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SCIENTIFIC REPORTS

OF THE

Imperial Institute of Agricultural Research, Pusa

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

1929-30

CALCUTTA: GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1931

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Scientific Reports of the Imperial Institute of Agricultural Research, Pusa

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

1929-30

REPORT OF THE DIRECTOR.

(W. H. Harrison, D.Sc., and F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S.)

I. Charge and staff.

Charge. Dr. W. McRae continued to officiate as Agricultural Adviser to the Government of India, and Director, Agricultural Research Institute, Pusa, up to 14th September 1929, when Sir T. Vijyaraghavacharya, Vice-President, Imperial Council of Agricultural Research assumed the functions of the Agricultural Adviser to the Government of India and Dr. McRae became Officiating Director, Imperial Institute of Agricultural Research, Pusa. Dr. W. H. Harrison, on return from leave out of India, was appointed as Officiating Director from 6th October 1929.

The post of Agricultural Adviser to the Government of India was abolished with effect from 12th October 1929 on Dr. Clouston's retirement.

The post of Joint Director was held by Dr. F. J. F. Shaw up to 5th October 1929, by Dr. W. McRae from 6th October 1929 to 19th February 1930 and again by Dr. F. J. F. Shaw from 20th February 1930.

Staff. Dr. J. Sen continued to officiate as Imperial Agricultural Chemist in addition to his own duties as Plant Biological Chemist, throughout the year under report, excepting for the period from 22nd April 1930 to 9th June 1930, when he went on leave and Mr. J. N. Mukerjee, 1st Assistant to the Imperial Agricultural Chemist was appointed to hold charge of the current duties of the Imperial Agricultural Chemist in addition to those of his own.

Dr. W. McRae on being relieved of the post of Director by Dr. Harrison, took over charge of the office of the Imperial Mycologist from Mr. J. F. Dastur on 6th October 1929 and the latter reverted to his substantive post of Mycologist to the Government of the Central Provinces. Dr. McRae proceeded on 10 months' leave out of India from 20th February 1930, and Dr. M. Mitra, 1st Assistant to the Imperial Mycologist was appointed to hold charge of the current duties of the post in addition to those of his own.

Mr. G. S. Henderson, on return from leave, took over charge of the post of the Imperial Agriculturist from Mr. M. W. Sayer on 15th October 1929. The services of Mr. Henderson were placed at the disposal of the Government of Bihar and Orissa for appointment as Director of Agriculture of the province from 2nd November 1929 and Mr. Sayer was appointed to officiate as Imperial Agriculturist in addition to his own duties as Secretary, Sugar Bureau. Mr. Sayer proceeded for a month's training with the Army in India Reserve of Officers at Dehra Dun from 24th April 1930 and Mr. Arjan Singh, Assistant to the Imperial Agriculturist was appointed to hold charge of the current duties of the post of Imperial Agriculturist in addition to those of his own.

Mr. T. Bainbrigge Fletcher proceeded on 7 months' leave out of India from 22nd April 1930 and Mr. P. V. Issac was appointed to officiate as Imperial Entomologist in addition to his own duties as Second Entomologist.

Consequent on Mr. Sayer's proceeding for a month's training with the Army in India Reserve of Officers from 24th April 1930, Mr. Hardyal Singh, Officiating Superintendent, office of the Secretary, Sugar Bureau, was appointed to hold charge of the current duties of the post of Secretary, Sugar Bureau, in addition to those of his own.

Mr. A. M. Mustafa was confirmed in the post of Agronomist with effect from the afternoon of 21st June 1929. On the expiry of his deputation to the Administration of the North-West Frontier Province, Mr. Mustafa proceeded on six months' leave followed by 18 months' study leave with effect from 5th October 1929.

The services of Dr. A. N. Puri, Physical Chemist on probation, were terminated from 3rd November 1929.

II. Research.

The research work carried out at the Institute aims at establishing principles which can be put into general practice by provincial agencies. The more important work of the year under report is summarized below :—

Botanical Section. The new wheats, Pusa 111, Pusa 112, Pusa 113 and Pusa 114 gave high yields at Pusa and at Shahjahanpur. Pusa 111 proved most resistant to rust while the attack was very slight on

the other selected varieties. Out of a large number of single plant cultures of the fifth hybrid generation of the crosses between Pusa 4 and Federation and Pusa 52 and Federation, 9 cultures were selected for seed multiplication on a large scale. Over 420 mds. of wheat seed were distributed to Departments of Agriculture and private growers during the year under report. A field trial to test the influence of Amophos on the yield of grain and straw in wheat showed that the difference in favour of Amophos was significant. B1 barley (which will henceforward be termed type 21) maintained its position as the best yielder and was closely followed by Types 20 and 12. B. S. 1 oats maintained its superiority over B. S. 2 and P. F. 1 in a yield trial and gave an outturn of 2,309 lb. to the acre at Dholi estate in Muzafferpur district. Hybrid No. 177 tobacco maintained its quality and yielded about 1,000 lb. dry cured leaf per acre. The new type of *Hibiscus Sabdariffa*, L. gave 39 mds. of fibre per acre and was well reported on by the Imperial Institute, London. Efforts are being made to evolve superior varieties of sesamum, linseed, *rahar*, gram, maize, peas, lentils, *urid*, *mung*, hemp and chillies either through selection or hybridization. In order to enable the Section to breed and test varieties of crops suitable for Northern India, a scheme for the utilization of a part of the area at the Imperial Cattle Breeding Farm at Karnal as a sub-station of the Section has been approved, and the Imperial Council of Agricultural Research have sanctioned for the purpose a non-recurring grant of Rs. 10,000 and a recurring grant of about Rs. 25,000 a year for five years.

Chemical Section. Further experiments on curing of tobacco by different methods confirmed the previous year's results that the leaves cured in the sun but protected from dew were the most suitable for cigarette manufacture. It was however found that the upper leaves in all the varieties of tobacco tested and under all the methods of curing employed were generally richer than the lower ones both in nicotine and amido nitrogen contents. Experiments relating to the effects of the manurial constituents on the quality of sugarcane juice indicated that the canes from no-manure plots contained the highest percentage of sucrose and the smallest amount of glucose, while the use of mustard cake combined with super and potash yielded the biggest crop. Investigations into the occurrence of symbiotic nitrogen fixing organisms within the roots of the rice plant and the influence of manures on crops and soils were continued.

Bacteriological Section. A series of experiments indicated that the addition of one or two per cent. of superphosphate to cow or bullock dung greatly diminishes the loss of nitrogen during ten months' storage and a much higher percentage of nitrogen becomes recoverable as ammonia from the dung and superphosphate mixture than from the

dung alone. Nitrification in different soils continued to be studied under different conditions. Investigations of the types of colon bacilli present in the Pusa dairy milk showed that types giving positive Methyl Red and negative Voges-Proskauer reactions predominated except during the rainy season, when the Aerogenes type, giving a positive Voges-Proskauer and negative Methyl Red reaction were the more numerous. Charcoal and cinders were the best materials tried in the experiments on potato storage. Seed potatoes that had been stored in charcoal gave a higher yield than those stored in other substances.

Mycological Section. WR type of *rahar* (*Cajanus indicus*) continued to indicate a higher degree of resistance to wilt than any other type. The tonnage experiments confirmed the last year's results that there is no indication as to the harmful effect of mosaic disease on the yield of sugarcane under the climatic conditions prevailing in Pusa and that there is no significant difference in the sucrose content of the juice of the healthy and diseased canes. A case of Downy mildew caused by a *Sclerospora* was observed on a shoot of Co. 316 cane at Pusa. This is the first record of its occurrence in India, and so far only the conidial stage has come to notice and the fungus is under study. Several other diseases of crops are under investigation.

Entomological Section. The bionomics of *Aphis sacchari*, Zehnt, on sugarcane, as well as the parasite of this insect were studied. From two years' observations it is evident that maximum parasitisation is reached by the middle of October. A series of examinations were made with a view to ascertain the relative immunity of Co. canes and it was found that Co. 205 was more susceptible than others to the attack of borers. Gram, *Tur* and peas stored in gunny bags with "amalgam tiles" in the Farm godowns in May 1929 were found in good condition and free from beetles. About 470 mds. of sun-dried rice stored at Kanke (Ranchi) in damp proof bins with "Mercury-tin amalgam tiles" suffered a small loss of 1·9 per cent. through *Tribolium Castaneum, Hbst*—which gained access through an opening at the lower end of the bin. Further experiments in this connection are in progress. Several pests of rice, cotton, fruits, etc., received attention during the year.

Agricultural Section. The results of the Permanent Manurial Experiments at Pusa were reviewed by a Committee of the Board of Agriculture held at Pusa in December 1929. The committee has made certain proposals regarding the system of cropping to be adopted in future and the arrangements of the plots in three distinct series, which are being given effect to. In sugarcane work, the testing of new Co. varieties in a nursery and on an estate scale was continued, the object being to multiply the seed of such varieties as are found suitable for the sugar tract in North Bihar. Experiments are also in progress to test the value of different fertilizers on this crop. The testing of various types of motor

tractors was continued. With the introduction of crude oil tractors and the consequent reduction of working costs, the tractor problem has assumed a different aspect. A crude oil tractor has therefore been purchased and comparative trials are in progress with a view to collecting reliable data on the subject. With the discontinuance of cross-breeding work in dairy cattle, the dairy herd at Pusa has now been limited to pure Sahiwal cows. A large area on the farm which was devoted to fodder growing has thus been made available for the multiplication of improved varieties of crops evolved in the Botanical Section and also for experimental purposes by the other Sections of the Institute. The selective breeding of pure Sahiwal cows was continued, and three of the best cows who completed their lactation during the period under review gave over 5,600 lb. milk each in a period of 304 days. With a drastic alteration in the ration and general treatment of the dry stock, the sterility ratio among the milch cows of this breed has decreased from 7·5 per cent. to 1 per cent.

Imperial Dairy Expert. The three cattle-breeding and dairy farms and the creamery at Anand under the control of the Imperial Dairy Expert continued to provide educational facilities in animal husbandry and dairying to Indian students, and judging from the number of applications received for the Indian Dairy Diploma Course, the demand for such training appears to be widespread and on the increase. The research work conducted at the farms included the development of milk yielding capacity of the Thar-Parkar and Hariana breeds with a view to finding out if the giving of reasonably heavy yields by the females will adversely affect the draught efficiency of the male. The experimental work consisted in the manufacture of various dairy products and the long distance transport of pasteurized milk. The Imperial Dairy Expert continued to co-operate with Provincial Agricultural Departments, city municipalities and private organizations and individuals in the matter of giving advice and assistance connected with the improvement of cattle breeding and dairying. Following the development of interest in this subject, the demand for such assistance is constantly increasing.

Physiological Chemist. Experiments on nutrition of growing animals showed that gram husk could under certain circumstances be safely used as a substitute for wheat bran. With the rations used both foods brought about approximately parallel increases in food consumption and in live weight. Early cut hay indicated better productive power than mature hay which is due partly to better consumption and partly to its high digestibility. These experiments with early cut hay indicate a line along which the nutrition of cattle in India can be improved. In collaboration with the military authorities an extensive experiment on rationing for milk production has been started at the Government Military Dairy Farm at Kirki, and is likely to furnish valuable data on the

subject. In the examination of Indian coarse fodders, it was found that the digestibility was related to the protein content which varied widely according to the characteristics of species and the stage of maturity. It was also found that with advancing maturity the amount of digestible protein and the starch equivalent value decrease steadily—a significance which is of great importance in the solution of cattle feeding problem in India. Physiological studies on acid-base balance of cattle urine have indicated that urine reaction and urine composition may at times influence mineral assimilation. Feeding tests have therefore been instituted to investigate this important point. Experiments have also been started for the study of sulphur metabolism as the sulphur content of many Indian fodders has been found to be low and this shortage is reflected in the composition of the urine.

Government Sugarcane Expert. An outstanding feature of the year was that an inter-generic cross between P. O. J. 2725 and *Jowar* (*Andropogon Sorghum*) was successfully performed. The resultant hybrids include a very wide range of forms and some of them have been found to ripen in about five months from the date of planting and to contain over 16 per cent. sucrose with over 85 purity. The possibilities of this line of work in the evolution of short duration varieties will be fully exploited. The work on the breeding of thick type of canes is beginning to take a practical shape, and it is hoped to send out for trial some promising seedlings during the ensuing year. With a view to securing facilities for the Coimbatore seedlings to be tested under local conditions in North India, a proposal for the establishment of a sub-station of Coimbatore at Karnal to be financed by the Imperial Council of Agricultural Research is under consideration of the Government of India.

Sugar Bureau. The work of extending the area under the improved cross-bred Coimbatore canes is steadily progressing in North Bihar through the activities of the Bureau. Co 213, Co. 210 and Co. 214 are now established in the Marhowrah area and their extension throughout the district is going on apace. Endeavours are being made to find out a suitable cane for replacing Co. 205 which though of easy and vigorous growth is not favoured by the miller owing to its poor juice and the difficulty of crushing. Five new varieties were put under trial, two of which show considerable promise. The Sugar Cable Service which is run by the Bureau continued to be self-supporting and to supply to the Sugar trade valuable information regarding the sugar crops of the World.

III. Training.

Imperial Institute of Agricultural Research, Pusa. The two-year post-graduate course was completed during the year by Messrs. R. B. Deshpande, B.Ag. (in Botany), Karam Singh, M.Sc. (in Entomology), and P. N. Vridhachalam, B.A. (in Chemistry). The Entomological

Assistant from the Central Provinces and the Assistant Professor of Agriculture in the Punjab Agricultural College who were admitted last year for special one-year courses in Entomology and Botany respectively also completed their training during the period.

Of the 37 candidates for admission to the new session commencing on 1st November 1929, five were considered suitable by the Selection Committee, and accordingly two were admitted for training in Mycology, two in Botany and one in Entomology. On the recommendation of the Director of Agriculture, Madras, an Assistant in Paddy Section who was awarded the " Raja of Parlakimedi Scholarship " was also admitted for training in Botany. In addition to these candidates, a student recommended by the Government of the United Provinces was admitted for a one-year course in Agriculture, but while under training he secured a State Scholarship in Agriculture and proceeded to England. An Agricultural Assistant from the Punjab and a Probationary Assistant Director of Agriculture from Bihar and Orissa were admitted to special one-year courses in sugarcane cultivation and general agriculture respectively. A student from Bihar and Orissa was also admitted for a short course training in the cultivation and curing of tobacco. Four post-graduate students of the Imperial Institute of Animal Husbandry and Dairying were, as usual, given short courses in estate management, cattle-breeding, plant diseases, etc.

Imperial Institute of Animal Husbandry and Dairying, Bangalore. Four post-graduate students completed their 15 months' course during the year and an equal number was admitted for the new session.

Twenty-seven students appeared for the Indian Dairy Diploma examination and twenty-two were declared successful. A large number of applications was received from provinces and Indian States for admission to the fourth session of the Diploma course which commenced in October 1929, and twenty-five students were selected after a personal interview at various centres. Short courses of practical training were given to forty-five candidates deputed by Provincial Governments, Military authorities and private organizations.

Imperial Cane-Breeding Station, Coimbatore. Two students (one of whom was an Assistant Agriculturist of the Hawaiian Sugar Planters' Association) took advantage of the facilities for training in cane-breeding technique available at the station.

IV. Publications.

As recommended by the Royal Commission on Agriculture in paragraph 47 of their report, the publication work which was carried out by this Institute was taken over by the Imperial Council of Agricultural Research which came into being in 1929. 12 Memoirs, 5 bulletins and

two other publications were issued while 24 publications were in the press when the work was transferred to the Council.

V. General Administration.

Buildings and works. The old electric generating plant at the Institute was replaced by a more modern and powerful one at a cost of Rs. 79,000.

Library. Four hundred and seventy-eight periodicals and 2,007 books, bulletins, reports, etc., were received in exchange and 377 periodicals and 652 volumes of new books, bulletins, etc., were purchased during the year. Two thousand two hundred and sixty-three publications were issued on loan out of which 352 were sent to scientific workers in the provinces and universities.

Hospital. Medical relief was afforded to 287 in-patients and 8,175 out-patients in 1929 as against 284 in-patients and 9,297 out-patients in 1928. Of the 1,098 operations performed, 29 were "selected" ones. Among cases of the more important tropical diseases, 429 were of malaria, 173 of Kala-azar, 113 of dysentery, 68 of plague, 8 of cholera, 2 of hookworm disease and 2 of leprosy.

The health of the residents of the Estate was on the whole satisfactory, and there was no serious outbreak of any epidemic disease, though the surrounding villages were visited by plague.

VI. Accounts.

The total expenditure during the financial year ended 31st March 1930, as shewn below, amounted to Rs. 7,35,054, as against Rs. 7,88,502 in the previous year :—

	Rs.*
General expenditure of the Institute including the office of the Director	2,56,784
Botanical Section	56,598
Chemical Section	68,559
Bacteriological Section	53,596
Mycological Section	40,850
Entomological Section	79,583
Agricultural Section	1,27,770
Sugar Bureau	30,492
Sugar Cable Service	20,822
Total	7,35,054

(* The figures are provisional.)

The following were the principal items of expenditure met from the grant of Rs. 6,000 placed at the disposal of the Agricultural Adviser to

the Government of India for expenditure on special agricultural experiments :—

	Rs.
1. Cost of a pumping set and two threshers supplied to the Baluchistan Administration for trial and demonstration	3,000
2. Cost of a winnower supplied to the Ajmer-Merwara Administration for demonstration	295
3. Cost of a disc-harrow for trial at the Pusa Farm . .	785
4. Cost of tobacco curing furnace and some other appliances for tobacco and plant breeding experiments in the Botanical Section	908
5. Cost of seed samples supplied by the Bombay Department of Agriculture for milling and baking tests .	138

The receipts during the year 1929-30 amounted to Rs. 1,10,214 as detailed below :—

	Rs.
Fees from students	3,262
Sale of Farm Produce	24,778
Sale of milk, cattle, etc.	38,767
Subscriptions to the Sugar Cable Service . . .	26,421
Other receipts	16,986
TOTAL .	1,10,214

REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

(F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S.)

