..	..	..	..	..	..	..	..	..	..
Died . . .	..	7	..	..	..	4	..	..	26	14	1	..	3	..	..	.
Sold . . .	2	8	..	..	..	..	..	..	4	2	..	..	1	..	..	..
Heifers transferred to milking herd	..	..	..	..	..	15	..	..	..	..	..	..	..	..	..	
Calves transferred to heading "Young Stock."	..	..	..	..	..	..	..	..	1	24	..	..	..	..	..	..
Young stock transferred to heading "bullocks."	..	..	..	..	5	..	..	..	..	..	..	.	..	..	..	..
TOTAL .	2	23	1	..	5	27	..	..	34	40	1		4	.	.	.
Number in herd on 31st March 1924.	6	137	1	6	5	69	2	..	27	52	1	2	26	2	2	11

NOTE. Animals to be considered as calves until 9 months old and on reaching that age to be classed as 'young stock" and to be transferred to that heading.

Dr.

APPENDIX XII.

Trading Account of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the period 1st July 1923 to 31st March 1924.

	Particulars	Expenditure	Amount due by dairy at end of the period	Value of Stocks at beginning of the period	Total (2+3+4)	Amount due by dairy at beginning of the period	Value of stocks at end of the period	Total deductions (6+7)	Net expenditure for the period (5—8)
	1	2	3	4	5	6	7	8	9
		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
	Expenditure as per Cash Book under the revenue heads :—								
Direct charges.	1. Grain and fodder	27,074 8 0	4,466 7 0	25,706 12 0	57,247 11 0	..	23,795 7 10	23,795 7 10	33,452 3 2
	2. Rent and grazing	155 0 0	342 14 10	..	497 14 10	..	..	..	497 14 10
	3. Purchase of dairy produce	35,314 10 3	267 2 6	474 9 0	36,056 5 9	..	239 4 6	239 4 6	35,817 1 3
	4. Ice, salt, acid, etc.	820 1 0	..	581 2 5	1,410 3 5	..	214 0 7	214 0 7	1,196 2 10
	Accommodation.								
Standing charges.	5. Rent of hired buildings	..	..	..	..	..	..	..	..
	6. Repairs (Stores and Charges)	1,708 15 11	30 0 0	2,912 14 1	4,651 14 3	..	2,941 8 1	2,941 8 1	1,710 6 2
	7. Rents and taxes	..	..	..	..	..	..	..	..
	8. Conservancy charges	..	..	..	..	..	..	..	..
	Plant and machinery.								
	9. Workshops, repairs, etc. (Stores and Charges).	3,457 11 2	..	3,155 7 10	6,613 3 0	..	3,304 0 11	3,304 0 11	3,309 2 1
	Production of Grain and Fodder.								
	10. Cultivation charges	320 0 0	..	62 8 7	382 11 7	..	52 12 0	52 12 0	330 2 7

General	*Fuel, light, water and misc. stores.*								
	11. Fuel, light, water, etc. . . .	6,831 13 11	..	7,357 11 3	14,189 0 2	..	9,239 14 11	9,239 14 11	4,949 10 3
	12. Durable articles costing Rs. 200 or less each.	1,006 11 0	..	672 0 0	1,768 11 0	..	1,152 0 0	1,152 0 0	616 11 0
Administration charges.	*Farm establishment and contingencies.*								
	13. Pay and allowances of European managers and students.	5,563 0 0	701 12 0	..	6,265 2 0	..	..	..	6,265 2 0
	14. Pay and allowances of Indian Establishments.	16,280 14 2	2,160 12 0	..	18,450 10 2	..	..	..	18,450 10 2
	15. Leave and superannuation allowances.	..	1,028 14 0	..	1,028 14 0	..	..	..	1,028 14 0
	16. Contingencies and miscellaneous charges.	9,012 1 4	4,970 11 0	420 15 0	14,363 11 4	..	671 2 9	671 2 9	13,692 8 7
	17. Refund of coupons and deposits .	200 1 6	..	..	200 1 6	..	..	..	200 1 6
	Transportation charges.								
	18. Travelling allowance and out-station allowances.	1,140 13 0	152 4 0	..	1,302 1 0	..	..	..	1,302 1 0
	19. Rail charges	837 7 6	..	..	837 7 6	..	..	..	837 7 6
	20. Sea, mechanical transport and road charges.	..	..	..	..	..	..	..	..
	21. *Head quarters and other yearly charges.*	..	..	..	..	..	..	..	..
	TOTAL .	1,09,811 8 9	14,089 13 4	41,314 0 5	1,65,875 6 6	..	41,010 12 7	41,010 12 7	1,24,264 9 11
	To net reductions in the value of Capital as per the attached Capital account								18,443 2 3
	To profit made .								8,529 13 8
	GRAND TOTAL .								1,51,237 9 10

NOTE. The figures in columns 12 and 14 represent the amount due to the dairy by customers less the amount due to customers by the dairy for unredeemed coupons and deposits.

APPENDIX XII.

Cr.

Trading Account of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the period 1st July 1923 to 31st March 1924.

Particulars	Receipts	Amount due to Dairy at the end of the period	Total (11 12)	Amount due to dairy at beginning of the period	Net receipts for the period (13—14)
10	11	12	13	14	15
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
By receipts as per Cash Book under the revenue heads—					
1. Dairy produce	1,05,594 11 3	9,493 7 10	1,15,091 3 1		1,15,091 3 1
2. Sale of skins	3 0 0		3 0 0		3 0 0
3. Grain and fodder	191 14 7	84 2 8	191 1 1		191 1 1
4. Fishery receipts					
5. Miscellaneous receipts	5,250 4 4	4,856 8 1	10,106 10 5		10,101 13 5
By receipts as per Cash Book under capital heads—					
1. Land and improvements to land					
2. Fittings and accessories					
3. Live stock— Dairy cattle	6,774 13 7	242 1 6	7,017 2 1		7,017 2 3
4. Draught animals	25 0 0		25 0 0		25 0 0
5. Plant, machinery and implements		131 0 0	131 0 0		131 0 0
TOTAL	1,17,249 11 11	15,178 4 11	1,32,778 0 10		1,32,778 0 10
By net increase (other than purchases or transfers from other farms and departments) in the value of Capital as per the attached Capital Account					18,459 0 0
By loss sustained					
				GRAND TOTAL	1,51,237 0 10

APPENDIX XIII.