I. INTRODUCTION.

Dr. Shaw held charge of the Section throughout the year. A new post of Special Research Assistant was created and the 3rd Assistant, Mr. Rakhal Das Bose, B.Sc., F.L.S., was appointed with effect from the 1st July 1929. A sum of approximately Rs. 2,840 was realized mainly from the sale of improved seeds and credited to the Government during the financial year 1929-30.

The area under Botanical Section being insufficient for the seed multiplication of the pure and improved varieties of crops, most of this work was carried out on the Pusa Farm with the collaboration of the Imperial Agriculturist. Though it was not possible to do similar work on a large scale on the Imperial Cattle Breeding Farm, Karnal, a small area was sown there with wheat hybrids.

Training. Chaudhury Ali Mohammad, B.Sc. (Agr.), after completing his one year's course in this section was appointed Oil-seed Botanist to the Government of the Punjab in the Superior Provincial Agricultural Service. Mr. P. D. Dixit, M.Sc., continued his course of instructions and was of material assistance in the investigation on gram, lentils, and oats, as well as the root system of barley and has also taken up the study of the cytology of the gram plant. Mr. R. B. Ekbote, L.Ag. (Hons.), has given considerable help in the investigations on *rahar* selection and hybridization and wilt-resistant experiments, wheat, chillies and hibiscus. He has been awarded this year the Woodhouse Memorial Prize by the Bihar Department of Agriculture for an essay on " The value of hybridization in the improvement of crops." Mr. R. M. Row, B.A., has been of considerable assistance in sesamum, linseed and tobacco investigations. Mr. M. B. V. Narasingarao, B.A., B.Sc. (Agri.), Parlakimedi scholarship holder, Mr. T. R. Mehta, B.Sc., and Mr. A. R. Akhtar, M.Sc., have joined this section in November 1929 for the full post-graduate course of instruction. They have each been of material assistance in one or more investigations in progress in the section. Four Dairy students, Messrs. K. A. Ayyanna, A. Gopalakrishnaya Naidu, Ajit Singh Gill and Alam Singh, attended a course of lectures for one week in mendelism and biometry. One student, Mr. Gour Gopal Das, from Bihar and Orissa received a short training in the breeding and curing of tobacco from the 13th January to the 10th February 1930.

Season and rainfall. The year 1929-30 was on the whole satisfactory. In the early part of the monsoon the rains were rather deficient while towards the end they were abnormally heavy, which made the *rabi* sowings about a week late. The cloudy weather in December and January aggravated the attack of rust on some varieties of wheat and linseed.

Statement of rainfall in Botanical Section in 1929-30.

Month	Average for 25 years	From 1st June 1929 to 31st May 1930	Difference
	inches	inches	inches
June 1929	7·53	5·91	—1·62
July	11·29	8·57	—2·72
August	14·46	9·24	—5·22
September	8·27	10·19	+1·92
October	1·82	10·78	+8·96
November	0·43	0·00	—0·43
December	0·16	2·15	+1·99
January 1930	0·35	0·32	—0·03
February	0·68	0·22	—0·46
March	0·42	0·51	+0·09
April	0·55	0·08	—0·47
May	1·44	1·75	+0·31
TOTAL	47·40	49·72	+2·32

Statement showing the yields of crops in the Botanical Section in 1929-30.

Crop	Plot	Area in acre	OUTTURN OF GRAIN IN LB.		REMARKS
			Actual	Per acre	
Wheat—					
P. 4	Barah 1 (part)	·15	317	2,117	
,,	S. T. G. 6 (part)	·02	29	1,506	
,,	Lawn plot 1	1·22	2,785	2,282	
P. 12	N. T. G. 4	·33	678	2,056	
,,	N. T. G. 6 and 7	·86	1,720	2,000	

Statement showing the yields of crops in the Botanical Section in 1929-30 —contd.

Crop	Plot	Area in acre	Outturn of grain in lb.		Remarks
			Actual	Per acre	
Wheat—contd.					
P. 52	Barah 3	·85	1,971	2,318	
,,	Barah 1 (part)	·15	382	2,548	
,,	Orchard 2-A	·71	1,005	1,414	Badly attacked by rust.
,,	Barah 1 (part)	·50	1,213	2,427	
P. 80-3	Musahar grass plot	·60	1,270	2,118	
P. 111	Lawn plot 3	·34	811	2,384	
,,	S. T. G. 3	·51	1,297	2,544	
P. 112	Orchard 2-C	·71	915	1,288	
P. 113	Barah Nursery (part)	·02	26	1,332	
P. 114	Lawn plot 2	·37	738	1,994	
P. 115	Barah 1 (part)	·03	91	3,054	
P. 116	,, ,,	·03	98	3,280	
P. 117	,, ,,	·03	80	2,702	
Federation	,, ,,	·15	359	2,390	
P. 161	S. T. G. 6 (part)	·02	34	1,742	
P. 162	,, ,,	·02	29	1,486	
P. 163	,, ,,	·02	34	1,742	
Reward Ottawa	,, ,,	·02	24	1,230	
Barley—					
B-4	Orchard 1-A (part)	·24	617	2,570	
,,	,, 1-B	·48	740	1,541	Sown late.
,,	S. T. G. 9	·19	369	1,941	Sown late.
Oats—					
B. S. 1	Pentagonal East	2·00	4,646	2,322	
,, 2	,, West	2·00	3,742	1,870	
Gram—					
T. 2	Orchard 6-A (part)	·12	84	700	
T. 6	,, ,,	·13	225	1,742	
T. 17	Barah 2 (part)	·43	771	1,795	
,,	River side Eastern plot	·76	933	1,229	
,,	Orchard 6-A (part)	·20	257	1,286	
T. 18	S. T. G. 9 (part)	·05	60	1,230	
,,	Orchard 6-B (part)	·17	243	1,434	
T. 25	Orchard 6-B (part)	·16	251	1,569	
,,	River side Western plot	·74	1,066	1,474	

Statement showing the yields of crops in the Botanical Section in 1929-30 —contd.

Crop	Plot	Area in acre	Outturn of grain in lb.		Remarks
			Actual	Per acre	
Gram—contd.					
T. 26	Orchard 6-A (part)	·12	122	1,024	
T. 28	Orchard 6-B (part)	·16	285	1,786	
T. 33	,, ,,	·16	237	1,486	
T. 34	,, ,,	·16	153	960	
T. 35	Orchard 6-A (part)	·13	144	1,119	
T. 51	,, ,,	·20	268	1,342	
T. 53	,, ,,	·20	174	871	
T. 58	,, ,,	·20	289	1,466	
T. 77	Orchard 6-B (part)	·16	160	1,005	
T. 78	,, ,,	·17	228	1,346	
T. 81	,, ,,	·17	243	1,434	
Rahar—					
A	Musahar outside No. 2	·29	343	1,183	
B	,, ,, No. 5	·28	340	1,214	
D	,, ,, No. 3	·29	306	1,054	
E	,, ,, No 4	·28	357	1,275	
F	,, inside No. 9	·22	123	566	
G	,, ,, No. 5	·22	141	645	
H	,, ,, No. 11	·22	306	1,395	
K	,, outside No. 6	·26	149	576	
K	,, ,, No. 11.	·24	159	666	
M	,, ,, No. 7	·26	268	1,033	
R	,, ,, No. 8	·25	273	1,094	
S	,, inside No. 1	·22	95	435	
S	,, ,, No. 2	·22	113	514	
T	,, ,, No. 10	·22	315	1,437	
Wilt-resistant A-4	,, ,, No. 3	·22	251	1,142	
,,	,, ,, No. 4	·22	131	596	
Chilli—					
T. 34	N. T. G. 5	·14	323	2,300	
T. 41	,,	·14	454	3,236	
T. 46	,,	·14	399	2,843	
T. 51	,,	·14	365	2,604	
Safflower—					
T. 30	S. T. G. 5	·032	20	641	

Statement showing the yields of crops in the Botanical Section in 1929-30 —contd.

Crop	Plot	Area in acre	Outturn of grain in lb.		Remarks
			Actual	Per acre	
Tobacco—					
Hybrid 177 . .	N. T. G. 2 . .	·37	246	664	
,, . .	Orchard 3-A . .	·55	207	376	
,, . .	N. T. G. 2 . . .	·37	388	1,047	Outturn of leaf (flue-cured).
,, . .	Orchard 3-A . .	·55	506	920	Outturn of leaf (flue-cured).
Hybrid 192 . .	,, 3-B . .	·54	739	1,367	Outturn of leaf (flue-cured).
,, 196 .	,, 5-B . .	60	615	1,024	Outturn of leaf (ground cured).
Linseed—					
T. 12 . .	N. T. G. 9 . . .	·40	300	752	
T. 121 .	,, 3 . . .	·36	373	1,030	
T. 124	,, 8 . .	·34	247	726	
T. 12 . . .	,, 10 . . .	·028	38	1,357	
T. 121 . . .	,, . .	·028	40	1,426	
T. 124 . . .	,, . . .	·028	28	1,000	
H. 2 . . .	,, . . .	·028	31	1,107	
H. 6 . . .	,, .	·028	25	894	
H. 10 . . .	,, .	·028	26	928	
H. 11 . .	,, . . .	·028	30	1,082	
H. 13 . . .	,, . . .	·028	30	1,082	
H. 16 . .	,, . . .	·028	28½	1,000	
H. 21 . .	,, .	·028	33	1,179	
H. 23 . .	, . .	·028	20	713	
H. 25 .	,, . . .	·028	26	928	
H 26 . .	,,	·028	29	1,041	
H. 32 . .	,,	·028	27	965	
H. 36 . . .	,, .	·028	29	1,041	
H. 38 . . .	,, . . .	·028	31½	1,102	
H. 40 . . .	,, . . .	·028	30	1,082	
H. 41 . . .	,, . . .	·028	36	1,287	
H. 42 . . .	,, . . .	·028	34	1,219	
H. 45 . . .	,, . . .	·028	23	820	
H. 46 . . .	,, . .	·028	24	856	
H. 52 . .	,, . .	·028	24	856	
H. 55 . .	,, . .	·028	29	1,041	
H. 61 . .	,, . .	·028	30	1,082	
H. 62 . . .	,, . . .	·028	34	1,219	
H. 63 . . .	,, . . .	·028	29	1,041	

Statement showing the yields of crops in the Botanical Section in 1929-30 —concld.

Crop	Plot	Area in acre	Outturn of grain in lb.		Remarks
			Actual	Per acre	
Linseed—contd.					
H. 65	N. T. G. 10	·028	29	1,041	
H. 66	"	·028	30	1,082	
H. 68	"	·028	34	1,219	
H. 69	"	·028	36	1,287	
H. 71	"	·028	20	713	

Statement showing the outturns of improved varieties from the Botanical Section grown on Pusa Farm during 1929-30.

Field	Crop	Area in acre	Outturn in lb	
			Actual	Per acre
Punjab 2 D	Oats B S 1	25	307	1,228
" 4 D	"	25	428	1,712
" 5 D	"	·25	346	1,384
" 7 D	"	25	482	1,928
" 8 D	"	·25	504	2,016
" 11 D	"	·25	362	1,448
General Area	"	87 00	..	1,679
Punjab A Block	*Rahar* A-2	1 0	1,220	1,220
	A	1 0	1,676	1,676
	G	1·0	1,335	1,335
	S	1 0	1,882	1,882
	T	1·0	2,055	2,055
	Gram T. 17	1 0	1,041	1,041
	T. 25	1·0	1,050	1,050
	Wheat P. 4	10·0	11,824	1,182
	" P. 12	10·0	16,441	1,644
	" P. 52	10·0	15,816	1,582

Statement showing the outturns of improved varieties from the Botanical Section grown on Karnal Farm.

Crop	Area in acre	Outturn in lb. per acre	Crop	Area in acre	Outturn in lb. per acre
Wheat—			*Wheat*—		
P. 52 × Fed. 17-1 . .	·03	2,776	P. 4 × Fed. 1-1 . .	·03	3,040
,, 20-1 . .	·03	2,412	,, 3-1 . .	·03	2,388
,, 38-1 . .	·03	2,498	,, 7-1 . .	·03	2,847
,, 64-1 . .	·03	2,696	,, 64-1 . .	·03	3,415
P. 114	·17	2,051	,, 97-1 . .	·03	2,644

Statement showing the outturns of improved varieties from the Botanical Section grown on various Government Farms and private estates to whom seed had been supplied.

——	Place	Crop	Area in acre	Outturn in lb. per acre	Remarks
Professor of Agriculture, Poona.	Poona . .	Wheat P. 111 .	1·0	389	
Assistant Economic Botanist, Sabour.	Sabour . . .	Wheat P. 112 .	·1074	2,326	
		,, P. 113 .	·1074	2,443	
		Oats B. S. 1 .	·33	934	
Basuli, Agricultural Farm, Gorakhpur.	Gorakhpur . .	Wheat P. 114 .	·7	1,171	
Dy. Dir. of Agriculture, Shahjahanpur.	Sugar Research Station, Shahjahanpur.	Wheat P. 111 .	·33	2,733	
		,, P. 112 .	·33	2,622	
		,, P. 113 .	·17	2,749	
		,, P. 114 .	·33	2,120	
		Barley 4 . .	1·0	2,755	(Type 21)
		,, 22 . .	1·0	2,807	(,, 12)
		,, 23 . .	1·0	2,651	(,, 20)
Assistant Director of Agriculture, Sabour.	Sabour . . .	Wheat P. 111 .	·75	1,409	
		,, P. 114 .	·75	1,388	
District Agricultural Officer, Malda.	Malda . . .	Oats B. S. 1 .	·33	1,107	
		,, B. S. 2 .	·33	594	
Agriculturist, Agr Res. Station, Sakrand (Sind).	Sakrand . .	Wheat P. 111 .	·50	580	
		,, P. 112 .	·50	794	
		,, P. 113 .	·50	678	
		,, P. 114 .	·50	730	

Statement showing the outturns of improved varieties from the Botanical Section grown on various Government Farms and private estates to whom seed had been supplied—contd.

——	Place	Crop	Area in acre	Outturn in lb. per acre	Remarks
Manager, Indigo Concern, Dholi.	Dholi . . .	Wheat P. 111 .	·22	1,885	
		,, P. 112	·22	1,817	
		,, P. 114 .	22	1,904	
		Barley 4 . .	22	3,845	(Type 21)
		Oats B S. 1 .	11 0	2,309	
Superintendent, Makrera Model Farm, Beawar.	Makrera . .	Wheat P 111 .		1,230	
		,, P. 112 .		1,998	
		,, P 113 .	..	1,845	
		,, P 80-5 .		1,681	
		,, P. 12 .	.	1,850	
		,, P. 52		1,947	
		,, P. 4 .	.	1,537	
		Barley 4 .	. .	2,152	(Type 21)
		Oats B S. 1 .	.	1,066	
Assistant Director of Agriculture, South East Bihar Range.	Monghyr Farm .	Wheat P 111 .	30	728	
	Jamui Farm	,, P. 111 .	·34	771	
	Banka Farm .	,, P 111 .	·25	332	
	Monghyr Dairy Farm	,, P 114 .	1 3	751	

II. Investigations.

Wheat (*Triticum vulgare*, L.). Though owing to late rains the *rabi* sowings were about a week later than usual, the yields from Pusa wheats were quite satisfactory. Pusa wheats Nos. 12, 52 and 4 each grown on 10 acres at the Pusa Farm gave good results yielding 1,644, 1,582, and 1,182 lb. per acre respectively. Their highest yields on a small scale in the Botanical Area were 2,056, 2,548, and 2,282 lb. per acre respectively.

The new wheats Pusa 111, Pusa 112, Pusa 113 and Pusa 114 gave yields of 2,544, 1,288, 1,332, and 1,994 lb. respectively in the Botanical Area. These wheats gave very good results at Shahjahanpur, the yields being 2,733, 2,622, 2,749 and 2,120 lb. per acre respectively. This suggests that these types possess a high yielding power. Pusa 111 seems to be the most resistant to rust as it has shown the highest bushel weight. The attack of rust was moderate on some varieties but in general it was

very slight on the selected ones. The bushel weights of the different varieties are shown in the following Statement :—

Wheat	Weight per bushel in lb.					Remarks
	1925-26	1926-27	1927-28	1928-29	1929-30	
Pusa 4	64 9	63·0	63 25	63 9	65 07	
Pusa 12	61 5	65 0	56 3	63·3	62 0	
Pusa 52	65 5	63·0	62 17	64 0	65·4	From a normal plot
					63 5	From a rusted plot
Pusa 80-5	65 0	56 5	55 9	65 3	63 1	
Pusa 111	·				66 0	
Pusa 112	·		·	..	61·5	
Pusa 114	..		·	·	60·0	Badly rusted and too late for Pusa

The fifth hybrid generation of the crosses between Pusa 4 and Federation and Pusa 52 and Federation was grown at Pusa and at Karnal. Out of 120 single plant cultures grown at Pusa, 97 were rejected and 23 were selected for further trials. At Karnal 55 single plant cultures had been grown out of which 21 were selected for further trials. Ten cultures at Pusa and 29 cultures at Karnal were grown on a large scale for studying the mass habit and yielding capacity ; of these 5 at Pusa and 4 at Karnal were selected for seed multiplication on a large scale. The following approximate quantities of wheat seed were distributed to Departments of Agriculture and private growers during the year under report :—

(1) Grown in Botanical Area, Pusa—

	Md.	Sr.
Pusa 4	31	20
Pusa 12	25	0
Pusa 52	29	0
Pusa 80-5	4	20
Pusa 111	22	0
Pusa 112	4	0
Pusa 113	1	20
Pusa 114	5	0

(2) Grown at Pusa Farm—

	Md.	Sr.
Pusa 4	170	0
Pusa 12	52	0
Pusa 52	76	0

A field trial to test the influence of Amophos on the yield of grain and straw in wheat was carried out. The wheat selected was Pusa 4 and the dressing used was 120 lb. per acre ; manured and unmanured plots were arranged in strips on the AB BA AB BA.....method.

The difference in the total yields of 12 contiguous pairs of plots and their average bushel weights was—

	Manured	Unmanured	Difference
Straw	2,748	2,449	+299
Grain	1,192	1,068	+124
Bushel weight . . .	65·75	65·07	..

A statistical test by Student's method showed that the difference was significant.

Barley (*Hordeum vulgare*, L.). Twenty-four types of barley have finally been selected and classified according to their taxonomic characters. Of these 19 types belong to the 6-rowed form and 5 types to the 2-rowed variety. The work on barley has been written up and will shortly be submitted for publication. B-4 barley (which will henceforward be termed Type 21) maintains its position as the best yielder and has been well spoken of by those who have tried this type. The Superintendent, Makrera Model Farm, Beawar, (Rajputana) has reported an outturn of 2,152 lb. to the acre while the Manager, Dholi Estate near Pusa, has obtained as much as 3,845 lb. to the acre. In the Botanical Section this year this type has yielded 2,570 lb. per acre. A yield trial with the four best yielding types, *viz.*, Types 21, 20, 12 and 7, was run in the year under review and Type 21 as usual proved the best. These four types were put in strips 4′×60′, replicated 10 times. At harvest a border of 5′ was removed at either end of each strip. The two end-rows and the three central rows of each strip were harvested, threshed and weighed separately. The yields were considered for the central rows and also for all the rows taken together. The errors were worked out by Engledow and Yule's method and the following results were obtained :—

Type	ALL ROWS CONSIDERED				CENTRAL ROWS ONLY CONSIDERED			
	Mean yield in grms.	Difference of yields	P E of difference	"Z"	Mean yield in grms.	Difference of yields	P E. of difference	"Z"
Type 21 . .	868·7	..	..	..	441·5	..	..	
Type 20 . .	712 4	—156·3	±18·7	8·4	378·8	—62·7	±11 1	..
Type 12 . .	709·4	—159·8		8·5	384 7	—56 8		5 6
Type 7 . .	691·8	—196·9		10·3	362·4	—79·0		7·2

The higher the value of "Z" above 2·7 the greater is the significance of the difference in yields between the control and the type under comparison.

Taking Type 21 as control it was found that this type was the best yielder, followed by Types 20 and 12 which were more or less similar,

while Type 17 gave the lowest outturn. The greater differences in yields, when all the rows were taken together than when the central rows only were considered, suggests that Type 21 utilises borders to a greater advantage than the other three types under comparison, probably by virtue of its greater tillering and standing power.

A paper on " Yield trials with some Pusa Barleys " was published in the *Agricultural Journal of India* in November, 1929. In this the results of a yield trial conducted in 1928-29 with three selected Pusa types of barley as compared to a local strain were considered and the results obtained were given a statistical interpretation by 3 principal methods of estimating yield trials.

A study of the root system of the different types of barley, isolated in this section, was undertaken last year and continued during the year under review. Four distinct types have been recognised and the result of this study will soon be submitted for publication.

A nitrogen estimation of all the types of barley was done by the Imperial Agricultural Chemist, Pusa.

OATS (*Avena sterilis*, L.). A yield trial with B. S. 1 and P. F. 1 oats was run this year in the Bhograsan Field with the co-ordination of the Imperial Agriculturist. Forty balanced strips, each half an acre in area, were sown alternately with the two varieties. Odds of 5·09 : 1 in favour of B. S. 1 were obtained ; in this experiment therefore the difference in yield is not statistically significant.

Another trial was conducted on a smaller scale in the Botanical Area in which strips 306′×5′ each were sown with B. S. 1, B. S. 2 and Pusa Farm oats and replicated ten times. B. S. 1 proved superior to Pusa Farm in this trial and odds greater than 30 : 1 were obtained in favour of B. S. 1; B. S. 2, however, proved inferior to Pusa Farm in this experiment.

B. S. 1 oats which was distributed to some extent last year has been reported to have yielded 2,309 lb. to the acre at Dholi Estate, District Muzaffarpur.

Hybridization. A number of promising strains have been selected from the F_4 generation of two crosses between Scotch Potato oats and two Pusa types and some very high yielding oats with very plump grains are expected to be evolved from these. The F_3 generation between Abundance and B. S. 4, the F_2 generations between Iowa 103 and B. S. 1, and the F_1 generation between B. S. 1 and a wild oats have been studied during the year. A natural cross grown from a stray seed in Orion oats has also been studied.

Smut-resistance trial. An experiment was conducted to study the incidence of smut in B. S. 1 oats and a strain obtained from Lyallpur. Seed of these two types was collected from a plot in which a preliminary trial was run last year, so that both had equal chances of natural infec-

tion. Two plots of each were sown in blocks 20′×20′ under six different conditions :—

Series I.—had seeds infected before storing by shaking them with dry spores in a cloth bag and sown dry.

Series III.—had seeds infected as above but sown after soaking in water for 2 hours.

Series IV.—had seeds infected just before sowing in a suspension of spores in water.

Series II.—had seeds infected just before sowing by shaking them with dry spores in a cloth bag and sown dry.

Series V.—had seeds neither infected nor soaked (control).

Series VI.—had seeds not infected but soaked in water for 2 hours.

At harvest plants from each plot were uprooted and the percentage of infected plants determined as shown in the following Table :—

Table showing the percentage of smut infection in B. S. 1 and Lyallpur oats in different series, 1929-30.

Series	Seed treatment	Total Number of Plants		No. of Smutted Plants		Percentage of Smutted Plants	
		B. S. 1	Lyallpur	B. S. 1	Lyallpur	B. S. 1	Lyallpur
V	Control-seeds neither infected nor soaked.	9,131	8,949	4	138	0·05	1·3
VI	Seeds not infected but soaked in water.	7,104	6,451	45	1,130	0·65	22·51
I	Seeds infected before storing and sown dry.	9,143	8,301	1,871	3,518	19·41	34·43
III	Seeds infected before storing and sown after soaking in water.	8,098	9,815	5,442	7,724	66·93	78·1
II	Seeds infected dry just before sowing	6,505	6,561	1,191	1,688	18 2	25·74
IV	Seeds infected just before sowing in a suspension of spores in water.	6,244	6,114	3,174	5,554	51·05	91·3

The percentage of infection in the Lyallpur oats is greater than that in the B. S. 1 variety in all the series, and we infer that B. S. 1 is more resistant to smut than the Lyallpur strain.

Tobacco (*Nicotiana Tabacum*, Linn.). During the year under review further experiments in flue-curing were carried out. The new hybrid No. 177 maintained its quality and yields of about 1,000 lb. dry cured leaf per acre were obtained with this type. On a commercial scale there has been a great increase in flue-curing in India and this method has now almost entirely supplanted the old rack curing method in the production of cigarette tobacco in India. With the establishment of flue-curing on a large commercial scale we may consider that a definite stage has been completed in the tobacco researches commenced in this section

in 1924. A sample of flue cured leaf of Type No. 177 was tested by the Indian Leaf Tobacco Development Co. and reported as equal to leaf valued at As. 8 per lb. Besides Hybrid 177, the other hybrids tried were 192 and 196. Both these are heavy yielders but they are late and all their leaves do not ripe uniformly and quickly, hence they have not proved superior to Hybrid 177.

Breeding. The old established 1 to 51 types of *Nicotiana Tabacum*, Linn., and 1 to 20 types of *N. rustica*, Linn., after a lapse of about 4 years were grown for the renewal of their seeds.

Observations on recently isolated types of *N. Tabacum*, Linn., were confirmed. In one of the types of *N. Tabacum*, L. the special temperature conditions required for the setting of seeds were studied.

In connection with the study of genetical factors in *N. Tabacum*, Linn., the F_1 of a cross of Type 43 × H. 156 were grown and studied.

Sesamum indicum, D. C. The isolation of the unit species of this crop has now been completed and the work sent in for publication as a Memoir, Department of Agriculture in India. In order to study the inheritance of characters in this crop a cross was made between a black seeded, late, single-capsuled, heavy-yielding type, and a white-seeded, early, 3-capsuled, lower-yielding type, in the year 1928. The F_1 of this cross was grown and studied in the year 1929. There was a fairly good demand for sesamum seeds from several provinces; arrangements will, therefore, be made to multiply the seeds of some of the most promising types for distribution next year.

Linseed (*Linum usitatissimum*, Linn.). The F_5 generation of the eight original crosses referred to in previous reports and the F_3 generation of the new crosses which were made in 1926-27 were grown. The results of these crosses are being sent for publication as a Memoir. From the F_4 generation of the eight original crosses, 74 pure cultures were obtained and their oil percentage are given below :—

Cross	Oil per cent. in		Cross	Oil per cent. in	
	1928-29	1929-30		1928-29	1929-30
1 × 12—					
H 1 . . .	37·05	37·03	H 9 . . .	42·16	42·46
H 2 . . .	40 99	40 47	H 10 . . .	43 00	42 20
H 3 . . .	39 60	38 66	H 11 . . .	43·13	43·25
H 4 . . .	40·12	38 88	H 12 . . .	42·38	42·98
H 5 . . .	40·33	39·37	H 13 . . .	40·14	39·49
12 × 1—			H 14 . . .	39·50	40·48
H 6 . . .	41·24	41·78	H 15 . . .	40·04	39 32
H 7 . . .	42·05	41·42	*8 × 12*—		
H 8 . . .	42·00	41·04	H 16 . . .	41·43	40·73

Cross	Oil per cent. in 1928-29	Oil per cent. in 1929-30
8 × 12—contd.		
H 17	39·50	38·33
H 18	42 02	41 06
H 19	42 89	41 83
12 × 8—		
H 20	40·68	40 00
H 21	41 80	39 74
H 22	41 93	41 47
11 × 12—		
H 23	44 03	43 29
H 24	39 99	38·95
H 25	42 92	41 97
H 26	43 14	41 19
12 × 11—		
H 27	42 56	41 40
H 28	36 57	36 92
H 29	38·72	39 93
H 30	40 20	38 40
12 × 22—		
H 31	40 26	41 14
H 32	42 96	41 33
H 33	41·48	41·47
H 34	40 57	40·30
H 35	40·52	40 26
H. 36	40·02	40 06
22 × 12—		
H. 37	38 80	39 04
H. 38	38 96	39 36
H. 39	37 71	37·86
1 × 121—		
H. 40	38·79	39·43
H. 41	39 90	38 72
H. 42	40·16	39·94
H. 43	40·42	40 43
H. 44	41·27	39·96
H. 45	43 37	41·62
H. 46	42·88	43·00
121 × 1—		
H 47	41 82	39·13
H. 48	41 33	40 02
H. 49	40 89	39 23
H. 50	40 48	38·86
H 51	40 61	39 02
H. 52	42 91	41 63
H. 53	41 02	39 64
H. 54	40·43	41·28
8 × 121—		
H. 55	44 03	40 26
H 56	41 60	40 08
H 57	41 16	40·31
121 × 8—		
H. 58	42 30	40·92
H. 59	41 19	38·01
H. 60	39 69	36 91
11 × 121—		
H. 61	41 57	38 75
H. 62	42 96	39 83
121 × 11—		
H. 63	44·64	41·52
H. 64	41·18	39·49
H. 65	42 56	39 57
H 66	42·79	39 97
22 × 121—		
H. 67	42 32	39 12
H. 68	43·16	40 50
H. 69	41 94	40 36
H. 70	42 84	39 90
H 71	42 63	39·15
H. 72	37·77	38·20
121 × 22—		
H. 73	41·77	38·68
H. 74	42·01	40·56

Cross	Oil per cent. in		Cross	Oil per cent. in	
	1928-29	1929-30		1928-29	1929-30
1×12—			*11×12*—		
H. 76 . . .	..	40·24	H. 85 . . .	..	40·33
H. 77 . . .	..	42·90	H. 87 . . .	..	41·68
8×12—			*12×11*—		
H. 80 . . .	..	39·11	H. 88 . . .	..	37·60
H. 81 . . .	..	38·74	*1×121*—		
			H. 89 . . .	..	41·56

Statement showing the oil percentage for the last 5 years of Types 12, 121, and 124.

Type	Year					Mean
	1926	1927	1928	1929	1930	
12	38·94	39·39	37·96	36 67	36·93	37·98
121	41·77	41·07	42·32	40·01	40·18	40 07
124	42·05	40·91	42·65	38·22	39·86	40 74

A variation of about 4 per cent. occurs therefore in the same type in different plots and different seasons.

Rahar (*Cajanus indicus*, Spreng.). The observations on the unit species isolated in this crop were carried on and the results were compared with those of the previous year. Nearly all the promising types were grown in a field infected by wilt disease, and one of these has been found highly resistant to wilt. It is hoped that this will compare favourably with the wilt-resistant type found previously.

A study of the inheritance of various characters was made in five F_2 generations of different crosses, *viz.*, Type WR×Type 1, 204×1, 172×1, WR×172, and 204×172. The important differential characters of the parental types are noted below :—

Type	Flower colour	Seed colour	Pod colour	Pod habit	Habit of growth	Immunity to wilt disease
WR or Wilt Resistant.	Yellow with patches of diffused red colour over the back of standard.	Fawn with brown patches.	Green with black streaks.	Open, *i.e.*, peduncles not crowded together on a branch.	Spreading .	Highly wilt resistant.
204 . .	Do. .	Do. .	Do. .	Do. .	Do. .	Do.
172 . .	Yellow, back of standard having half ring of red colour at the base and distinct red lines radiating from it.	Silver grey with brown patches.	Green .	Do. .	Do. .	Non-resistant.
1 . .	Yellow . .	Silver grey .	As in WR .	Crowded .	Erect .	Do.

As regards flower colour the F_2 of WR×1 and 204×1, each showed a dihybrid segregation of 9 having faint red lines on the standard : 3 like WR or 204 parent : 3 like Type 1 parent : 1 ringed (a new phenotype). Other crosses showed a monohybrid segregation of 3 : 1, as follows :—

Cross.		
WR×172	3 like 172 :	1 like WR
204×172		or 204
172×1	1 like 172 :	2 like F_1 : 1 like T. 1

The seed colour is inherited according to a monohybrid scheme in 4 crosses and according to dihybrid in one cross. Strong linkage was observed between the factor for red seed colour and a factor for flower colour. The segregation in pod colour was 3 streaked : 1 green ; in pod habit 3 crowded : 1 open ; and similarly 3 erects : 1 spreading appeared in F_2 as regards plant habit. Stature showed a monohybrid ratio of 3 dwarfs : 1 tall with a strong linkage between shortness and crowded pod habit. The genetical interpretation was also given to the results obtained regarding the inheritance of stem colour and leaf vein colour. Certain F_2 plants have been selected for further study in the F_3 generation.

The F_2 of WR×1 and 204×1, *i.e.*, of the crosses between the wilt resistant types and a non-resistant type, were also grown on infected land, and from the comparison of the phenotypes that survived in this land with those that occurred on the non-infected plot, the correlation of morphological characters with the property of resistance was studied.

Gram (*Cicer arietinum*, L.). The description and classification of all the new and old unit species isolated at Pusa was checked and revised and is being sent now for publication. The number of the new types is 59 which with the 25 original types make a total of 84 distinct varieties of this crop. The study of some natural crosses made in past years indicates that the pink colour of flowers in gram, is the result of two complementary factors, one of which produces blue colour and the other though having no effect by itself changes blue colour into pink. This year some crosses have been made by Mr. A. R. Akhtar, M.Sc., a student of the 1st year post-graduate course here, which will throw light on the point. The promising types were grown on a large scale and the outturn results show that Type Nos. 28, 33 and 58 are the best among the large Kabuli types, small Kabulis and yellow grams respectively. Proper yield tests are, however, necessary in future.

A cytological investigation was carried on by Mr. P. D. Dixit, M.Sc., a second year student of post-graduate course in this section to compare

Type 79 the gigantic mutant with its original Type 24. The results show that there is an increase in the size of cells and the number of layers of various tissues in the mutation as compared with the parental type. The number of chromosomes observed in the root-tips was also larger in the mutation than in the parent type, being 16 in the former and 14 in the latter. The work is still in progress. Another mutation of gigantism was observed in Type 22 but unfortunately the plant did not form seed.

Maize (*Zea Mays*, L.). In the year 1929 twelve selfed lines were under study in the white-seeded race and 15 in the yellow-seeded, each group being derived from a single plant of year 1925. Some of the lines have been subject to self-fertilization for 4 years and some for 3 years, but none of these has become pure by this time ; of course, 7 or 8 years are at least necessary to make the lines pure. The work of making them pure by further inbreeding will be continued in 1930.

Peas (*Pisum sativum*, Linn., and *P. arvense*, Linn.). The work of isolating the unit species of the Indian pea was completed ; 65 types of *P. sativum*, Linn., and 46 types of *P. arvense*, Linn. have been obtained. The results will be published shortly. A study of the inheritance of characters in crosses between these two species has been made in order that the students might gain personal experience of the phenomena which form the basis of the modern theory of genetics. It was, of course, not anticipated that the results obtained with the hybridization of Indian peas would do more than confirm the extensive studies on this subject which have been carried out in other countries and this anticipation has been justified in the results.

From the unit species which have been isolated, or from the progenies of the different crosses, it is hoped to obtain a type which will be of considerable utility in the Agricultural economy of Bihar and similar regions. Such a type should be a bushy, erect, dwarf variety of early maturity ; it would provide food for man and beast and would, of course, be a valuable restorative of nitrogen to the soil.

Lentils (*Ervum lens*, Linn.). The F_3 generation of three crosses in this crop were studied during the year under review. The study confirmed the F_2 results obtained and reported last year. Although two crosses T. 25×T. 17 and T. 25×T. 5-A showed monohybrid segregation in flower colour, the third cross T. 47×T. 25 showed some complications. It may be pointed out that the nature of segregation of this character in this cross was not very clear even in the F_2 and although an explanation has been suggested for this, it can only be confirmed by further experiments.

Brassica, Linn. The work on isolation of unit species of brassica varieties has been started in the year under report.

Sterility in *taramira* (*Eruca sativa*, L.) which is a brassica substitute is also being investigated.