Statement showing the outturn of crops on the Imperial Institute of Animal Husbandry and Dairying, Bangalore, during the 9 months ending 31st March 1924.

Where grown	Description of fodder	Outturn in lb.
Bangalore	Green sorghum	702,320
	Green sunflower	20,800
	Rhodes grass, green	34,935
	Guinea-grass, green	218,445
	Lucerne, green	226,666
Bommanapally	Hay	91,020
	Dry sorghum	28,620
	TOTAL	1,322,806

APPENDIX XIV.

Produce Statement of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, 9 months ending 31st March, 1921.

NUMBER OF GOVERNMENT OWNED ANIMALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR		AVERAGE YIELD OF GOVERNMENT OWNED ANIMALS IN MILK PER DAY		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR		MILK								BUTTER			
															PURCHASED		Average price paid per lb. for butter purchased
Cows	Buffaloes	Cows	Buffaloes	Cows	Buffaloes	Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lb. milk required to make 1 lb. butter	Manufactured	From Govt. Farms	From other Sources	
		lb.	lb.			lb.	lb	lb.	lb.	lb.	lb.	lb	lb.	lb.	lb.	lb.	Rs. A. P.
In milk. 26,630	In milk. 870	All over herd. 11 5	All over herd. 20 1	73 96	Cent per cent.	4,20,330	681	3,07,301	62,768	6,268	1,305	56,500	19 9	2,170	Purchased. 300	20,000	1 2 8
Dry. 5,428		In milk. 15 2	In milk. 20 1												Surplus. 375		

APPENDIX XV.

Disposal of produce of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, 9 months ending 31st March 1924.

To Wellington Institute	NEW MILK				Separated milk fed to farm stock	CREAM		BUTTER			
	SOLD			Loss		Sold	Average price per lb.	SOLD			To Farm Stock
	To hospitals and prisons	To officers and civilians	To troops					To hospitals and prisons	To civilians and officers	To troops	
				lb.	lb	lb.	Rs. a. p.				lb.
3,715 lb. @ 0-3-7 per lb.	69,184 lb @ 0-4-0 per lb.	42,054 lb. @ 0-3-6 per lb.	91 992 lb. @ 0-3-0 per lb. To married families. 92,150 lb. @ 0 2 0 per lb.	8,519 lb. Loss. To Farm Stock. 46,319 lb.	56,300	1,365	1 12 0	4,253 lb. @ 2-0 0 per lb.	5,806 lb. @ 1-10-0 per lb	20,033 lb. @ Rs. 1-8 0 per lb. To Troops 250 lb. @ Rs. 1-8-0 per lb. To Wellington Institute. 3,367 lb. @ Rs. 1-6 0 per lb. To Married Families.	18

Stock in hand at beginning and close of year.

—	New milk	Separated milk	Cream	Butter	Ghi
	lb.	lb.	lb.	lb.	lb.
At 1st July 1923	..	..	13	301	..
At 31st March 1924	80	..	0-2	140	..

APPENDIX XVI.

Statement showing yields of cattle on the Imperial Institute of Animal Husbandry and Dairying, Bangalore, during the 9 months ending 31st March 1924.

Yield	Number of cows
Under 1,000 lb.	5
Between 1,000 and 2,000 lb.	6
Between 2,000 and 3,000 lb.	8
Between 3,000 and 4,000 lb.	19
Between 4,000 and 5,000 lb.	23
Between 5,000 and 6,000 lb.	20
Between 6,000 and 7,000 lb.	7
Between 7,000 and 8,000 lb.	2
Between 8,000 and 9,000 lb.	1
Between 9,000 and 10,000 lb.	2
Between 10,000 and 11,000 lb.	...
Between 11,000 and 12,000 lb.	...
Between 12,000 and 13,000 lb.	1

APPENDIX XVII.

Balance sheet of the Imperial Institute of Animal Husbandry and Dairying, Wellington as at 31st March 1924.

Liabilities	Amount	Assets	Amount
	Rs. A. P.		Rs. A. P.
To Liabilities . .	2,425 2 0	By Capital— Lands . . .	8,067 0 0
„ Government . .	1,43,611 4 8	Buildings . .	66,225 0 0
„ Profit . . .	1,010 15 1	Live stock Dairy .	35,220 0 0
		Live stock Draught .	1,435 0 0
		Plant, machinery and Implements.	13,020 0 0
		TOTAL .	1,24,576 0 0
		By stock .	18,130 7 3
		By outstandings .	4,340 15 3
TOTAL .	1,47,047 6 6	TOTAL .	1,47,047 6 6

Dr. APPENDIX XVIII.

Trading Account of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the period 1st July 1923 to 31st March 1924.