Oryza sativa, L. About 700 single plant seeds were collected from all over Bihar and Orissa and work is being commenced on this crop.

Urid and *Mung* (*Phaseolus mungo*, Linn., and *P. radiatus* Linn.). Work on the isolation of pure line cultures of these two crops continues and some good strains have been evolved. A study of their root system has been made and has furnished additional evidence of the adaptation of different types of root systems to suit different sets of soil conditions.

Hemp (*Cannabis sativa*, Linn.). A study of the effect of external stimuli on the sex-ratios of Indian hemp has been carried out in this Section for a number of years. Previous investigators elsewhere have suggested that a change of sex in a plant of *Cannabis* could be brought about by inducing a disturbance in the physiological equilibrium of the plant, the methods generally used being the mutilation of flowers and vegetative parts and the injection of chemical substances.

Schaffner who has made a study of reversal of sex in plants, states that " the sexual condition is simply a state of the living substance which may continue for a greater or less length of time before a neutral state or the opposite sex conditions is set up." He believes that sex cannot be associated primarily with special chromosomes and that sex in the higher animals is no more determined by Mendelian factors than in plants. He is convinced that chromosome differences, where they exist, are merely indicators of sex and not determiners. Chromosome differences, he assumes, may influence the metabolism of the cell and thus influence the determination of sex, but it is possible to overcome this influence in the cell and to cause a reversal of the sexual state even in the presence of an allosome difference.

Pritchard has shown that by inducing a disturbance in the plant's physiological equilibrium by the removal of flowers and vegetative parts and by injection of chemicals into the stem, a change of sex could be brought about.

Keeping these facts in view this investigation was commenced and the results obtained from time to time have been incorporated in previous reports. In 1926-27 observations on about 3,600 plants seemed to show that there was a tendency towards monœciousness in the Indian hemp. About 21·7 per cent. of the total population of that year developed this character. In one culture, *viz.*, H-17, there was a very small percentage of monœcious plants, about 1·5 per cent. and it was considered desirable to multiply the seed of one bagged plant from this culture and to continue this study with the progeny of that plant; 1,532 plants were raised from this seed during 1928-29, of which 649 were mutilated or otherwise

treated. Of these 649 plants 10 plants, or 1·54 per cent., reversed their sex as shown in the following table :—

Treatment	Number of Plants		
	Male	Female	Reversed
Apex cut	122	120	0
Lower branches pruned	83	81	7
Upper branches pruned	81	82	1
Flowers removed	17	20	2
Flowers removed and chemicals introduced	23	20	0
Total	326	323	10

In the remaining 883 untreated plants 13 plants or 1·52 per cent. were observed to undergo natural reversal. The close resemblance of these two figures, 1·54 and 1·52 per cent., of sex reversal, brought about by artificial means on the one hand and natural reversals on the other, throws a suspicion that both of them may after all be due to some factor which is inherent in the plant and not to any external stimulus. During the year under review about 1,000 plants were grown, of which 972 survived. Of these only 50 plants were treated differently and 3 changed their sex (6 per cent.) while 20 plants out of the remaining 922 (or 0·02 per cent.) normally changed their sex without any treatment. It appears probable that in the Indian variety with which we have worked drastic mutilations etc. have no effect in bringing about this change of sex.

The present culture H-17 also shows a great change in the sex ratios of plants as compared with the ratios obtained with other cultures in previous years.

Sex-ratios in Cannabis sativa observed in Botanical Section, Pusa.

Year	Seed	Sex ratios in					
		Preliminary census			Final census		
		Male	Female	Monœcious	Male	Female	Monœcious
1925-26	Mixed	1	2 73	0 4	1	3 5	0 5
1926-27	Mixed	1	3 44	0 96	1	3·51	1·24
1926-27	Single plant cultures	1	2·1	0 63	1	2 34	0 93
1927-28	Culture H-17	1	3 0	0	1	3 2	0
1928-29	Culture H-17	1	1 16	0 007	1	1 21	0·059
1929-30	Culture H-17	1	1 14	0·004	1	1·2	0 061

Some seed of this H-17 culture was also sent to the Director of Agriculture, Madras, and reports from there confirm the sex-ratios obtained here. This ratio of 1 male to 1·11 female indicates the unfitness of this culture for *Ganja* cultivation, as male plants are absolutely useless for drug purposes. It is, however, an ideal type for the study of reversal of sex.

Effect of illumination. A study of the effect of different periods of sunlight and of continuous illumination with electric light during the night was also taken up with this crop. Pot cultures were raised and were exposed to different conditions of light. Sunlight alone was observed to bring about a normal development of flowers and seeds in plants. Plants exposed to additional illumination during the night, however, were healthier and their vegetative growth was more vigorous although their floral and seed development was greatly retarded. The results obtained will be written up in detail for publication.

Chillies (*Capsicum annuum*, Linn., and *C. frutescens*, L.) The 52 types, already described in Memoir, Department of Agriculture in India, Botanical Series, Vol. XVI, No. 2, 1928, and a few additional ones, isolated since then, were grown for perpetuation and maintaining fresh seed stock.

Types 34, 41, 46 and 51, were selected as high yielding commercial types for a yield trial experiment. The plants were grown in rows. They were spaced 2½′ each way (between rows and between plants). Each type was replicated 24 times and the arrangement of the rows was in the following manner :

ABCD BCDA CDAB DABC ABCD and so on.

The yield of end rows and plants was not included in the actual calculations, to do away with border effect. Yule and Engledow's method was followed for interpreting data. The differences between the yields of Type 34 and Type 41, Type 34 and Type 46, Type 41 and Type 46, Type 41 and Type 51 and Type 51 and Type 46 are statistically significant while those between Type 34 and Type 51 and Type 41 and Type 51 are not statistically significant. Type 46 gave the highest yield last year and though it stands second this year for undry weight it has the highest dry weight and is the best yielder. Type 41 is the next best and Types 51 and 34 are 3rd and 4th respectively. The table below shows the comparative yields per acre of the 4 types in 1928-29 and 1929-30.

Type	Yield per acre undry 1928-29	Yield per acre undry 1929-30	Yield per acre after drying and exposing*
	lb.	lb.	lb.
34	3,325	3,300	793
41	6,358	3,236	921
46	6,600	2,843	1,121
51	5,430	2,604	864

* This weight was obtained by taking an average sample of each type immediately after each picking and finding out the moisture percentage in an oven, running at about 100° to 105° F. temperature. The oven-dried fruits were then exposed to air in shade for a week and weighed. The yield of each picking for each type was reduced to this final weight.

The F_2 generation of the cross Type 3 × Type 29 consisting of over a thousand population was grown and the following qualitative and quantitative characters were studied :—

Qualitative (1) colour in vegetative and floral parts, (2) position of fruit and (3) colour of ripe fruit.

Quantitative (1) length of petal, (2) length of pedicel (3) length of fruit stalk, (4) length of fruit, (5) thickness of fruit, and (6) weight of fruit (fresh, ripe).

The qualitative characters when considered separately gave each a close 3 : 1 ratio suggesting a single factor difference. When considered in pairs on dihybrid basis a close dihybrid ratio was realised beween Colour in vegetative parts and Fruit position, and also between Fruit position and Ripe-fruit-colour. The "fit" was bad, however, in the case of Flower colour and Ripe fruit colour on dihybrid basis, there being an excess in the parental classes and deficiency in the single-dominant classes suggesting linkage between flower and fruit colour. The frequencies were—

	Purple flower Red fruit	Purple flower Orange fruit	White flower Red fruit	White flower Orange fruit
Observed . . .	640	179	185	78
Expected . . .	608·4	202·8	202·8	67·6

The amount of linkage as calculated by Emerson's and Fisher's Product Ratio methods is not very great being about 42 per cent. Due to this linkage between "flower colour" and "fruit colour" the trihybrid ratio, when all the three characters were considered together, was also not in close agreement with the theoretical ratio. These observations and interpretations will be confirmed when the F_3 generation will be studied next season.

In the quantitative characters, *viz.*, Petal length, Fruit length and Weight of fruit, the F_1 had a mean nearly equal to the arithmetic mean of the two parents or in other words F_1 was nearly intermediate between the parents. In the case of "Length of Pedicel" and "Length of Fruit stalk" the shorter parent was more or less dominant. In the case of "Thickness of fruit" the F_1 had thicker fruits than those of either parent. In all cases in F_2 the mean was more or less equal to the mean of the F_1, the parental forms were recovered and the value of σ was higher than that of the parents or the F_1. The distribution was normal except in the case of "Length of Pedicel" and "Length of fruit stalk" where it was skewed. Two more cases of linkage both between a qualitative character and a quantitative character, *viz.*, "Fruit Position" (Pendent or Erect) and "Fruit Length" and "Fruit Position" and "Fruit Stalk Length" were observed, pendent habit being more often associated with long fruit and long fruit stalk than with short fruit and short fruit stalk.

Patwa (*Hibiscus cannabinus*, Linn., and *H. Sabdariffa*, L.). Eight old types of *cannabinus* and 4 old types of *Sabdariffa* were maintained. The new type of *Sabdariffa* mentioned in the last year's report thrived very well and was immune to the curious disease which badly attacked *cannabinus* types. On a small plot it gave 39 maunds of fibre per acre. Its fibre was sent to the Imperial Institute, London, to ascertain its quality and value. Their report is as follows :—

"*Description.* The sample consisted of uncombed, interlaced ribbons, measuring up to 2 inches in width and from 7 to 8½ feet in length. The fibre varied in colour from white to pale yellowish-brown and was of good lustre. It was clean and well retted, but a few weak points were evident due to the effect of branching. The strength was comparable with that of jute, but the fibre was harsher and rather coarser than the latter material.

Results of examination. The sample was submitted to chemical examination with the following results, which are shown in comparison with the figures obtained for sample of 'extra fine' Calcutta jute and of commercial Bimlipatam jute (*Hibiscus cannabinus*) :

	Present sample	Extra fine Calcutta jute	*Hibiscus cannabinus*
	Per cent.	Per cent.	Per cent.
Moisture	9·6	9·6	12·5
Calculated on moisture-free fibre—			
Ash	0·6	0·7	1·3
Loss on A-Hydrolysis .	10·7	9·1	11·8
Loss on B-Hydrolysis .	13·7	13·1	15·1
Loss on water washing .	0·9	..	..
Cellulose . . .	75·6	77·7	75·4

These results show that the present sample resembles both jute and *H. cannabinus* in general character and contains about the same amount of cellulose.

Commercial value. The fibre was submitted to a firm of merchants in London (Messrs. Wigglesworth and Co. Ltd.) who described it as well grown fibre, carefully retted and well cleaned, of good colour and strength and superior to commercial Bimlipatam jute (*Hibiscus cannabinus*). They valued the fibre at £25 per ton with 'first marks', Calcutta jute at £26 10*s*., and stated that it would be saleable in London in large quantities.

It may be added that Bimlipatam jute is usually quoted at about £2 per ton below the price of 'first marks' Calcutta jute.

Remarks. In view of the favourable results of examination and valuation it is suggested that consideration might be given to the possibility of producing this fibre on a commercial scale for shipment in competition with jute and its substitutes. The Imperial Institute will be

glad to be informed of any developments which may take place in this connection."

Hybridization. A number of crosses were made by the students between the new type and old varieties of *cannabinus* and *Sabdariffa.* In the cross with *cannabinus* 2 per cent. of capsules were set but no viable seed was formed, but 50 per cent. of the cross with *Sabdariffa* varieties formed good seed. This suggests that the *new patwa* is more closely related to *Sabdariffa* rather than to *cannabinus* and confirms the identification at the Royal Botanic Gardens at Calcutta and Kew.

III. Publications and Programme.

Publications.

1. Shaw, F. J. F. . .	Summary of the Progress of Research in Agricultural Botany for the year ending 31st March 1930, for inclusion in the Report of the Privy Council.
2. Khan Sahib Abdur Rahman Khan.	A new type of roselle hemp. *Agri. Jour. of India*, Vol. 25, No. 3, May 1930.
3. Kashi Ram . .	Studies in Indian oilseeds, No. 4. The types of *Sesamum indicum*, DC. *Mem. Dept. Agr. in India, Bot. Ser.*, Vol. XVIII, No. 5.
4. Shaw, F. J. F., and Rakhal Das Bose.	Yield trials with some Pusa Barleys. *Agri. Jour. of India*, Vol. XXIV, 1929, 373-396.
5. Alam, M. . . .	The Problem of Sterility in Indian Crops and Fruit trees. (Woodhouse Memorial Prize Essay, 1928-29.) *Agri. Jour. India*, Vol. XXIV, 1929, 293-314.
6. Ekbote, R. B. . .	The value of hybridization in the Improvement of Crops. (Woodhouse Memorial Prize Essay, 1929-30.) *Agr. Jour. India*, Vol. XXV, 1930.

Programme for 1930-31.

Investigations will be continued on the lines indicated in this report on the following crops :—wheat, barley, oats, maize, tobacco, chillies, pulses, gram, linseeds, brassica, *rahar*, peas, paddy, etc. Experiments in the curing of tobacco and the inheritance of resistance to wilt disease in *rahar* will be continued. The training of students will continue as in previous years.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST.

(J. SEN, M.A., PH.D.)

I. ADMINISTRATION.

During the year, Dr. J. Sen, Plant Biological Chemist, held charge of the Section, in addition to his own duties, except for seven weeks, from 22nd April to 9th June 1930, when he proceeded on short leave. Mr. J. N. Mukherji, First Assistant, held charge during this period.

Dr. A. N. Puri held charge of the post of the Physical Chemist till 2nd November 1929, since when the post has been kept in abeyance.

II. EDUCATION.

Mr. P. N. Vridhachalam, B.A., from the Travancore State who was admitted to the Post-Graduate course in November 1927, completed his course of training in August 1929. Mr. J. N. Chakravarty, M.Sc., who was admitted to the Post-Graduate course on 16th November 1928, has just completed his course.

III. METEOROLOGY AND DRAIN-GAUGES.

The usual meteorological and drain-gauge records were maintained. Two new meteorological instruments have been recently set up, one is the combined Anemo-Biagraph and Wind Direction Recorder, recording the wind direction and the wind velocity and the other is the Natural Syphoning Recording Raingauge which maintains a continuous record of the rainfall.

In connection with drain-gauges, sunhemp and wheat crops from the gauges and 145 samples of drainage waters were examined.

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

A. The following samples were analysed and reported upon :—

Soils	21
Manures	8
Feeding Stuffs	41
Oil seeds	85
Sugars	5
Sugarcanes	269
Molasses	1
Indigo	14
Tobaccos	11
Milk	3,056
Waters	3
Miscellaneous	8
TOTAL	3,522

Four samples of soil were received from the Imperial Institute of Veterinary Research, Muktesar, and one from the Executive Engineer, Irrigation Department, Baluchistan. Fifteen samples of soil from various places in Bihar and Orissa were sent by the Secretary to the Government of Bihar and Orissa, Public Works Department, for examination in the laboratory. Soils of certain localities behave unsatisfactorily in supporting buildings erected thereon, this being specially the case with black soils found in some places. A determination of the "sticky point" and "shrinkage on drying" of these soils was conducted and the results furnished to the sender. From the known engineering characteristics of the samples it would be possible to trace a correlation between their behaviour from the structural point of view and their physical properties as determined in the laboratory.

Analysis of a sample of water from the Quetta Lora and specimens of soil and salt deposit from the bed of the Lora were carried out for the Executive Engineer, Irrigation Department, Baluchistan.

Two samples of well waters were received from Ajmer. The waters were highly saline and were unsuitable for irrigation purposes. The very large amount of magnesium salts as also the presence of sulphates and chlorides of alkali metals and lime endowed the samples with aperient properties to which reason is perhaps to be attributed their reputed beneficial medicinal effects, to which the sender had referred.

The five samples of sugar mentioned in the list above were received from the Director of Agriculture, Bhopal, being prepared by Khan Bahadur Hadi's process.

Of the miscellaneous samples, mention may be made of a "powder for refining sugar," hailing from Bhavnagar, Kathiawar. It was found to be nothing but carbonate of soda.

The Botany Department of the Khalsa College, Amritsar, have started B.Sc. classes in Agriculture and at their request representative samples of local soils were supplied along with details about the particular localities from which they were collected and the history and character of the specimens.

At the desire of the Imperial Bureau of Soil Science a comprehensive note on all soil investigations carried out at Pusa and certain allied topics was sent to them through the Director. Prof. B. Polynov, President of the Sub-commission for the map of Asiatic Soils in the International Society of Soil Science, was supplied with certain particulars about Indian soils about which he had sent a query.

Many of the visitors who came to the Section during the meetings of the Board of Agriculture and of the Imperial Council of Agricultural Research evinced a keen interest in investigations being carried out here such as those on soil nitrate movement, determination of soil acidity,

curing of tobacco, detection of adulteration of butter and *ghee*, etc. Some data in connection with our soil nitrate work were furnished to Mr. G. Clarke, while particulars about apparatus in the plant biochemical laboratory in which Mr. F. J. Warth was interested were supplied to the latter.

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

Agricultural Section.—Five samples of manures, 263 samples of sugarcane and 3,056 samples of milk were analysed.

Botanical Section. Two samples of wheat, 24 samples of barley, 85 samples of oilseeds and 11 samples of tobacco were examined.

Mycological Section. A sample of manure, a sample of phosphate, 6 samples of sugarcane and 5 samples of extracts from Richard's solution were examined.

Bacteriological Section.—A sample of molasses was analysed.

Sugar Bureau.—A sample of manure and a powder for refining sugar sample were analysed.