Particulars	Expenditure	Amount due by dairy at end of the period	Value of stocks at beginning of the period	Total (2+3+4)	Amount due by dairy at beginning of the period	Value of stocks at end of the period	Total deductions (6+7)	Net expenditure for the period (5—8)
1	2	3	4	5	6	7	8	9
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
To Expenditure as per Cash Book under the revenue heads—								
1. Accommodation—Rent and Repairs to Buildings including conservancy charges.	539 12 0	23 11 0	582 10 0	1,146 1 0	..	514 10 0	514 10 0	631 7 0
2. Repairs to plant and machinery	287 13 0	18 0 0	881 7 7	1,187 4 7	..	942 0 6	942 0 6	245 4 1
3. Feed of dairy cattle including grazing charges.	15,119 11 5	197 8 0	16,175 6 7	31,702 10 0	..	7,733 13 10	7,733 13 10	24,058 12 2
4. Hire of cattle and purchase of dairy Produce.	24,757 0 6	..	211 14 0	24,969 7 6	9 12 9	295 2 8	304 15 5	24,664 8 1
5. Ice, salt, acid and other manufacturing sundries.	..	138 8 0	199 10 9	338 2 9	..	260 11 6	260 11 6	77 7 3
6. Production of grain and fodder cultivation.	117 3 5	..	162 2 0	279 5 5	..	23 0 0	23 0 0	256 5 5
7. Fuel, light, water and miscellaneous stores including durable articles.	3,072 8 11	72 5 0	5,173 1 5	8,317 15 4	..	7,394 2 7	7,394 2 7	1,123 12 9
8. Workshops	..	..	..	..	..	..	..	..
9. Medical Stores	5 0 0	..	750 0 2	755 0 2	..	566 14 2	566 14 2	188 8 0
10. Pay and allowances of European Managers and students.	3,869 2 0	304 1 0	..	4,173 3 0	..	..	..	4,173 3 0
11. Pay and allowances of Indian Establishment (Permanent or temporary)	9,124 1 0	1,176 13 0	..	10,300 14 0	..	..	..	10,300 14 0
12. Contingencies and miscellaneous charges including Refund of coupons.	1,151 9 9	398 12 9	322 11 0	1,873 2 3	504 15 3	400 0 0	904 15 3	968 7 0
13. Travelling and outstation allowances	1,763 8 0	60 12 0	..	1,429 1 0	..	..	..	1,429 4 0
14. Rail charges	171 1 6	34 12 0	..	206 0 6	..	..	..	206 0 6
15. Superannuation and leave allowances	662 2 9	..	..	662 2 9	..	..	..	662 2 9
TOTAL	60,516 6 1	2,425 2 9	24,050 0 3	87,630 15 3	514 12 0	18,130 7 3	18,645 3 3	69,985 12 0
To net reductions in the value of Capital as per the attached Capital Account								10,017 2 6
To profit made								1,010 15 1
GRAND TOTAL								80,013 13 7

APPENDIX XVIII—*concld.*

Trading Account of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the period 1st July 1923 to 31st March 1924—continued.

Particulars	Receipts	Amount due to dairy at the end of the period	Total (11+12)	Amount due to dairy at beginning of the period	Net receipts for the period (13—14)
10	11	12	13	14	15
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
By receipts as per Cash Book under the revenue heads—					
1. Dairy produce	63,205 15 10	4,249 8 9	67,455 8 7	..	67,455 8 7
2. Ice sales	..	..	..	..	..
3. Piggery receipts	..	..	..	..	..
4. Grain and fodder	4,088 12 0	72 4 9	4,161 1 6	..	4,161 1 6
5. Miscellaneous receipts	957 7 9	19 1 9	976 9 6	..	976 9 6
TOTAL	68,252 1 4	4,340 15 3	72,593 3 7	..	72,593 3 7
By receipts as per Cash Book under Capital heads—					
1. Lands	..	..	..	..	..
2. Buildings	..	..	..	..	..
3. Live stock	2,160 0 0	..	2,160 0 0	..	2,160 0 0
4. Plant and Furnishings	100 0 0	..	100 0 0	..	100 0 0
TOTAL	70,512 4 4	4,340 15 3	74,853 3 7	..	74,853 3 7
By net additions (other than purchases and transfers from other farms and departments) in the value of Capital as per the attached Capital Account					5,160 10 0
By loss sustained					..
GRAND TOTAL					80,013 13 7

APPENDIX XIX.

Capital Account of the Imperial Institute of Animal Husbandry and Dairying, Wellington for 9 months ending 31st March 1924.

Particulars	Land and improvements to land	Buildings and accessories	Live stock		Plant, Machinery and implements	Total
			Dairy cattle	Draught animals		
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1. Opening balance on 1st July 1923	8,067 0 0	65,070 0 0	26,121 0 0	1,411 0 0	12,787 0 0	1,13,457 0 0
2. Purchases	..	1,073 4 6	13,164 7 0	..	1,437 13 0	15,675 8 6
3. Transfers from other Farms and Departments	..	..	..	..	..	..
4. Appreciation charges	..	..	..	..	..	..
5. Increase in value through re valuation by biennial or other valuation committees.	..	..	3,532 0 0	49 0 0	..	3,581 0 0
6. Transfers from stock	..	814 10 0	..	65 0 0	700 0 0	1,579 10 0
Net increases (4 + 5 + 6)	..	814 10 0	3,532 0 0	114 0 0	700 0 0	5,160 10 0
GRAND TOTAL	8,067 0 0	66,957 14 6	43,117 7 0	1,525 0 0	14,922 13 0	1,34,593 2 6
1. Depreciation charges	..	732 14 6	..	..	1,138 13 0	1,871 11 6
2. Decrease in value through re-valuation by biennial or other valuation committees.	..	..	1,171 0 0	93 0 0	..	1,164 0 0
3. Casualties	..	..	3,286 7 0	..	..	3,286 7 0
4. Condemnations	..	..	3,106 0 0	..	164 0 0	3,370 0 0
5. Transfers to other farms and Departments	..	..	..	..	..	..
6. Transfers to stock	..	..	65 0 0	..	..	65 0 0
Net reductions (1 to 6)	..	732 14 0	7,988 7 0	93 0 0	1,302 13 0	10,017 2 6
Closing balance on 31st March 1924	8,067 0 0	66,225 0 0	35,229 0 0	1,435 0 0	13,620 0 0	1,24,576 0 0

APPENDIX XX.

Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the period ending 31st March 1924.

	ADULT STOCK		YOUNG STOCK		CALVES		DRAUGHT CATTLE	
	Cows		Cows		Cows			
	Bulls	Cows	Bulls	Heifers	Bulls	Heifers	Cow bullocks	Ponies
Strength of herd on 1-VII-1923	3	66	..	..	4	25	13	3
Born	..	..	..	..	21	19	..	..
Purchased	1	1	1	..	..	..	..	..
Average price paid for animals purchased including freight.	Rs. 3,120	Rs. 2,366	Rs. 80	..	..	..	..	..
Transferred from other Government dairies.	1	..	..	..	..	..	..	..
Transferred from Young Stock	..	..	..	..	..	..	..	..
Transferred from Calves	..	..	..	20	..	..	1	..
TOTAL	5	70	1	20	25	44	14	3
Transferred to other Government dairies.	..	..	..	..	..	..	..	..
Transferred to Adult stock	..	..	..	..	..	..	..	..
Transferred to Young stock	..	..	..	..	..	20	..	..
Bullocks	..	..	..	..	1	..	..	..
Died	1	1	..	..	1	4	..	..
Sold	2	3	..	..	16	1	..	..
Average price for animals sold	Rs 700	Rs. 152	..	..	Rs. 4-3-6	Rs. 8-8-0	..	..
TOTAL	3	6	..	..	21	28	..	..
Strength of herd 31st March 1924	2	64	1	20	4	16	14	3

NOTE. Animals to be considered as calves until 12 months old and thereafter to be classed as "young stock" and to be transferred to that heading.

APPENDIX XXI.

Statement showing the outturn of crops on the Imperial Institute of Animal Husbandry and Dairying, Wellington, during the 9 months ending 31st March 1924.

Description of fodder	Outturn in lb.
Maize	89,780
Barley, Oats and wheat	101,209
Berseem	13,760
Sorghum	49,425
Green grass	1,553
TOTAL	255,727

APPENDIX XXII.

Produce Statement of the Imperial Institute of Animal Husbandry and Dairying, Wellington for the period ending 31st March 1924.

NUMBER OF GOVERNMENT OWNED ANIMALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR		AVERAGE YIELD OF GOVERNMENT OWNED ANIMALS IN MILK PER DAY		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR		MILK								BUTTER			
														Manufactured	PURCHASED		Average price paid per lb. for butter purchased
Cows	Buffaloes	Cows	Buffaloes	Cow	Buffalo	Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lbs. milk required to make 1 lb. butter		From Gov. Farms	From other Sources	
		lb	lb			lb.	lb	lb.	lb.	lb.	lb	lb	lb.	lb.	lb.	lb.	Rs. a. p.
In milk 12,515	.	Over Herd in milk. 18 16	.			..	.	.	.	.	..	.	.	.	..	..	..
Dry. 1,905		Over whole Herd 1 05	.	71 87	..	2,27,710	1 020	1,64 884	41,110	3 7 0	1,019	37,097	21 17	1,407	230	19,190½	1 3 9
TOTAL 17,410																*	

APPENDIX XXIII.

Disposal of Produce of the Imperial Institute of Animal Husbandry and Dairying, Wellington for the period ending 31st March 1924.

NEW MILK				SEPARATED MILK			CREAM		BUTTER SOLD TO		
SOLD			LOSS								
To Hospitals and prisons	To Officers and Civilian	To Troop		Sold	Average price per lb.	Fed to farm Stock	Sold	Average price per lb	Hospitals and prisons	Officers and civilian	Troops
Rs. A. P.	Rs. A. P.	Rs A. P		Rs. A P	Rs A P.			Rs A P	Rs A. P	Rs. A P	Rs A P.
@ 0 5 6	@0 3 9	@ 0 3)		@0 2 0	0 2 0			@1 12 0	@ 2 0 0	@1 10 0	@ 1 8 0
24,201	35,642	52,042	1,322	1 700		15,997	1,040		1,232	4 835	12,018
Married families.		Fed to farm stock	Separated					Churned	Married families		Farm stock fed.
@ 0 2 0									@ 1 6 0		
52,309		23,190	11,130		.	..	..	2,680	2,695	..	20

Stock in hand at beginning and close of the Period.

	New Milk	Separated milk	Cream	Butter	Ghi
At 1st July 1923	.	..	..	160½	.
At 31st March 1924	108	..	1	207	.

APPENDIX XXIV.

Statement showing yields of cattle on the Imperial Institute of Animal Husbandry and Dairying, Wellington, during the 9 months ending 31st March 1924.

Yield	Number of cows.
Under 1,000 lb.	2
Between 1,000 and 2,000 lb.	3
Between 2,000 and 3,000 lb.	8
Between 3,000 and 4,000 lb.	10
Between 4,000 and 5,000 lb.	11
Between 5,000 and 6,000 lb.	11
Between 6,000 and 7,000 lb.	7
Between 7,000 and 8,000 lb.	4
Between 8,000 and 9,000 lb.	4
Between 9,000 and 10,000 lb.	1

REPORT OF THE PHYSIOLOGICAL CHEMIST.

(F. J. WARTH, M.Sc., B.Sc.)

I. CHARGE.

Mr. A. V. Iyer acted as Physiological Chemist up to 26th November, 1923, when I took over charge from him.

II. TRANSFER OF THE SECTION FROM PUSA TO BANGALORE.

On 2nd July, 1923, Mr. Iyer received orders that the Section was to be transferred to Bangalore. The experiments initiated by me at Pusa were therefore discontinued and the work of packing apparatus and chemicals taken in hand. The transfer was completed during October.