V. Research.

1. *Experiments on curing of tobacco.*—Experiments on curing of tobacco conducted in previous years have shown that tobaccos cured on racks are in general better in colour and are more suitable for cigarette manufacture than ground cured tobaccos. These latter are darker in hue and they possess a larger proportion of volatile nicotine. It has further been shown that of tobaccos cured on racks, those which have been "cured in sun, protected from dews after dusk" as also those which have been "cured in the sun, unprotected from dews for first three days and afterwards cured in sun protected from dews for about 10 days and finally cured in shade," give the best result in respect of colour, texture and paucity of volatile nicotine. They have as a matter of fact been declared in the expert opinion of the Indian Tobacco Leaf Development Company, Dalsingsarai, to be the best of all our tobaccos cured by various methods. This year (1929-30), only two varieties of tobacco 'Pusa Type 28' and 'Adcock' were grown and both were "cured on racks in sun protected from dews after dusk." With a view to avoid the attack of mildews and also to ensure the harvesting of the leaves at their proper stage of ripeness these tobaccos, as in last year, were cured on racks after first removing their stems (*i.e.*, leaves alone), the lower and the upper leaves separately. The cured product, as noted in previous years, possess a bright yellow colour and good texture.

The three varieties of tobacco, *viz.*, Adcock, Pusa Type 28 and Surujmukhi, which were grown and cured last year by five different methods have been examined for their nicotine, sugars, starch and amido nitrogen contents, both in their uncured stage and after they were cured. These constituents have been recognized by several investigators to

possess a direct bearing on the quality of tobacco, and attention was paid to their examination with a view to correlate the figures with the actual results obtained. An attempt was made to study the changes in, or rather the destructive changes undergone by, these constituents during the processes of curing. Curing was effected by the following processes :—

(1) Curing on ground, by the ordinary country method.
(2) Curing on racks in the sun all through (*i.e.*, exposed to the sun and night dews).
(3) Curing on racks in the sun, but protected from dews after dusk.
(4) Curing on racks in the sun, unprotected from dews for first three days, after which the leaves are cured in sun protected from dews for about 10 days and finally cured in shade.
(5) Curing on racks in the shade all through.

So far as the nicotine content is concerned, there had always been a considerable loss of it, both in case of lower and upper leaves during the process of curing by all the methods which were followed. The loss of nicotine varied between 18 to 35 per cent.

Ground cured tobaccos with very few exceptions were found to contain more nicotine than the corresponding rack cured ones. Of the rack cured samples the one " cured on racks in shade " invariably contained a higher nicotine content than others, whereas the one " cured in sun protected from dews " generally contained the least. It may be mentioned here that ground cured tobaccos, apart from their dark colour, have always been declared as unsuitable for cigarette purpose. Of the rack cured samples the one " cured in shade ", though suitable for cigarette, has always been found to be inferior to either of the two cured by methods 3 and 4. During the process of curing it is mostly nicotine in the volatile state which appears to be expelled and the more it is destroyed the better is the quality of the product for purposes of cigarette manufacture.

The following table gives the nicotine content under various processes of curing :—

Table showing the nicotine content of tobacco under various processes of curing.

Description of sample	Ground cured	SUN CURED ALL THROUGH			SUN CURED PROTECTED FROM DEWS			SUN CURED BY METHOD No. 4			AIR CURED IN SHADE		
		Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper	Mean
Adcock 1928 .	3·10	1·60	3·02	2·31	1·47	2·30	1·90	..	2·42	..	2·51	3·31	2·91
Pusa Type 28, 1928	2·23	1·55	2·39	1·97	1·50	2·33	1·91	1·62	1·95	1·78	2·28	2·61	2·45
Adcock 1929 .	2·88	2·10	3·21	2·65	1·81	3·26	2·53	..	..	..	3·27	3·00	3·14
Pusa Type 28, 1929	3·91	3 31	3·35	3·33	..	..	..	3 09	3·49	3·29	3·75	3·77	3·76
Surujmukhi 1929 .	3·56	..	..	2·32	..	..	3·15	..	..	3·04	..	..	3·17

So far as starch is concerned, the loss of this constituent was far greater than what was observed in case of nicotine. The loss here is at least 50 per cent. and at times had been found to exceed even 80 per cent. In case of sugars there had invariably been an increase after curing in all cases of rack cured samples, but in case of ground cured, there had been a marked decrease.

The consumption of starch was, in the majority of cases, greater in case of ground cured tobacco than in the corresponding rack cured ones. In the rack cured samples, the sugar contents varied within short limits and none of the four methods (Nos. 2 to 5) enumerated above produced any appreciable variation : the starch contents, though varying between wide limits, seemed hardly affected by any of the four different processes of curing.

The presence of amido nitrogen is associated with the quality of tobacco. Of the samples so far examined, the amido nitrogen was found to be least in the ground cured samples and, in majority of cases, the most in the one " cured on rack, in the sun but protected from dews." It was noted that the upper leaves in all the varieties and all under processes of curing are generally richer than the lower ones, both in nicotine and amido nitrogen contents.

2. *Effect of manurial constituents on the quality of sugarcane juice.*— This subject was further studied during the year. Eight new plots were laid down near the Nawabi stables and the manurial applications, which consisted of superphosphate (100 lb. P_2O_5 per acre) and sulphate of potash (50 lb. K_2O per acre) with and without mustard cake (120 lb. N per acre), were made in two doses, $\frac{1}{3}$rd after germination of sets when plants were about a foot high, and $\frac{2}{3}$rds a couple of months later just before the advent of the monsoon. Occasional irrigation was given to the plots. The plants were periodically subjected to analyses and the following results were obtained.

The no-manure plots yielded canes the juice of which contained the highest quantity of sucrose and the smallest amount of glucose.

The use of mustard cake tended to increase the yield, the biggest crop being obtained from the plot which received an application of cake +super+potash.

The effect of the manurial treatments on the quality of *gur* was not studied this year, as about harvest time Mr. Sanyal was away on deputation in connection with work at Bhopal on Khan Bahadur Hadi's process.

3. *Experiments at Bhopal on the manufacture of sugar.*— The modifications introduced by Khan Bahadur S. M. Hadi in the indigenous method for manufacturing sugar as followed in Rohilkhand lay claim to superiority over the latter in certain respects. Further, the Hadi process is maintained to be fairly simple and one which could be easily availed of by the indigenous manufacturers. Sugar manufacture is one of the vitally important industries, but owing to the backward stage of develop-

ment in the country a multiplication of well-equipped up-to-date power factories is difficult. It is thus very desirable to test the possibilities of such manufacturing processes as are claimed to be relatively simple and, at the same time, to be advances over the methods prevailing in the land. The Imperial Council of Agricultural Research decided to see for themselves as to how the Hadi process works out in actual practice and at their instance Messrs. P. B. Sanyal and A. Hossain of this section were deputed to conduct a series of trials at Bhopal. A full complement of apparatus and chemicals required for this investigation and the services of a trained laboratory assistant were also lent from here. The period of deputation of the staff lent was at first to be a month but later this was extended to a month and a half, as the work was heavy and as a number of auxiliary problems had to be attended to. Mr. Sanyal's report has been forwarded through the Director to the Imperial Council of Agricultural Research.

4. *Potato storage experiments.* Towards the end of March 1929 an experiment was started in storing potatoes in different ways. The treatments consisted of sprinkling lime (with and without sulphur), tobacco powder and also dipping in 5 per cent. sulphuric acid and subsequent drying in shade. It may be noted that in the last case the tubers attain a black colour but there is no harmful effect on their taste and germination.

The incidence of rotting was practically the same (28 to 35 per cent.) except in the case where the potatoes had been graded to tubers of small size (10·5 per cent.). At the conclusion of the storage period it was noted that 42 per cent of sound potatoes were left over and that the losses due to rotting and to loss of moisture during the storage were about equal being in the neighbourhood of 30 per cent. each.

Germination. Seed potatoes from the above different lots were sown in the beginning of November 1929. Germination was satisfactory in all the cases.

Influence of temperature on rotting. In last year's report it was noted that rotting was heavier when the atmospheric temperature was higher and that small sized potatoes suffered this loss to a less extent than the tubers of bigger size. This has been confirmed by the figures obtained in the case of potatoes stored in an incubator at 33°—38°C. These results are compared below with those of storage in the atmosphere.

STORAGE ARRANGEMENT	INCUBATOR			ATMOSPHERE
Mean temperature	96°F			85°F
Period	10 days	18 days	29 days	28 days
	per cent.	per cent	per cent	per cent.
Amount of rotting (small sized potatoes) .	20	52	60	1·2
Amount of rotting (medium sized potatoes) .	32	73	73	4 6
Amount of rotting (big sized potatoes) . .	59	76	81	7 2

The predominating influence of heat on the phenomenon of rotting is very clearly shown above. It is also seen that small sized potatoes are the most economical to store.

Change in composition. The potatoes stored in an incubator at 33—38°C. were subjected to periodical analyses. The figures obtained demonstrated that ammoniacal nitrogen suffered a marked increase but that total (organic) nitrogen remained constant. There was a pronounced increase of dextrine. These results are similar to those recorded in last year's report in the case of potatoes stored at atmospheric temperatures.

5. *Dispersion of soil.* As a corollary to Dr. Puri's work, Mr. Bhailal M. Amin has been studying the influence of varying amounts of sodium chloride in effecting the dispersion of soils for their mechanical analysis.

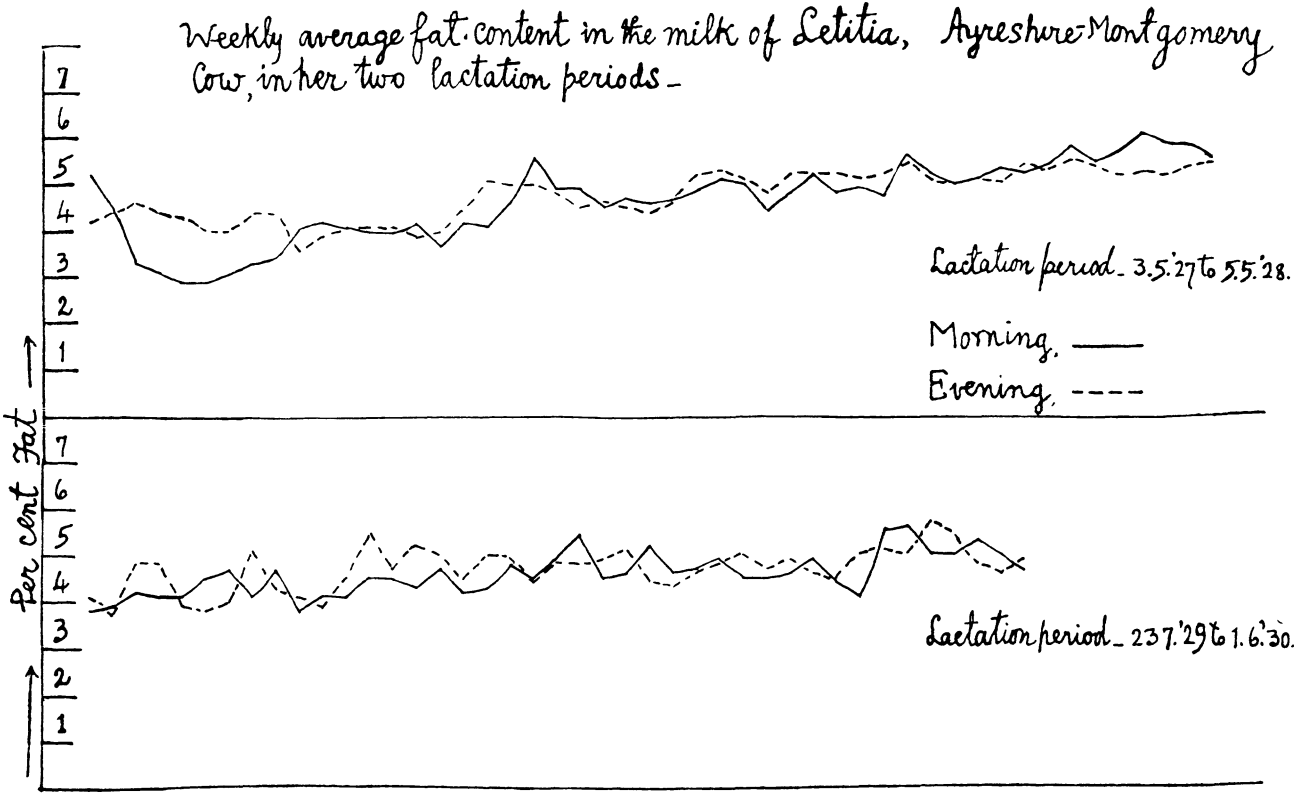
In one set of experiments 15 grams of soil were treated for half an hour with 100 c.c. of sodium chloride solutions of various strengths. The liquids were then filtered off and the residues washed first with 100 c.c. of $\frac{N}{10}$ sodium chloride solution and then with 25 c.c. of distilled water. The washed soils were suspended in water, $\frac{N}{10}$ caustic soda solution added till it was alkaline to phenolphthalein and the suspension finally made up to 1,500 c.c., after which the requisite fractions were taken out just as in the usual pipette method. The following results were obtained : —

Pusa soil treated with sodium chloride solution.

Strength of sodium chloride solution	0·05 to 0·02 m.m.	0·02 to 0·01 m.m.	0·01 to 0·005 m.m.	0·005 to 0·002 m.m.	0·002 m.m. and below
5 N	14·60	13·84	9·06	3·70	29·90
2·5 N	10·68	12·92	9·80	3·80	30·20
N	16·40	10·08	10·22	3·40	30·30
½ N	17·76	11·80	11·10	3·30	28·20
$\frac{1}{10}$ N	15·60	13·74	10·66	2·40	29·00
0 (Distilled water only)	25·60	12·00	8·80	2·40	5·40

The above figures demonstrate the efficiency of sodium chloride in dispersing clay. When no sodium chloride is used, particles 0·002 m.m. and below amount to only 5·4 per cent. whereas on treatment with sodium chloride the figure rises to 30 per cent.

The above soil is a highly calcareous (Pusa) sample. It is to be noted that in this case a preliminary treatment with hydrochloric acid had been avoided, as such a procedure would obviously be open to certain objections due to the soil containing about 40 per cent. calcium carbonate. But even without treatment with acid, there was effected a very good flocculation through the action of sodium chloride solution.


Weekly average fat content in the milk of Letitia, Ayreshire-Montgomery Cow, in her two lactation periods -
Per cent Fat
7
6
5
4
3
2
1
Lactation period - 3.5.'27 to 5.5.'28.
Morning. ——
Evening. ----
Lactation period - 23.7.'29 to 1.6.'30.

It was of interest to study whether it is necessary to subject the soil suspension to shaking in order to accelerate the course of flocculation. In this connection the following figures, which were obtained with a sample of black cotton soil from Nagpur, may be quoted.

Nagpur soil treated with N-sodium chloride solution.

Diameter of particles	Soil suspension not shaken	Soil suspension shaken for 6 hours
0·02 to 0·05 m.m.	6·62	6 08
·05 to ·01 m.m.	8 84	8 72
·01 to 005 m m.	6·42	6 46
·005 to ·002 m.m.	5 80	6 42
< 0 002 m.m.	55 64	55 00

It will be seen that flocculation was as efficient in the suspension which had not been subjected to shaking as in the one which had been shaken for six hours.

In this connection it is of interest to refer here to the note on methods for the chemical and physical analysis of soils by Kaniwetz which appeared in the *Proceedings of the International Society of Soil Science*, 1930, vol. 5, pp. 40-42, wherein the effect of solutions of varying concentrations of hydrochloric and acetic acids and of sodium and ammonium chlorides on the dispersion of soils for mechanical analysis is examined. The best dispersion was produced by N-sodium chloride. Repeated boiling of the suspensions did not alter the degree of dispersion.

6. *Study of the variations in the fat content of milk of selected cows.*— Samples of milk of 3 Montgomery and 3 Cross-bred cows were examined twice daily during the full course of their lactation periods. The increase in fat content with the progress of the lactation period was observed as in the previous years. The observation made previously regarding the tendency of a cow in the way of keeping up a definite character, under normal conditions, as regards the fat content in her milk, is illustrated in the attached chart showing the weekly average fat per cent. in the milk of the cow " Letitia " in her two lactation periods.

7. *Investigations by Plant Biological Chemist.*

1. *Rice Work.* The crude cultures obtained from Pusa and from Coimbatore have been continued. In the meantime fresh plants of two varieties of rice were collected from fields of private cultivators this season in order to find out whether the presence of organisms could be detected in their roots. In addition, plants were also collected from a small plot within the compound of one of the bungalows at Pusa where

Dahia variety of paddy, obtained from Sabour, had been specially grown this year. It may be noted that this land had for a long series of years only carried kitchen garden crops previously. It is interesting to note that all the roots examined had the organisms within them.

Water and sand cultures of rice plants were tried with the object of finding out the relation between their growth and the actual presence of the organisms. For the first purpose individual seedlings were grown in sterilized sand and transferred to water cultures at the proper stage. The culture media contained minerals but no nitrogen. In some there was also added glycerine or mannite, which was thought to be of help in maintaining suitable conditions for the development of the organisms. The plants, however, began to wilt where glycerine was present, and a similar effect was also later produced where mannite had been applied. In another set of cultures attempts were made to conduct the operations under as sterile a condition as possible. Rice seeds both husked and unhusked, were used. It was noticed that husked seeds when treated with mercuric chloride to effect the destruction of any organisms present on the outside, were difficult to germinate. Unhusked seeds were therefore used in the rest of the experiments. Besides, trying seeds treated with mercuric chloride, blank experiments with untreated seeds were also carried out simultaneously. All these were germinated in sterile sand and then transferred to sterile liquid media, these latter containing minerals but no nitrogen. Some had mannite in addition. Afterwards inoculations with crude cultures of the root organisms were made in some of the solutions. Unfortunately the plants developed chlorosis and they ultimately died off, those which had mannite being the first victims. It might be that in these experiments the seedlings were transferred to liquid cultures at too early a stage of development but the most important consideration for success seems to be the choice of a suitable culture medium.

Sets of cultures in sand were also tried, an addition of nutrient mineral solution, with and without mannite, having been made to the sand. Here also efforts were made to maintain the underground portions of the plants under as aseptic conditions as possible. The growth of seedlings was again retarded at the preliminary stage by the presence of mannite. The development of the plants, although not so bad as in the water cultures, was also not very vigorous. It was, however, possible for the plants to set seeds. The nitrogen figures in connection with a case of this nature are recorded below. The result is of interest, although it is not maintained here that the amount of nitrogen necessary for the development of the plants was assimilated only through the activities of bacteria in the roots.