III. FITTING UP OF THE LABORATORY AND NUTRITION STALLS AT BANGALORE.

The most important work during the year has been the fitting up of the laboratory at Bangalore. This had been commenced when I took over charge, but in view of the increased number of students to be accommodated the fitting up had to be temporarily stopped by me, while the plans were modified to provide the necessary additional accommodation. The constructional work on the Physiological Chemist's laboratory and on the students' lecture room and laboratory was then pushed on and had been practically completed by the 31st of March. Since then the gas and water supplies have been set up. The laboratory is almost ready for work now and will be able to undertake the most essential analyses for feeding experiments within three weeks. Two buildings which include nutrition stalls and the requisite store and recording rooms for nutrition experiments were designed and constructed by the end of March. Since then fittings have been added. These buildings are now in use for preliminary trials. The weighbridge has been set up and is now in daily use.

IV. Training of Post-graduate Students.

The short experience gained during the three months of this work has shown that this training course is one of the most important and useful functions of the Nutrition Section. Having the entire dairy herd including cows of known pedigree and performance as well as a complete range of young stock to select from for experimental purposes and having at the same time the services of a laboratory devoted to nutrition work, it is possible for the post-graduate students to carry out instructive and useful nutrition experiments. The course of training which covers one year includes :—

(*a*) An advanced lecture course on animal nutrition.

(*b*) The planning and carrying out of a nutrition experiment under the direction of the Physiological Chemist.

(*c*) The study of all nutrition experiments in progress here.

The work is thoroughly practical. The students have to handle and care for the animals in their charge, and have to study their feeding capacity and rationing.

Five students (3 from the Punjab and 2 from Bombay) are at present undergoing training.

The practical work on which they are engaged includes feeding of calves, determination of production value of certain rations for young stock and feeding experiments in relation to milk production.

V. Collaboration with Provincial Departments in work on Animal Nutrition.

An experiment on the production value of certain rations has been prepared and detailed instructions for its execution drawn up for the Madras Department of Agriculture. This experiment is now being carried out at Coimbatore. A similar experiment with different rations

has been drawn up for the Mysore Department of Agriculture. The trial is being conducted at the Mysore Palace Dairy Farm, Rayankere, assistance in laboratory work being provided by the Physiological Chemist.

In conclusion, it is to be noted that the last six months have been mainly spent in fitting up the laboratory. In anticipation of its completion the work outlined above has been commenced. Now that the laboratory is ready, these tests will be put on a quantitative basis.

VI. Programme of work for 1924-25.

A. Major Subjects.

1. Determination of digestion coefficients of important Indian coarse fodders and concentrates.

2. The study of the nitrogen metabolism of Indian cattle and the determination of maintenance rations.

3. A study of rations for milk production.

4. Experiments on the nutrition of growing animals.

B. Minor Subject.

1. A study of some of the chemical methods involved in the above enquiries.

C. Training of post-graduate students in animal nutrition.

This is a new and distinct branch of the work of the Physiological Chemist.

REPORT OF THE SECRETARY, SUGAR BUREAU.

(WYNNE SAYER, B.A.)

I held charge of the office of the Secretary, Sugar Bureau, throughout the year. The subordinate staff remained unchanged, except for the addition of two Fieldmen sanctioned for one year from 1st April, 1924. The Bureau still continues on a temporary footing, its term having been extended till 31st March, 1925, and the handicap imposed by this hand-to-mouth existence was more marked than ever.

Besides answering enquiries from the public on all matters pertaining to sugar as far as possible with the limited staff available, the Bureau carried out important work on the agricultural, commercial and industrial sides of the sugarcane industry. These activities are briefly described below.

I. AGRICULTURAL.

At the close of last year's activities, the Bureau had brought the selected varieties Co 214, 213 and 210 to the stage of large scale distribution. As a result of these activities, all large growers in North Bihar and those in the United Provinces whose estates march with the Bihar White Sugar Tract were provided with these canes. In spite of the monsoon of 1923 proving to all intents a failure in parts of North Bihar, these canes did extremely well and the growers were perfectly satisfied with the results they obtained. For their appreciation of these canes distributed by the Bureau, reference may be made to the article on "Selected Coimbatore Canes in Growers' Fields in North Bihar" published in the "Agricultural Journal of India," Vol. XIX, Part V.

The superiority of these Coimbatore varieties over the local cane Bhurli from the factory point of view is shown

graphically in the chart opposite which gives the results of analyses carried out weekly from 17th November 1923 to 24th April 1924. The comparative curves of Bhurli and Co 213 for $\frac{\text{sucrose}}{\text{fibre}}$ per cent. show that whereas Co 213 improves during the season, Bhurli deteriorates in this respect. It may be mentioned that each analysis was made on an entire stool of cane.

As mentioned in last year's report, the main scheme for growing these three Coimbatore varieties for supply as seed-cane to large cane-growers in the White Sugar Tract was carried through during the year, financed by funds placed at my disposal by the growers concerned. In spite of the fact that Pusa in 1923 suffered from the worst monsoon within memory—24 inches against a normal 45—the crop was excellent. The effect of the short rainfall was, however, distinctly evident in the reduced tonnage due to the canes failing to fill out. (Optimum tonnage will always be linked to optimum rainfall.) The result was that we were short of nearly one-fourth of the quantity we had undertaken to supply. But with some 10,000 maunds of Co 210 and Co 213 made available from Sipaya where these canes were also grown on a large scale by the Deputy Director of Agriculture, Bihar and Orissa, we were able to fulfil our part of the contract and my thanks are due to that officer for his invaluable assistance in this matter. The short monsoon was followed by a total failure of winter rains and the canes distributed were of necessity planted in land deficient in moisture. An exceptionally severe hot weather followed and the rains did not break till 20th June. This combination of circumstances has formed the severest test possible, but in the reports now being received all growers are unanimous in stating that these canes have gone through this exceptional test far more successfully than the local cane and a good crop is assured. This means that North Bihar is now established with these three improved canes and their rapid increase in growers' hands is merely a question of time. To sum up—the White Sugar Tract has now got three canes which will completely revolutionize the

sugar industry, and the Sugar Bureau is fully justified of the foresight and initiative displayed in its agricultural policy. A policy of complete distribution is now being formulated in which I hope the Local Government will participate, as my small staff, which has so successfully shown the way, can hardly be expected to go further. Both factories and growers are now convinced of the value of the work and willing to afford all the assistance in their power. What is wanted now is a definite policy on the lines of which work can be planned out for a term of years instead of the present hand-to-mouth existence which effectually smothers any detailed programme for the future.

These canes have also been sent to Antigua in the West Indies where they are making splendid progress according to the reports received from those to whom they were supplied. Java and Formosa also asked for Co 210 and Co 213. The careful watch these countries keep on all cane work being done elsewhere speaks volumes for the initiative of the authorities in those countries.

During the year under report, these canes were sent up to the Punjab for trial at Gurdaspur and Lyallpur and also for growing on the British Cotton Growing Association's farm at Khanewal. They have also been supplied to Burma where Messrs. Finlay, Fleming & Co. intend to test them on their sugarcane estate at Sahmaw. I have also sent up Co 213 for trial on the Assam Sugar Estates and Factory at Topolia, District Kamrup, where Co 210 is already showing good results.

As it is desirable to have another early ripening variety to replace Co 214 when it shows signs of deterioration, two early ripening canes, Co 232 and Co 233, were grown on a field scale for mill trial. About three acres were put down under Co 232 and one acre under Co 233. The crop was grown in a rather sandy field at Birowlie about two miles away from Pusa, which was rented for the purpose. Co 232 which is a tall, straight growing cane grew well, but the deficient rainfall affected the weight of

the crop. Co 232 gave 360 maunds of stripped cane per acre, while the yield of Co 233 was a miserable 220 maunds. Both these canes are early ripening as mentioned above, and the short rainfall hastened their maturity. Unfortunately, however, it was not possible to arrange for a mill trial till the 19th of December when they were put through the Champaran Sugar Factory at Barrah. The following were the results of the mill trial :—

	Sugar % on cane	Fibre % on cane	Analysis of first juice		Analysis of mixed juice		
			Brix	Purity	Brix	Sugar	Purity
Co 232 . .	12 65	15·55	21 00	77·61	19 20	14·20	73 95
Co 233 . .	10 35	17·13	20 00	69 50	16·00	10 49	65·56

It will be seen from the above analytical figures that even Co 232, which is better than Co 233, is not very desirable from the factory point of view, because of its low purity and its fibre content being higher than that required by the mills. For detailed description, reference should be made to the article on the subject published in the "Agricultural Journal of India," Vol. XIX, Part IV.

It is clear that, as the season was abnormal and the cane when supplied to the mills was over-ripe, further tests are necessary. Co 232 has, therefore, been planted again on a field scale to find out its tonnage per acre in a normal year and its behaviour in the mill when crushed at the right time. It has been arranged to have the mill test carried out in November 1924 along with further mill trials of other canes. Co 233 has not been found satisfactory either in the field or the factory, and for this reason it has definitely been discarded.

It has been mentioned in the previous year's report that the ratooning qualities of the approved canes Co 217, 213

and 214 are being tested at Pusa. The results so far have shown that Co 210 is a good ratooner, Co 214 coming next to it, while Co 213 stands last when there is short rainfall. When, however, the monsoon is favourable, Co 213 improves its position as it is a cane which readily responds to water and manure. From the reports received from growers who have ratooned these canes, it appears that they are satisfied with the superior ratooning qualities of these seedlings over those of the local Hemja or Bhurli, and it now looks pretty certain that among large growers the local variety will soon be replaced by the improved canes being distributed from Pusa.

Besides this, in the experimental plot at Pusa several new seedling canes are being tested. During the year under report 46 seedling canes were under observation.

Name of seedling	Parentage*
Co 205	Vellai × *Saccharum spontaneum*.
Co 220	Red Ribbon × Katha.
Co 225	Red Ribbon × Saretha.
Co 227	P. O. J. 213 × Fiji.
Co 228	Karun × M 5459 (A Striped Mauritius rogue).
Co 231	P. O. J. 213 × Kansar.
Co 238	P. O. J. 213 × Fiji.
Co 239	Chittan. General collection.†
Co 240	Maur. 90 × M 4600 (Saretha × *Saccl. spon.*).
Co 241	P. O. J. 213 × Katha.
Co 242	Green Mauritius × *Saccl. spon.*
Co 243	A. 2 × Co 206 (An Ashy Mauritius rogue).
Co 244	P. O. J. 213 × Co 205.
Co 245	Vellai × M 1428 (A Naanal rogue).
Co 246	Maur. 1237 × Co 206.
Co 247	Maur. 1237 × Co 206.
Co 248	P. O. J. 213 × M 2 (A Kaludai Boothan rogue).

* In giving the parentage of crossed seedlings the mother is always put first and the father second; Vellai × *Saccl. spon.* means "Vellai" is the mother and "Saccl. Spontaneum" the father.

† General collection means that the seeds were collected from unbagged flowers, i.e., without any definite attempt at controlling the male parentage.