Nitrogen originally present in a seed (calculated from closely agreeing duplicate analyses of 12 seeds) = 0·00023 gm. Nitrogen in one plant

(calculated from closely agreeing quadruplicate analyses of 3 plants each)=0·0024. gm.

2. *Influence of manures on crops and soils.* An examination of soils from the manurial plots of the Imperial Agricultural Chemist in the North Pungarbi Field has been carried out. There are four treatments, *viz.*, nil, green manure, superphosphate and green manure+superphosphate. Superphosphate was used at the rate of 50 lb. P_2O_5 per acre; and green manure was applied by ploughing in a quantity of *Sanai* plants growing in an outside plot of an equal area. The plots were laid out in 1923 since when they have every season, except 1927-28, been treated with the requisite manures and a *rabi* crop of oats has been grown on them, fallow conditions being maintained during *kharif*. In 1927-28 no manures were used and the crop was one of wheat, but last season the usual doses of manures were applied and oats were grown again.

Before the experiments were started the soil of the plots were carefully sampled and a determination of total and available phosphoric acids (the latter both with 1 per cent. citric acid and with 1 per cent. potassium carbonate) were made as these constituents are generally held to be some of the most important factors in the fertility under the local conditions prevailing in the case of the highly calcarious soil at Pusa. The analytical figures demonstrated no appreciable variation in P_2O_5 contents between the individual plots.

The crop yield figures show however that the plots were not quite uniform in their productive capacity. Even making a due allowance for this, it can generally be maintained that a combination of green manure+superphosphate always produced the biggest yield, next came the green manure plot and then the superphosphate plot. Further the increased yield in the green manure+superphosphate area over the blank was very roughly equivalent to the sum of the individual increases in the green manure and in the superphosphate areas.

A few points about variation in the composition of the crops produced from the different plots have already been noted in last year's annual report, and a reference will now be made here to some of the results of an examination of the soils (0″-6″) and subsoils (6″-12″) of the plots which has been carried out.

A series of determinations of organic nitrogen in the different soil layers, up to 3 ft. deep, showed that during July 1928, the percentage figures generally varied between 0·028 and 0·024 in all the soils up to a depth of 12 inches. Below this depth the values, with rare exceptions, varied between 0·022 and 0·007. In October of the same year lower amounts were obtained but an analogous difference between the upper (up to 12″) and the lower (below 12″) layers was still noticeable. It is interesting to note that besides the general variations noted above, the

soil layers seem to maintain individual characteristics of their own. To illustrate this point a few figures are quoted below.

Depth.	%Organic Nitrogen in air dry soil.						
	0-3″	3″-6″	6″-12″	12″-18″	18″-24″	24″-30″	30″-36″
1928 *July*, Plot 1 no manure .	0 028	0 029	0 027	0 019	0 014	0 027	0·007
„ *October*, Plot 1 no manure .	·028	·029	·022	·018	·012	·024	·005
„ *July*, Plot 2 Green manure .	·027	·010	·029	·018	·012	·009	·007
„ *October*, Plot 2 Green manure	·023	007	·027	015	·010	·002	·002

It may be noted that just after the first set of borings had been taken (May) manurial applications were made to the plots. In the case of plot 2 the green manure had been ploughed in just after the date of the first set of analyses recorded above.

Interesting figures were also obtained in the determination of nitrates in the soil. Figures obtained with layers up to 18″ deep are recorded in the following table :—

Nitrates in the different soil layers.

	NITROGEN (AS NITRATES) PARTS PER MILLION DRY SOIL.									
	July					October.				
	0-3″	3″-6″	6″-12″	12″-18″	0″-18″ calculated*	0″-3″	3″-6″	6″-12″	12″-18″	0″-18″ calculated*
1. No manure	1·690	0 791	0·447	0·350	*0·679*	1·336	8·792	0·615	0·427	*2·035*
2. Green manure	0 618	0 618	0·684	0·352	*0·551*	4·578	10·550	4·108	0 350	*4 007*
3. Super	0·768	0 610	0 359	0 354	*0 467*	0 098	1·559	2·196	0·272	*1 099*
4. Green manure + super	0·771	0·607	0·452	0·359	*0 500*	0 216	2·638	18 370	2 215	*7·337*
5. No manure	0·768	0·597	0 363	0 451	*0 499*	0 335	0·252	2 951	2·298	*1 847*
6. No manure	0·189	1 230	0 934	0 461	*0·702*	0 359	0 269	1·468	1·367	*1·050*

* These calculations have been based on the assumption that each six inch soil column contains equal weights of dry soil. This assumption is not rigorously true but the figures arrived at above are sufficiently accurate for comparative purposes,

From the above it is seen that before the application of the manures there was a fairly uniform distribution of nitrates in all the plots. The large increase following cases where green manure had been applied, and specially when it is used in combination with superphosphate, is quite apparent.

It is proposed to give a more extended account of the results of the examination of the physical, chemical and biochemical properties of these soils in a later publication.

As these plots in the North Pungarbi Field are not quite uniform, a new series of 19 plots, each $\frac{1}{80}$ acre, has recently been laid down in the Pot Culture House area. Multiplicate plots will thus be available for any work, if considered necessary. *Marwa* is being grown in 12 of these new plots to test their initial fertility.

3. *Miscellaneous.* Experiments have just been commenced on finding out a convenient mehtod of utilizing bones in the country. This piece of investigation has been entrusted to the section by the Imperial Council of Agricultural Research.

Six paddy soils collected from Coimbatore, Karimganj and Jorhat have been submitted to chemical and biochemical analysis. The results obtained to date show that they are deficient in lime content. The courses of ammonification and nitrification are very poor in the case of the Assam soils. The studies are being continued.

8. *Investigations conducted by the Physical Chemist.*

1. *General.* Work has been done by Dr. Puri on the subject of soil colloids. Various problems, *e.g.*, base exchange and soil acidity, dispersion and flocculation of soil colloids, methods of their determination, saturation capacity and degree of saturation of soils, determination of sticky point, etc., have claimed his attention. Accounts of these investigations have been submitted to the Imperial Council of Agricultural Research with a view to their publication. Reference will be made here only to two of his papers which have already been published by the Department.

2. *The hypothesis of "unfree" water in soils.* Dr. Puri's experiment showed that dry soils are unable to remove any water from sugar solutions of concentration from 4 to 8 per cent. At high concentrations there is evidence that a weaker solution is taken up leaving the solution more concentrated. Dr. Puri concludes that as in soil solutions one is generally dealing with much lower concentration of simpler molecules than sucrose, it is extremely unlikely that any unfree water exists in soils.

3. *A new method of dispersing soils for mechanical analysis.* A simple method of dispersing soils has been evolved. Ten to twenty grm. of soil are left with 100 to 200 c.c. of N. NaCl solution for about half an hour with occasional stirring The suspension is then filtered and washed with

about 500 c.c. of the same solution on the filter paper. It is finally washed with about 100 c.c. of $\frac{N}{10}$ NaCl solution and when the whole of it has been drained off, about 10 c.c. of water is gently poured on the soil which has been brought to the bottom of the filter paper. This displaces the major portion of NaCl. The suspension is afterwards transferred to a stout beaker with 300—500 c.c. of water. $\frac{N}{10}$ NaOH is then gradually run in till the suspension is just alkaline to phenolphthalein (used as an external indicator) and is mechanically shaken for 1 hour or left for 5—6 hours with occasional hand-shaking, when it is ready for making up to the desired volume for the pipette method.

Apparently there is no necessity for the use of hydrogen peroxide. In the tropics one is seldom called upon to deal with soils containing a high percentage of humus which hydrogen peroxide is supposed to destroy. However, if some workers wish to retain its use, there is no reason why sodium chloride treatment should not precede or follow the hydrogen peroxide treatment.

As regards efficiency in producing dispersion, Dr. Puri found that sodium hydroxide and lithium hydroxide are much more powerful than ammonia which is universally employed for final dispersion in the mechanical analysis of soils. In the above new method recourse is therefore had to a preliminary treatment with sodium chloride which results in replacing all the ions by Na in the exchange complex.

The proposed method combines all the advantages of acid treatment as regards reproducibility and attainment of maximum dispersion, and is free from such objections as the loss of varying amounts of soil constituents that is inevitable when the soil is treated with acid.

VI. Programmes of work for 1930-31.

A. Imperial Agricultural Chemist.

1. Effect of manurial combinations on the quality of cane juice and the *gur* produced therefrom.
2. Composition of crops as affected by manurial treatment.
3. Study of the soils of tobacco tracts in India.
4. Study of the causes producing heat-rot in potatoes.
5. Variation in the composition of milk.
6. Studies in dispersion of soils.

B. Plant Biological Chemist.

1. To study the influence of organic matter on the soil.
2. To study the question of nitrogen recuperation in Indian soils.
3. To investigate the fixation of nitrogen by plants.

VII. PUBLICATION.

PURI, A. N. . . . A new Method of Dispersing Soils for Mechanical Analysis. (*Mem. Dept. Agri. Chem. Ser.*, Vol. X, No. 8.)

" " . . The hypothesis of unfree water in soil. (*Agri. Jour. India*, Vol. XXIV, No. 5, 1929.)

SEN, A. T . . A study of the Capillary Rise of Soil Moisture under Field conditions. (*Mem. Dept. Agri. India, Chem. Ser.* Vol. X, No. 9.)

SEN, J. . . . . Report of the Progress of Agricultural Chemistry in India for the year 1929-30, for the Committee of the Privy Council for Scientific and Industrial Research, London.

REPORT OF THE IMPERIAL AGRICULTURAL BACTERIOLOGIST.

(J. H. WALTON, M.A., M.Sc.)

I. ADMINISTRATION.

I held charge of the section throughout the year, except for the period of 17 days from 23rd October to 8th November 1929, when I was under training in the Army in India Reserve of Officers and Mr. N. V. Joshi was in charge of the section.

Mr. N. V. Joshi was on leave on average pay for 1 month and 1 day from 17th March 1930 when Mr. C. S. Ram Ayyer acted in place of Mr. N. V. Joshi and Mr. Hari Har Prasad for Mr. C. S. Ram Ayyer.

Mr. S. V. Desai was granted an extension of study leave for 12 months from 1st October 1929 and Mr. N. D. Vyas continued to officiate in his place.

II. TRAINING.

There were no post-graduate students in the section during the year. I gave the Dairy Diploma students at Bangalore a course of instruction in Dairy Bacteriology.

III. SOIL BIOLOGY.

Nitrogen Fixation. Two further sets of experiments to estimate nitrogen fixation by green algæ were completed, and others are in progress. Small gains of nitrogen were again detected.

Two series of rotation experiments to test the influence of leguminous crops on the conservation of soil nitrogen were started. In the first series, a *rabi* crop of wheat is taken and *kharif* crops are (i) maize, (ii) maize and *urid* alternately, (iii) maize and *urid* mixed, (iv) *urid*. In the second series a *kharif* crop of maize is taken and the *rabi* crops are (i) barley, (ii) barley and *kerao* alternately, (iii) barley and *kerao* mixed, (iv) *kerao*.

The soil nitrogen in the *dhab* area has again been well maintained by the system of cropping employed.

Green Manures. The manurial values of *Crotalaria juncea* and *Crotalaria sericea* were compared in small plots of oats, two sets in quadruplicate. The plots manured with *C. sericea* gave the higher yield of grain by 11 per cent. As *C. sericea* is succulent and its decomposition in the soil less hampered by lack of moisture than that of *C. juncea*, it should prove to be the more useful green manure for certain districts. Further, it does not produce the woody growth of *C. juncea* and so is less liable to encourage infestation of the soil by white ants.

The manurial value of the tops of Mexican sunflower was found to be equal, weight for weight, to that of *sanai* (*C. juncea*), and in nitrification tests, equal amounts of nitrate were recovered.

Conservation of nitrogen in dung. The addition of one or two per cent. of superphosphate to cow or bullock dung greatly diminished the loss of nitrogen during ten months storage, and at the end of the period there was a much higher percentage of nitrogen recoverable as ammonia from the dung and superphosphate mixture than from the dung alone.

The table gives the result after ten months' storing.

	Loss of nitrogen per cent	Per cent. of original nitrogen recovered as ammonia.
Bullock dung	9 10	6·58
„ „ +1 per cent. Superphosphate .	5 37	13·36
„ „ +2 „ „ .	3 85	15·47
Cow dung	25 92	8·53
„ „ +1 per cent. Superphosphate . .	11·91	24·08
„ „ +2 „ „ . .	7 04	29 81

The original nitrogen content of the bullock dung was 0·22 per cent. and of the cow dung 0·34 per cent. The richer dung lost more nitrogen than the poorer, and in it the value of superphosphate as a conserver of nitrogen was much the higher.

Nitrification and Lime requirements in Acid soils. In the report for 1928-29 it was mentioned that in two acid soils from Neterhat, Chota Nagpur, the maximum nitrification and growth of linseed plants were obtained only when twice the lime requirement of the soil, calculated by the Hutchinson and MacLennan method, was added. This year in Dacca unmanured soil, pH 5 9, and with a calculated lime requirement of 0·152 per cent., one and a half times the amount of the lime requirement had to be added to produce the maximum crop of linseed. Maximum nitrification of sulphate of ammonia was found when three times the calculated lime requirement was added. In the Neterhat soil the beneficial effect of the previous year's addition of lime was still prominent.

Nitrification of Calcium cyanamide. When calcium cyanamide was treated with dilute sulphuric acid for two or three weeks and then added to Pusa soil, two-thirds of the added nitrogen was recovered as nitrate. No nitrate was recovered when untreated cyanamide was added. Urea was formed by the acid treatment. Treatment with

alkali also results in urea formation, but only one-fifth of the nitrogen of alkali-treated cyanamide was recovered as nitrate from Pusa soil.

Nitrification of calcium cyanamide was tested in acid soils from Jorhat and Dacca, and gave results as follows :—

(*a*) Jorhat soil. Unlimed, unmanured, cultivated. pH 5·1 : Nitrification started between the eighth and twelfth week of incubation ; 37 per cent. of the added nitrogen was nitrified in twenty weeks. When the soil was limed, 52·5 per cent. of the added nitrogen was nitrified in sixteen weeks.

(*b*) Jorhat soil, uncultivated. pH 5·7 : Nitrification started in less than eight weeks and 56·6 per cent. of the added nitrogen was nitrified in sixteen weeks. With liming this amount increased to 61·5 per cent.

(*c*) Dacca red soil, unmanured. pH5·9 : No nitrification of cyanamide, ammonium sulphate or mustard cake was found after eight weeks.

(*d*) Dacca Kitchen Garden soil, limed. pH6·5 : 56 per cent. of the added nitrogen of cyanamide, 50 per cent. of that of mustard cake, and 37·5 per cent. of that of ammonium sulphate was nitrified in eight weeks.

As the nitrification of calcium cyanamide is often long delayed or non-existent when quantities large enough to add 30 mgms. of nitrogen to 100 gms. soil are taken, the changes taking place in the early stages were studied in seventeen soils from different parts of India.

Every twenty-four hours for three days, and at shorter intervals with some soils, the production of urea and ammonia, the disappearance or persistence of the cyanamide form of nitrogen, and the hydrogen-ion concentration of the soil were determined. The results showed that in soils of pH 7·0 or more, no urea was produced and in these soils cyanamide persisted for the three days and even after many weeks incubation did not nitrify. In the soils of pH5·0—6·9 there was production of urea, disappearance of the cyanamide form of nitrogen, and, except in one soil from Dacca, nitrification began after incubation for a varying number of weeks.

Alkali salts and nitrification. Further results were obtained during the year. In Kalol soil the addition of 0·75 per cent. of sodium carbonate delayed the nitrification of ammonium sulphate and suppressed that of mustard cake. In Chinsurah soil 1 per cent. sodium carbonate failed to prevent the nitrification of mustard cake. The maximum amount of nitrate found was 24 mgms. per 100 gms. soil in which 0·2 per cent. sodium carbonate was added ; when 1 per cent. was added the amount of nitrate found fell to 12·9 mgms. In Jorhat soils nitrification of both mustard cake and ammonium sulphate was stimulated by additions of sodium carbonate up to 0·2 per cent., but adversely affected by higher

concentrations. Nitrification in these soils was depressed by 0·2 per cent. sodium sulphate.

In Pusa soil 0·2 per cent. sodium sulphate had no influence on nitrification. 0·5 per cent. checked nitrification for four weeks, after which time it proceeded normally. 0·1 per cent. of sodium chloride did not affect the nitrification of ammonium sulphate but retarded that of mustard cake. Increasing doses of sodium chloride hindered nitrification, till 1 per cent. checked it for ten weeks, after which it proceeded slowly.

Cellulose fermentation. In recent publication it has been stated that certain organisms decompose cellulose when nitrogen is supplied in the form of ammonium sulphate. The cellulose fermenters isolated at Pusa can act only when peptone is the source of nitrogen.

Other Biological Studies. Chemical analysis of Jorhat soils pointed to a deficiency in lime and phosphoric acid. Addition of either of these stimulated the production of carbon dioxide from organic matter, but phosphate alone did not improve nitrification. When lime had been added, the phosphate then increased both the rate and amount of nitrification. Sulphur was oxidised in the soil to the amount of 34 mgms. of 100 mgms. added to 100 gms. soil, after four weeks.

Nitrification in soils from the Tarnab Farm, Peshawar, was very active and carried on at a rate unsurpassed by that in any other soil we have examined.

IV. Dairy Bacteriology.

The average plate counts of the bacterial content of the milk supply, are given below, with those of the previous year for comparison.

Month.	Average count per cc.		Coli counts 1929-30		
	1928-29	1929-30	Days present in 1/100 cc.	Days absent in 1/100 cc.	Days absent in 1/10 cc.
July	17,300	18,800	2	13	4
August	22,250	13,300	5	7	1
September	22,150	17,140	2	11	4
October	17,000	11,400	..	8	6
November	12,600	8,200	1	11	11
December	12,000	5,500	.	10	10
January	9,400	5,900	.	15	15
February	9,900	5,700	.	12	11
March	8,800	12,800	3	11	..
April	15,450	40,000	6	4	..
May	19,800	61,200	2	14	..
June	24,600	5,700	1	15	11

The counts were generally lower than those of the previous year, but there was a marked rise in the months of April and May.