Name of seedling	Parentage
Co 250	Karun × M 5459.
Co 251	247-B seedling. General collection.
Co 252	P. O. J. 213 × M 2.
Co 253	P. O. J. 213 × M 5459.
Co 255	P. O. J. 213 × Co 205.
Co 256	P. O. J. 213 × Co 205.
Co 257	P. O. J. 213 × M 4600.
Co 258	Vellai × Co 206.
Co 259	P. O. J. 100 × Co 206.
Co 260	Chittan × Co 206.
Co 261	Chittan × M 10805 (Vellai × *Sacch. spon.*)
Co 262	ditto ditto.
Co 263	Mauritius 1237 × Co 206.
Co 264	Pundia × Co 205.
Co 265	Green Sport × Co 206.
Co 266	Green Sport × Co 205.
Co 267	Naga B × Co 206.
Co 268	Yellow Bamboo × Co 206.
Co 269	B. 254 × Co 206.
Co 270	B. 3747 × Co 206.
Co 271	Black Cheribon × Co 206.
Co 273	P. O. J. 213 × Co 222 (Vellai × *Sacch. spon.*)
Co 274	ditto ditto
Co 275	ditto ditto
Co 276	ditto ditto
Co 277	ditto ditto
Co 278	P. O. J. 213 × Maur. 55.
Co 279	P. O. J. 213 × Maur. 131.
Co 280	P. O. J. 213 × Purple Mauritius.

Out of these seedlings the following have been selected for further experiment :—Co 205, 248, 250, 255, 260, 270, 273, 275, 278 and 280. Co 205 has done very well so far. It is not a cane that the growers in the White Sugar Tract are likely to grow on high land; but as it has the reputation of withstanding drought as well as water-logging, it can well be used for waste lands and *jheels*. This cane is now being supplied to Birowlie, Bowarrah and Gangoulie with a view to test how it does under the conditions mentioned above when met with in the district.

Co 248* appears vigorous and fair in tillering. Its sucrose in juice is 17·8, purity 88·8, cane similar to Co 213 type.

Co 250 is a lighter coloured cane with fair vigour. Sucrose in juice 18·58, purity 90·0.

Co 255: Fair vigour, satisfactory tillering. Sucrose in juice 19·30, purity 96·5.

Co 260: Fair vigour, cane of Co 210 type in thickness. Sucrose 17·09, purity 88·1.

Co 270: A light coloured cane, apparently a strong grower. Sucrose 18·72, purity 90·72.

Co 273: A strong grower with satisfactory habit; canes perhaps slightly thinner than Co 213. Sucrose 18·00, purity 91·3.

Co 275: Satisfactory in the matter of vigour, stand and habit, three points of considerable importance in a field crop; good tillering, perhaps a little thinner than desirable. Sucrose in juice 16·14, purity 89·8.

Co 278: Satisfactory in stand, vigour and habit; canes similar to Co 213. Sucrose 18·72, purity 91·9.

Co 280: Satisfactory in vigour, stand and habit; fair tillering, a light coloured cane. Sucrose 17·89, purity 89·8.

Six further seedlings, embracing a departure from the ordinary which it is calculated will prove well suited to the White Sugar Tract, are now on trial by the Bureau. But it is too early to report other than to say that I consider that one at least heralds a further revolution if its present promise is maintained. The Bureau in its cane testing work on the agricultural side has now established a definite routine which enables us to gauge the agricultural possibilities of a cane in a much shorter period than formerly, while we are now in possession of data regarding the essential factors required to meet the agricultural and climatic conditions in the tract which will do away with a great deal of the preliminary testing and investigation which was

* These canes were crushed in a 2 roller bullock-driven mill and analysed in the first half of January 1924.

required formerly. I have, therefore, every hope that in future improved canes will find their way to growers in a much shorter period.

During the year under report, manurial experiments were carried out with different nitrogenous manures, oil-cake, nitrate of soda and ammonium sulphate but as the season was abnormal the results were inconclusive. At the suggestion of the Secretary, Sugar Bureau, the use of sulphate of ammonia which is now available in quantities from the coal fields of Bengal and Bihar at a favourable price, having regard to the percentage of nitrogen contained in it, is now being taken up by large growers. Nitrate of soda seems to be particularly useful as a quick-acting fertilizer for forcing the growth of the cane crop.

The Secretary, Sugar Bureau, devised a three-row ridger working behind a tractor to meet the requirements of growers of cane who are faced with the planting of a large acreage at the optimum time, and sent up the plan to Messrs. Ransomes, Sims and Jefferies to work up. These ridgers have arrived, have been tested and found to do excellent work, the one difficulty being that of organizing the labour to keep pace with the ridger. The planting outfit recommended by the Secretary, Sugar Bureau, consisting of a double mould board plough, sub-soiler and gatherer and roller is being widely taken up in the White Sugar Tract, and the growers are now keenly alive to the improved implements put out by the Bureau.

II. Industrial.

The Bureau continued to be in close touch with sugar factories in India. Returns for the working season of 1922-23 were obtained and statistics regarding the production of refined sugar in India both from cane and from *gur* (unrefined, raw sugar) were compiled and published in the "Indian Trade Journal". During the year under report, three new factories, *viz.*, the Bihar Sugar Works (Pachrukhi, District Saran), Noori Sugar Works (Bhatni, District Gorakhpur), and Ganga Deshi Sugar Factory (Buxar,

District Shahabad) began to manufacture sugar direct from cane. These factories have also got the necessary plant to refine *gur* in the off season.

The Padrauna Raj Krishna Sugar Factory situated in Gorakhpur District, which was hitherto a refinery, added a cane crushing and sugar manufacturing plant. The Unao Sugar Works which was temporarily closed resumed working under different management, while two well established cane-crushing sugar factories in North Bihar added *gur* refining plants. A refinery has also begun work at Masulipatam. During the season 1923-24, there was an increased area under cane in the United Provinces, and it is estimated that there was an excess production of some 79 lakhs maunds of *gur* over the previous year. The prices of cane and *gur*, therefore, ruled easy, and both factories and refineries had plenty of raw material in the United Provinces. In North Bihar, on the contrary, as the monsoon was a failure, some factories could not get enough cane for crushing.