In April the dairy was short of hands owing to a severe cholera epidemic in the district, but when in May the full staff was present and the counts went even higher, the matter called for investigation. The utensils were found to be above suspicion, and the increased counts were finally attributed to the time that elapsed between milking and distribution, and the prevailing high temperatures. Reference to the literature of the subject and previous results obtained at Pusa did not indicate that there should be any great multiplication of bacteria in 2½ hours at 37° C., but in a repetition of the experiment, milk giving an initial plate count of 8,200 colonies per cc. gave counts of 29,600 after 1½ hours and 85,000 after 2½ hours at 37° C. In the month of June, distribution began soon after milking, so that milk was not an hour old when supplied to the consumer. This, combined with the extra care given to cleanliness, resulted in record low counts for the month of June; also, contrary to the experience of previous years, there was no rise in the counts on the break of the monsoon.

Plate counts were made from the middle milk of sixty Montgomery cows during the year. With six cows the average count of several samples was over 10,000 colonies per cc. Four of the six had given high counts in the previous years.

Investigation of the types of colon bacilli present in milk were carried on throughout the year. It was found that types giving positive Methyl Red and negative Voges-Proskauer reactions predominated except during the rainy season, when the Aerogenes type, giving a positive Voges-Proskauer and negative Methyl Red reaction were the more numerous. Whenever there was a heavy fall of rain in the dryer season of the year, this latter type appeared, and might predominate for a day or two.

Sterilization of milk. Difficulty has often been found in sterilizing milk for use as a laboratory medium, especially in the hot weather. The text book method of intermittent sterilization for 30 minutes on three successive days fails regularly, owing to curdling of the milk between the first and second heatings. A method has been developed, requiring four heatings, which has overcome the difficulty. The milk after heating is cooled to check the germination of surviving spores, and held up at 37°C. for 1 hours to allow these spores to germinate, before subjecting them to the next heating.

V. Disinfection Experiments with E. C. and Bleaching Powder.

Germicidal efficiency of E. C. and Bleaching Powder Solution. Further experiments on the germicidal efficiency of E. C. showed that this could

be much improved by the addition of a little acid to the dilution water. The solution consisting of 200 cc. E. C. (2 per cent.) in 100 litres of water containing 3·5 grams of citric acid caused almost complete destruction of spores of such bacteria as *B. subtilis, B. mesentericus*, etc., in 30 minutes. When the acid was omitted the spores survived 60 minutes contact.

Bleaching powder solution containing 2·5 per cent. available chlorine was tested for its germicidal efficiency on bacterial spores; this was found to be equal to that of E. C.

Silkworm feeding. Experiments on feeding silkworms with mulberry leaves smeared with the organisms of muscardine, flacherie, and pebrine, and treated with E. C. in various dilutions, showed that a dilution of 1 in 200 was effective in checking the mortality arising from the infection.

As bleaching powder is now cheap and the cost of a solution containing 2·5 per cent. available chlorine is much less than that of E. C. of about the same strength, and our experiments have shown that it is as efficient as E. C. for destroying bacterial spores, the substitution of bleaching powder for E. C. in the disinfection of silk houses has been recommended. The cheapness of the solution now recommended, *viz.*, bleaching powder solution containing about 2·5 per cent. available chlorine diluted 200 times with water containing one ounce citric acid per 10 gallons, when compared with the cost of the formalin and even the E. C. solutions previously employed, will result in a considerable saving in the cost of disinfection of silk nurseries and rearing houses.

Stability of Bleaching Powder solution and E. C. A comparison was made of the stability of solutions of Bleaching Powder, Bleaching Powder in 20 per cent. brine, and E. C.

The table below shows the gradual loss of chlorine.

Date.	Strength of Solutions, per cent. available chlorine.		
	Bleach.	Bleach in brine.	E. C.
March 27	2·59	2·21	2·04
April 20	2·55	2·09	2·02
May 26	2·38	1·96	1·89
June 23	2·22	1·81	1·89

Bleaching powder kept in stoppered bottles deteriorated in chlorine content from 31·8 per cent. to 22—24 per cent. between March 25th and June 23rd. The bulk kept in the open drum fell from 31·8 per cent. on March 25th to 25·5 per cent. on May 25th, 20·3 per cent. on June

6th and 13·1 per cent. on June 23rd. The great fall in June is partly due to the absorption of atmospheric moisture and weighing of the wet sample.

In establishments such as dairies, sugar factories, etc., where disinfectants are or may be used in large quantities, the cheapness of bleaching powder should encourage its employment as a substitute for more expensive disinfectants, and also where, on account of cost, disinfecting agents have not hitherto been employed.

VI. Silage.

Sugarcane tops were successfully converted into silage. Besides the laboratory preparation in jars, a small pit of cane-top silage was prepared. The quality of the silage was improved by the addition of water to bring the moisture content up to 78-80 per cent. After sixteen days the pH was 4·0 and the total acidity, on the weight of dry matter, had risen from 1·65 to 8·8 per cent., and after two and a half months to 15·3 per cent.

Berseem silage was readily eaten by cattle, but acid development was very weak; in 7½ weeks the pH was 5·55 and total acidity only 3·96 per cent. A mixture of berseem and oat straw appeared to give a better product, but further experiments will be necessary to find a suitable and readily available product, low in nitrogen content, with which to mix the berseem.

VII. Acetic Fermentation.

The country method of vinegar production from sugarcane juice in the Punjab was studied by Mr. C. S. Ram Ayyer. The method is crude and no precautions are taken in connection with the cleanliness and purity of the culture. Samples of the product tested rarely contained more than 4 per cent. acetic acid. A pure culture of the vinegar bacteria, isolated from the crude product, produced seven per cent. of acetic acid in cane juice previously fermented with a pure culture yeast.

Cashew juice may be fermented to produce vinegar containing 4 per cent. acetic acid. The juice contains an acrid ingredient which spoils the flavour of the vinegar. The acridity is greatly reduced by the addition of 0·25 per cent. common salt.

Waste molasses can be mixed with cashew juice, and with the increased sugar content a vinegar containing 7 per cent. to 8 per cent. acetic acid has been produced.

VIII. Preservation of Vegetables.

Experiments on the preservative value of spices used in the preparation of mango and other pickles were carried out and the results published.

Further experiments on the preparation of Sauerkraut showed that this can easily be done on the domestic scale. The method was extended to cauliflower, and the heads, broken into small stalks, as for pickling, were well preserved by salting, using 2½ per cent. of salt. After two or three weeks fermentation, the addition of certain spices, alone or in combination with mustard oil, made a product pleasing to the Indian palate. Without the preliminary fermentation a satisfactory product could not be obtained. Certain lactobacilli were responsible for the fermentation.

IX. Potato Storage.

Experiments on potato storage were continued. Charcoal and cinders were the best materials tried; seed potatoes that had been stored in charcoal gave a higher yield than those stored in other substances.

X. Plant Diseases.

Maize. A stem-rot of maize was very common in villages round Pusa and was also found on the Pusa Farm. A description of the disease has been published.

Hibiscus esculentus (*Bhindi, Lady's Finger*). Nodulation and deformity of the root of this plant were caused by an attack of eel-worms.

Tobacco. Diseased tobacco plants from Berhampore showed symptoms of mosaic. They were received too late in the season for successful inoculation experiments.

Potato. Samples of two consignments of potatoes that had deteriorated in transit by rail, were examined. One sample was affected by dry rot caused by fungal attack, the other by a bacterial wet rot.

Citrus Canker. This disease was found to be widespread in the Benares and Allahabad districts both on young nursery plants and on well grown trees.

XI. Programme of Work for 1930-31.

List of Subjects.

1. Conservation of soil nitrogen.
2. Nitrification studies.
3. Bacteriology of silage.
4. Dairy Bacteriology.
5. Utilisation of E. C. and Bleaching Powder.
6. Bacterial Diseases of plants.

XII. Publications.

Hari Har Prasad and Joshi, N. V.	Preservative value of spices in pickling raw fruits. *Agri. Jour. of India*, Vol. XXIV, Part VI, November 1929.
Hari Har Prasad . .	A Bacterial Rot Stalk of Maize. *Agri. Jour. of India*, Vol. XXV, Part I, January 1930.
Joshi, N. V. and Puri, A. N.	The Influence of Exchangeable ions in soil Colloids on Bacterial activity and Plant growth. *Mem. Dept. Agri. India, Bact. Ser.* Vol. II, No. 4, 1930.
Ram Ayyar, C. S. . .	A comparative study of the germicidal efficiency of E. C. and Formalin on Bacterial Spores. *Agri. Jour. of India*, Vol. XXV, Part I, January 1930.
Vyas, N. D. . . .	A method of increasing the manurial value of Bone Phosphate. *Imp. Inst. of Agri. Res. Pusa, Bulletin* No. 204, 1930.

REPORT OF THE IMPERIAL MYCOLOGIST.

(M. MITRA, M.Sc., PH.D., D.I.C., F.L.S.).

I. CHARGE AND ESTABLISHMENT.

Mr. J. F. Dastur officiated as Imperial Mycologist up to 5th October 1929, when he reverted to his original post in the Central Provinces as Government Mycologist. Dr. W. McRae held charge of the section from 6th October 1929 to 19th February 1930, when he proceeded on ten months' leave and Dr. M. Mitra was placed in charge of the section in addition to his own duties. Dr. W. McRae was appointed Joint Director from 6th October 1929 in addition to his own duties as Imperial Mycologist. Mr. L. S. Subramaniam officiated as First Assistant up to 27th September 1929, when Dr. M. Mitra, the permanent First Assistant returned from England after completing his training there. The post of Second Imperial Mycologist was still held in abeyance.

II. TRAINING.

Mr. T. R. Mehta, B.Sc., worked in the section as a post graduate student up to the end of October 1930, when he was transferred to the section of the Imperial Economic Botanist for further training. Mr. P. R. Mehta, B.Sc., continued his post graduate training during the year. Messrs. R. N. Mathur, M.Sc., and U. B. Singh, M.Sc., were admitted for post graduate study in November 1929. Mr. Khanna, a student of the Agricultural section, worked in the section on the sugarcane crop from the middle of February 1930. Four students from the Imperial Institute of Animal Husbandry and Dairying, Bangalore, received a short course on diseases of fodder crops during March 1930. Dr. K. D. Bagchi, Forest Mycologist, Dehra Dun, worked in the section in April in connection with his study on pine rusts.

III. DISEASES OF PLANTS.

1. Rahar (*Cajanus indicus*). (i) *Wilt of Rahar* (*Fusarium vasinfectum* Atk.). This investigation, which has for its object the isolation of a type of *rahar* which will be resistant to wilt disease, was continued in collaboration with the Imperial Economic Botanist and considerable success has been achieved in that line. In the permanent manurial plots, B series, WR type which in 1928-29 crop appeared to possess a higher degree of resistance than any other type, was tried during the year. The results obtained were encouraging and a comparison of figures of wilted plants and the percentage of wilt with those of last seven seasons in which ordinary seed was sown as shown in the table below will point to the degree of resistance to wilt shown by type WR.

Wilted rahar plants on the permanent manurial plots in Pusa.

B Series.

Plot	Manures applied per acre	1917-18	1919-20	1921-22	1923-24	1925-26	1927-28	Average	1929-30
I	No manure { Number of wilted plants	129	47	37	78	16	22	54 8	0
	{ Percentage of wilted plants			1 3	1 6	0 5	0 9	1 0	0
II	Farmyard manure to supply 10 lb nitrogen	126	76	71	172	74	72	98·5	7
		..		2 8	3 7	2	2 5	2·7	0 2
III	Farmyard manure to supply 20 lb nitrogen	319	250	275	486	287	340	326·1	17
		..		11 7	11 4	8	12·0	10 7	0·6
IV	Farmyard manure to supply 30 lb nitrogen	703	760	886	1,551	902	807	934·8	39
				37 5	39 0	28 9	31 6	34 2	1 6
V	Rape seed to supply 20 lb. nitrogen	141	253	216	320	177	133	206 6	2
				10 3	9 1	6 0	5 0	7 6	0 08
VI	Sulphate of ammonia to supply 20 lb nitrogen	346	360	248	482	208	142	297 6	3
		..		10 3	11 4	6 5	5 0	8 3	0 12
VII	Sulphate of potash to supply K_2O as in Farmyard manure No III	588	393	365	521	154	110	356 8	6
				17 2	12 1	4 7	4 0	9 5	0 23
VIII	Superphosphate to supply P_2O_5 as in Farmyard manure No III	1,903	1 452	898	1,408	687	483	1,138 5	13
		..		47	35 8	20	18 0	30 2	0 61
IX	{ Sulphate of potash to supply K_2O as in No III	2,354	1 222	718	1,006	421	350	1,011 8	7
	{ Superphosphate to supply P_2O_5 as in No III	..		37 8	28 4	11·4	14 0	22·9	0 34
X	{ Sulphate of ammonia to supply nitrogen as in No. III	1,814	989	719	874	345	240	830 1	7
	{ Sulphate of potash to supply K_2O as in No III								
	{ Superphosphate to supply P_2O_5 as in No III			40 3	21 6	11	10 4	20 8	0 31
XII	Deep rooted leguminous crop (rahar) in a cereal rotation	233	252	141	281	93	48	171 6	2 00
				7 1	6 1	3·8	2 0	4 7	0 09
XIV	One deep (rahar) and one shallow rooted (peas) leguminous crop in the rotation	386	415	215	335	169	113	272 1	3
				11 3	7 2	5 1	5·0	7 1	0 09
XV	A leguminous crop and green manure in the rotation	111	189	66	150	143	64	120 5	6
				3 9	6 2	5	3 0	4 5	0 29
XVI	Green manure and superphosphate to supply P_2O_5 as in No III	511	642	387	600	823	670	605 5	19
				24 8	25	31 2	33·8	28·5	1·0

From the table it will be noticed that the highest death took place in plot IV in which it is 1·6 per cent. and in plot XVI in which it is 1·0 per cent. But these figures are far less when compared with the average figures of last seven seasons, *viz.*, 34·2 and 28·5 per cent. respectively.

A general survey of the wilt was carried out in the cultivators' plots in the vicinity of Pusa with a view to find out the percentage of wilt in those plots where local seed is sown and also to eliminate any possibility of doubt regarding the percentage of wilt which may have been generally less during the year in the district. The result of this survey showed that the disease was in general conformity with that of the previous years. The following figures give an idea of the disease in the various localities where it was surveyed.

Number of wilted plants in the cultivators' plots in the vicinity of Pusa.

Locality	Total No. of plants	Number wilted	Percentage of wilt
Rahamatpore	2,149	176	8·1
Muktapur	2,085	268	12·9
Doadpura	1,750	539	31·9
Jatmalpore	2,396	356	14·8
Nawabganj	4,449	1,059	23·8
Bowarah-Kothi	8,832	1,088	12·3
Malinagar	3,016	472	15·6
Samastipore Road (*a*)	964	309	32·0
Samastipore Road (*b*)	1,074	126	11·7
Dholi village	5,988	543	9·4
TOTAL	32,703	4,936	(average) 15·1

In the B block of the Punjab Experimental area it was decided during 1926-27 to stop growing *rahar* for two seasons and to test the land during the third year in order to see whether the disease had survived. All the eight plots were sown with the treated *rahar* seeds of susceptible type

The number of wilted plants and percentage of wilt is given below—

Plot	Number of wilted plants	Percentage of wilt
1B	435	35·4
2B	547	44·6
3B	939	77·4
4B	1,169	94 38
5B	48	3·9
6B	184	14·9
7B	836	67·9
8B	1,184	96 5

From the above figures it appears that the fungus is still alive in the soil and a mere two year rotation is not sufficient to get a healthy crop.

In an artificially infected plot which has retained its high degree of infection for several years, three types of *rahar* T_1, T_{204} and WR isolated in the Botanical Section were sown. As reported previously, T_1 was highly susceptible and T_{204} was like WR a resistant variety. All the 83 plants of T_1, 161 out of 166 of T_{204} and 410 out of 416 of WR died of wilt. *Rahar* has been growing on this piece of land for the last seven years and all these years artificial infection of the soil has been continued with the result that the land has become *rahar* sick and so no satisfactory result has been obtained. A similar result has been obtained in the Botanical area plot where the resistance trial has been going on for the last four seasons. Here 226 plants out of 228 of T_1, 308 out of 683 of T_{204} and 411 out of 866 of WR have died of wilt. The high death rate of WR here also is due to the soil being sick of continuous *rahar* growing. The surviving plants in these plots produced normal pods and seed but a microscopic examination of the vascular system showed the presence of the wilt fungus in most of the plants.

An experiment to test the resisting power of A_4 has been started in the three pairs of plots in D Block of the Punjab Experimental area. These plots were infected previously with wilt fungus and had no *rahar* last year. A row of A_4 plants alternates with a row of T_1 which is a highly susceptible type.

Last year an experiment was carried out to find out the effect of superphosphate on the root development of *rahar* plants and the results obtained were that in the first two layers containing superphosphate the larger roots were more numerous and the branching rootlets were still more numerous whereas in the lowest layer the difference was not parti-

cularly marked. This experiment was repeated and last years' results were confirmed.

(ii) *Rhizoctonia solani* Kuhn has also been found to cause wilt of *rahar* to a small extent. The fungus was isolated and an inoculation experiment gave about 80 per cent. positive results. This wilt is rare.

(iii) Another disease of *rahar* was noticed which causes *sterility*. No fungus has been found in the plant tissue. Experiments will be carried out this year to see whether it is a *virus* disease.