As a testimony to the way in which the factories in the White Sugar Tract value the work now being done by the Bureau, the Indian Sugar Producers' Association, of which these factories are members, has granted a sum of Rs. 15,000 to the Secretary, Sugar Bureau, to enable him to continue the sugarcane experiments till the proposed sugar cess becomes an actuality. The Government of India have also placed at the disposal of the Indian Sugar Producers' Association free of charge for a period of one year in the first instance a farm of about 143 acres called the New Area at Pusa, and it is hoped that the nucleus of a fully equipped cane experimental station for the White Sugar Tract will be built up on this foundation. It is on this land that Co 232, 213 and 210 have been planted for the mill trials to be carried out in November 1924.

As mentioned in previous reports, the Bureau continued to bring to the notice of factories the names of suitable persons seeking employment as Works Chemists or

Managers, and we attach great importance to this as we are convinced that with the improved canes that will soon be available to the factories they should try to increase their efficiency by employing qualified men who have received scientific and practical training in a sugar house before they are placed in positions of responsibility. The era of high prices of sugar will soon come to an end, and in the keen struggle for existence which is bound to come at no distant date ill-equipped and inefficient factories will go to the wall. It is high time, therefore, for the industry to put its house in order, and we are very pleased to note from the improved returns that this is obviously being done.

III. Commercial and Statistical.

The Bureau began during the year to collect from various representative centres the prices of good eating cane *gur*, refining cane *gur* and palmyrah and date *gur*. These are regularly sent by me for publication in the "Indian Trade Journal." Statistics as regards stocks of sugar in the principal Indian sugar markets, *viz.*, Bombay, Calcutta and Karachi, are also supplied to the Director-General, Commercial Intelligence, for publication in the same Journal. This office also furnishes the Department of Statistics with a note regarding the condition of the crop and estimates of sugar production in the principal cane-growing countries of the world for incorporation in the All-India Sugarcane Forecasts.

The Bureau continued to assist the sugar trade in India by publishing in the "Indian Trade Journal" statistical notes bearing on the production and consumption of this commodity in the principal sugar producing and consuming countries of the world. Forty-seven such notes were published during the year.

The Sugar Cable Service was continued during the year on a self-supporting basis as before, Government incurring no expenditure on its behalf while deriving indirectly a revenue of over Rs. 16,000 through the extra business which

the Post and Telegraph Department get. So long as it is conducted as a business and not as Government routine, having as its aim the satisfaction of the requirements of the members in the matter of prompt communication of market reports received by cable, immediate replies to their enquiries and the supply of the information they want from foreign markets, it will be a success, but I cannot see it continuing to flourish unless these conditions are maintained. It is of the greatest value to India. It enables the Bureau to keep in touch with all the foreign sugar countries and its benefits have been realized by all members. It represents the second of the Sugar Bureau's successful departures from the ordinary course of routine and has proved as successful in its way as the agricultural ventures alluded to before.

IV. Miscellaneous.

Library. During the year under report, 216 volumes were added to the library either by purchase, exchange or free supply and by binding loose copies of periodicals. The books are available for reference by those interested in the subject.

Museum. During the year under report, samples of all grades of Java sugar from Dutch Standard 8 to 25 were received on payment from Messrs. McLaine, Watson & Co., Batavia. Samples of Cuban raw and plantation white sugar were also received through the courtesy of the Director of the Agricultural Experiment Station, Santiago de las Vigas, Havana. These have been placed in the museum. As in the previous years, samples of sugar made in Indian factories were renewed during the year.

Publications. Besides the 47 notes published in the "Indian Trade Journal," a review of the sugar trade in India during the official year 1922-23 was published by me as a supplement to that journal dated 13th December, 1923. Three notes were also contributed to the "Agricultural Journal of India." Before the close of the year the following two articles were written up and submitted to the Agri-

cultural Adviser to the Government of India for publication :—

Sayer, W. . .	Mill Trials of Coimbatore Sugarcane Seedlings 232 and 233.
,,	Selected Coimbatore Canes in Growers' Fields in North Bihar.

V. Conclusion.

The work done by the Bureau in the testing of improved varieties of cane and their distribution to growers has so impressed the sugar factories in the White Sugar Tract that a move is now on foot to bring the question of the white sugar cess before the legislature for consideration and final adoption. The root cause of the stagnation of the sugar industry in India has been in the past the inadequate supply of raw material, and this is bound to continue so long as the inferior local canes are grown. The introduction of exotic canes will do no lasting good, and India must fall into line with other countries in the matter of raising her own superior cane seedlings by crossing where necessary, testing them both in the field and the factory and then distributing only the approved ones to the growers. This work is at present being done by the Coimbatore Cane Breeding Station and the Sugar Bureau, and as it is of such immense importance to the industry it should be placed on a sound and permanent footing.

As usual, I have to express my acknowledgments to a large number of officers and others who have helped me in my work either financially or by giving advice or other facilities that I required. Where so many have helped, it would be invidious to mention names, but I have particularly to thank the firm of Messrs. Begg, Sutherland & Co., who have always readily placed funds at my disposal for mill trials of selected seedlings, Mr. Noel Deerr for valuable advice on numerous technical points, Rao Saheb T. S. Venkatraman, the Government Sugarcane Expert, for the most willing assistance he has been giving me, and the Indian Sugar Producers' Association for providing

the finance to carry on research work on cane during the year 1924-25.

I think that what has been achieved has justified both advice and expenditure, and it is merely a question of more funds for the Bureau to advance further into the field.

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