(iv) *Leaf-spot* disease caused by a species of *Cercospora*. A study of the leaf spot disease of *rahar* caused by *Cercospora* was started. A large number of isolations were made from materials collected at Pusa and at Allahabad. The Pusa strain differed markedly from that obtained from Allahabad. The morphology of these two strains was studied in detail. Both these strains were regarded by Mr. S. F. Ashby of the Imperial Bureau of Mycology as two different species which are not identical with *Cercospora instabilis* Rangel or *Vellosiella cajani* (Henn) Rangel (*Cercospora cajani* Henn) previously recorded on this host by P. Henning and Rangel. A study of these strains was made on a number of artificial cultural media of varying constituents under various physiological conditions such as humidity, temperature, light and darkness, aeration and also a detailed study of the two species with regard to H-ion concentration. *Cercosporas* from other pulses are being isolated with a view to determine whether the two species under study are identical with any of the species isolated from other pulses.

(2) *Sugarcane. Mosaic disease.* In addition to the varieties mentioned in the previous reports, Co. 313 was found infected in Pusa during the year under report. The infection was, however, limited as only one clump was found to have been affected. The Cane Breeding Station at Coimbatore and the Dairy Farm at Karnal, remained free from disease. No report was received from any of the provinces about the appearance of the disease on new varieties.

The extent of mosaic disease on the farm at Pusa was very small. The crop in the Farm was rogued out during May and June 1930, the total area under sugarcane being about 40 acres. Thirty one varieties were grown on a field scale and only the following had the disease while the rest were free.

Variety.	Area.	Percentage.
Co. 210	13·0 acres	·005
Co. 213	6·7 „	·13
Co. 299	2·04 „	·03
Co. 313	0·31 „	·002

The original Co. 213 which was also sown last year and gave 0·3 per cent. of disease is free from mosaic this year. The setts of Co. 213 shown above were brought from outside without previous examination for mosaic.

In the nursery twenty varieties were grown and all were free from the disease except Co. 281 which had eight cases of mosaic and these were removed.

Infection experiments. The disease has been transmitted from Co. 213 to Co. 240 and Co. 290 and from Co. 240 to Co. 213.

Mosaic infection.

——	No. of shoots inoculated	No. of shoots showing mosaic.	Date.	Incubation periods.
				Days
Co. 213 to Co. 240 . .	4	2	14-4-30	25
Co. 213 to Co. 290 . .	6	2	14-4-30	29
Co. 240 to Co. 213 . .	11	11	14-4-30	25

Varietal test. The following varieties were tested for their liability to mosaic disease :—

Co. 205, Co. 210, Co. 213, Co. 214, Co. 219, Co. 223, Co. 237, Co. 243, Co. 244, Co. 248, Co. 275, Co. 281, Co. 285, Co. 287, Co. 290, Co. 300, Co. 301, Co. 302, Co. 303, *Katha*, *Saretha*, *Chunnee*, *Uba* and *Hemja*. For the test, the infected material of Co. 205 was used. All the cane varieties mentioned above were planted in rows with a row of Co. 205 (mosaic) interstripped. Thus there was a healthy row of one of the above varieties alternating with a row of Co. 205 mosaic. There was no spread of the disease from Co. 205 to any of the above healthy varieties except Co. 299 of which five clumps became affected and Co. 303 of which one became diseased ; as soon as this was discovered, the diseased clumps were rogued out and the crop allowed to ratoon with a view to observe whether there was natural infection or whether the disease come in through the use of infected setts. No infection has since been noticed and it is apparent that the infection did not spread from Co. 205 (mosaic) but might have been carried from the original setts.

Tonnage experiment. An acre of Co. 213 planted with setts taken from canes whose leaves had mosaic symptoms was grown alongside an acre of Co. 213 from setts selected from cane with no mosaic symptoms. Under identical conditions a 2/5th acre of mosaic affected Co. 205 and a

2/5th acre of healthy Co. 205 were grown alongside. The total yield in both these experiments was as follows :—

——	Healthy.	Diseased.
Co. 213	629-38 maunds	618-30 maunds
Co. 205	210-20 ,,	213-30 ,,

While Co. 213 shows a decrease due to the disease, the reverse is the case with Co. 205. The difference in yield is, however, negligible and this year's results confirm those of last year that there is no indication as to the harmful effect of mosaic disease on the yield under the climatic conditions prevailing in Pusa.

The juice of both healthy and diseased canes was analysed but no significant difference in the sucrose content of the two was observed or detected.

Top rot disease. Very few cases of this disease were noticed during the year. A large number of inoculation experiments were carried out with two strains of *Fusarium* isolated from diseased plants but no successful results were obtained. Further isolations and inoculation experiments are in progress to determine the parasitic organism causing the disease.

Downy mildew of sugarcane. A case of Downy mildew caused by a *Sclerospora* was observed on a shoot of Co. 316. This is the first record of its occurrence in India and so far only the conidial stage has come to notice. The infected leaves have a mottled appearance like mosaic. The spots are small, very close to one another and running between the veins. A similar disease has been recorded from Australia, Fiji, Philippines and Java and is known as *Sclerospora sacchari*. In the present case the leaf-sheaths are not spotted nor have the leaves any reddish spot as has been described in the above mentioned species. Conidiophores arise singly or in clusters of 2-4 from stromatic mass, bulbous at the base, branched 2-4 times at the tip with broad conical sterigmata and have septa up to three and in measurement $132\text{-}264 \times 16\text{·}5\text{-}27\text{·}5\mu$, the average being $186 \times 22\mu$. The sterigmata are $4\text{·}4\text{-}27\text{·}5\mu$ in measurement. Conidia are elliptical or oblong with a small papilla at the proximal end and $22\text{-}45\text{·}1 \times 16\text{·}5\text{-}26\text{·}1\mu$ in diameter, the average being $34 \times 20\mu$.

The fungus is under study and further observations are being made to determine its identity. So far it cannot be definitely said whether it is *S. sacchari* though it resembles that disease to a great extent.

(3) *Piper betel.* As in last year, the wilt appeared in all the experimental plots at Chinsurah. There was no disease from October to April but it was considerable during the monsoon. The percentage of infection

was, however, much less than what it was last year. At Chinsurah out of seventy-seven wilted plants two died of insect attack, sixty-two died of *Rhizoctonia solani*, twelve from *Sclerotium Rolfsii* and only one from *Phytophthora* ; thus this year also the largest number of deaths took place from *Rhizoctonia*. At Banhoogly, Santragachi and Bira, the efficacy of spraying with Bordeaux Mixture was established and the cultivators are well impressed with the results produced in experimental plots. Some of them have purchased sprayers and are very keen on spraying.

Infection experiments were tried with the Bengal, Madras and the Malayan strains of *Phytophthora* on *Dhaldhoga* variety of betel-vine. Thirty plants in all in a group of ten each were inoculated with each of the three strains ; of these seven with the Bengal stram, four with the Madras strain and one with the Malayan strain took infection. A different strain of *Rhizoctonia* has been isolated from diseased betel-vine at Chinsurah.

(4) *Cinchona*. A large number of diseased specimens of Cinchona was received from the Government Cinchona Plantation at Munsong. Species of *Diplodia*, *Fusarium*, *Verticillium*, *Nectria* and *Botrydiplodia* were isolated. Inoculation experiments with some of these organisms have so far given negative results. Inoculation experiments with all these fungi have been repeated at Munsong on young cinchona plants. The seedling disease at Munsong was again under investigation during the year and a species of *Fusarium* has been isolated from infected roots and also from the collar region. The bleeding disease reported last year was also under investigation and attempts are being made to isolate a fungus, the hyphae of which are present in the diseased tissues.

(5) *Gram*. The leaf blight fungus *Mystrosporium* sp. reported previously was very prominent in the Botanical area of this Institute, out of ninety-three types of gram grown only five having been found to be free from the disease. Infected spots were noticed on the stem, petiole and seed coat in addition to those on leaves and defoliation was very common. A survey of the disease showed that so far it is only found at Pusa, there being no trace of it at Coimbatore, Lyallpur and Sabour. The temperature relationship of this fungus was studied and it was observed that the fungus grew best between 18-25° C., the optimum being at 22° C. The colour of the mycelium grows lighter at 28° C. and at above 31° C. there is no sporulation. The fungus tolerates a wide range of acid media, being able to grow at 3-7·8 pH, the maximum growth being at 7·2 pH and it renders the acid medium alkaline. The germination of seed is not affected ; the spores are also killed if seeds are treated with a 0·5 per cent. formalin solution.

Wilt. All the strains of *Fusarium* isolated from wilted plants gave negative results though the infection experiment was repeated several times. During the year a new strain of *Fusarium* was isolated.

Rhizoctonia solani was isolated from about twenty-five varieties of gram. It attacks the plant at an early stage of its growth. Inoculation experiments carried out proved its parasitic nature on this host.

(6) *Potato rot.* In addition to wet rot and *Fusarium* rot, *Rhizoctonia bataticola* (Taub) Butl. was isolated from rotting potatoes. Preliminary experiments showed that the fungus caused rot only between 33° C.-38° C. while at temperatures below 33° C. it was not parasitic. Strains of *R. bataticola* from gram and sesamum were also able to infect potato.

(7) *Maize cob rot.* A good deal of rot takes place in maize cobs stored in Pusa. On examination the fungus found responsible for the damage proved to be *Botrydiplodia theobromae* Pat. In the earlier stages the kernel develops a few pycnidia and the number gradually increases till the grain content is completely replaced by a black spore mass. The spores are 17·5-25·5 × 10-13·5μ in diameter, the average being 21·7 × 12·1 μ. The fungus was studied in detail on a large number of cultural media under various physiological conditions. The range of H-ion concentration tolerated by this fungus varies from 2·9 to 7·6 and the optimum is at about 7·1. The fungus grows best under a humid atmosphere of 70·4 per cent. though the range of humidity tolerated by it is 47-92·3 per cent. Ultra violet radiation checks the growth but slight exposure to it encourages pycnidial formation and spore germination is inhibited. Similarly X-rays check the growth but slight exposure to these rays stimulate spore germination. Light as in other pycnidia forming fungi influences formation of pycnidia. A study of the temperature relationship shows 31° C. to be the optimum for its growth. During the course of this study a saltant was isolated which is characteristic in producing a brown pigment in the medium. It, however, differs from its parent in being sterile. A further physiological study of the fungus is in progress.

(8) *Bunt on wheat. Tilletia indica* n. sp. Specimens of diseased seeds of two hybrid wheats were collected at Karnal, Punjab. These wheats were both from a cross between Federation and Pusa 52 and had been bred in the Botanical Section at Pusa and sent to Karnal for trial under Punjab conditions. An examination showed the presence of a species of *Tilletia* which appeared to differ from *T. tritici* (Caries) and *T. laevis* (foetens) which have been previously recorded on wheat. This diagnosis was confirmed at the Imperial Bureau of Mycology and the name *Tilletia indica* has been proposed for the new smut. The kernels are partially affected and not swollen. The embryo tissue is destroyed and in many cases only this area covers the place of attachment of the grain infected. In some cases the infection spreads to the tissues along the groove but the endosperm material lying along the smooth side of the grain is uninfected; thus the fungus is more highly differential than *T. tritici* and *T. laevis* which leave only the glumes and epidermal tissues of the kernels unaffected. The spores are rounded or oval 18-40μ in diameter. The

proliferations of the wall are reticulate. A detailed study of the fungus is in progress. Attempts to make the spores germinate have so far failed. This smut will, however, receive further attention next season.

(9) *Helminthosporiose. Wheat.* In addition to *Helminthosporium sativum* P. K. & B. which causes leaf spot, and foot and root rot diseases of wheat, a study of the various isolations made from different localities has revealed the presence of the following species. A species was isolated from specimens of wheat attacked with foot-rot disease in Poona. The parasitic nature of the organism was proved and a detailed study in culture under standard conditions showed it to be different from *H. sativum* or any other known species on wheat or any other grass and therefore a new name was proposed, *viz.*, *H. vicolor* n. sp. Another species of *Helminthosporium* was isolated from diseased specimens of wheat received from the Central Provinces. The fungus showing the closest resemblance to it is *H. halodes* Drech. on *Distichlis spicata* but the spores of the Indian strain are shorter, broader and slightly less septate. A detailed study showed that though it may not be identical with *H. halodes* it is, however, very closely allied to it. Hence the name *H. halodes* Drech. var. *tritici* nov. var. has been given. In addition to the two new species of *Helminthosporium* on wheat mentioned above another species has been found to be very common in Pusa. The spots formed are very much like those of *H. sativum* but on microscopic examination it is found that the fungus is quite different from the latter and resembles *H. tritici-repentis* Died. known to occur on *Agropyran repens* and *A. semicostatum* and also resembles *H. tritici vulgaris* described by Nisikado on wheat in Japan. A closer study shows that it is more like *H. tritici repentis* Died. with which it agrees in shape of conidia and other detailed characters.

Thus the following species of *Helminthosporium* occur on wheat in India :—*H. sativum* P. K. & B., *H. vicolor* Mitra, *H. halodes* Drech. var. *tritici* Mitra, and *H. tritici repentis* Died.

Barley. A cultural study of *H. sativum* on wheat and barley showed that the barley strain is different from that of wheat in forming less aerial growth, in its darker colour and more spore formation. A study of the saltants of these two strains from wheat and barley has established that the barley strain is capable of giving rise to saltants of the wheat strain type and *vice versa*. A large number of saltants from these two parent strains revealed that they possessed varying powers of infection. Some are more vigorous than the parent strains, while others are less so.

Panicum frumentaceum. A detailed examination of a species of *Helminthosporium* on this host proved it to be different from any of those previously recorded on various species of *Panicum* and other grasses and so the name *H. frumentacei* n. sp. has been given.

Rice. Helminthosporium Oryzae on rice consists of a number of strains. The saltants isolated from this fungus contain several strains, some with

shorter and others with longer spores. For example, in one long-spored strain, the average length is 123μ, average width 21μ , and the average degree of septation is 9, while in one small spored strain it is 63μ, 14μ and 5μ respectively. The discrepancies as exist in the description of *H. Oryzae* as given by various authors can be set down readily to the effect of environmental conditions or to the existence of a number of strains within the species.

Sugarcane. An extensive study of *H. sacchari* Butl. shows that the original description of the Indian strain of this fungus requires some revision especially with regard to spore size. Like other species, this species also consists of several strains, some with shorter and others with larger spores. In size the conidia in culture range from 30-112×11·5-18·5μ (average 68·3×15·3μ) and are 3-11 septate (average 6·9). The average size of one saltant was found to be 81μ in length, 16μ in width and 8·4 septation. *H. sacchari* Butl. and its saltants cover a range of variation sufficiently great to include, as far as spore size is concerned, all the forms of *Helminthosporium* causing " eye spot " disease of sugarcane.

Jowar. (*Sorghum vulgare*). In addition to *H. turcium* Pass, which has been recorded on this host, a species which was recently found identical to *H. Maydis* Nisikado et Miyake was recorded from the Punjab.

Ginger. A cultural study of the species known to occur on this host in Pusa showed it to be a strain of *H. Maydis* Nisikado et Miyake.

Eleusine. The following species of *Helminthosporium* on various species of *Eleusine* have been found :—*H. nodulosum* (Berk and Curt) Sacc. on *E. coracana* and *E. aegyptiaca*, *H. leucostylum* Drech. on *E. coracana*, *H. tetramera* McKinney on *E. aegyptiaca* and *H.* sp. on *E. indica.* Of all the above species *H. nodulosum* was found to be the most virulent parasite, attacking all parts of the plant and in all stages of its growth. *H. nodulosum* and *H. leucostylum* were found to be seed-borne. The diseased seeds shrivel up and mycelium is found on glumes and palae. The diseased seeds when sown always give rise to diseased seedlings which under favourable conditions soon die and in case of surviving plants they are found to be weak and stunted in growth. However, *H. leucostylum* was found to be a much weaker parasite than *H. nodulosum. H. tetramera* as it has been named was originally recorded on wheat by McKinney and this is the first record of its occurrence on *Eleusine aegyptiaca.* All the strains were studied in artificial culture on a number of media and the temperature-relationship was also determined. This study showed that the optimum growth was between 27·5° C.-30° C. and maximum up to 38·5° C. The thermal death point in all cases was 59-60° C. for ten seconds exposure. There is a good deal of variation in the size and septation of spore and much depends on the temperature and nature of media. They tolerate a range of H-ion concentration varying from 2·9 to 8·0 and the best growth is shown at 7·1 pH. Whatever the H-ion concentration of the

medium may be, they are changed to pH. 2·9-3·0 after fifteen days growth, *i.e.*, a tendency for the media to become acid.

Cross inoculation experiments showed that *H. nodulosum* is capable of infecting maize, *Setaria italica* and *Panicum frumentaceum* while it is unable to attack wheat, oats and barley. A further study of these strains of *Helminthosporium* under various physiological conditions is in progress.

General. As in the last year an estimate of *Helminthosporium* on wheat was made again this year in Pusa according to Tehon's method. Pusa 4 was found to be highly infected, having a percentage of infection of 37·5 and in other varieties it ranged from 17·9 to 3·3. A record of it was also made on a local variety grown in the vicinity of Pusa. At Karnal 37 cultures of a cross between Pusa 52 and Federation were examined and the percentage of leaf affected by the spots varied from 1·8-13·9 on five cultures, while the rest were free from the disease, while again in 6 cultures of crosses between Pusa 4 and Federation only four cultures had the disease ranging from 4-7 per cent. infection.

An estimate of *Helminthosporium sativum* on barley grown in the Botanical Area, Pusa, was also made and the average percentage of leaf area affected ranged from 2·8-11·8 in different varieties.

(10) *Wheat rust.* A survey of rust on all the varieties of wheat grown in the Botanical Area was made again this year. The orange rust was first observed about the third week of December and by January it was noticed on most of the varieties grown in Pusa. The percentage of leaf surface covered by the rust postules was measured according to the method suggested by Tehon which was also followed last year and the following results were obtained :—

Variety.	Orange rust.	Yellow rust.
Pusa 4	4·3	0
Pusa 12	14·9	0
Pusa 52	0	5 1
Pusa 111	4 5	0
Pusa 112	5 0	0
Pusa 113	0	17·6
Pusa 114	2·8	0
Pusa 80-5	6·7	0
Federation	0	0

Black rust appeared as usual and in a fair amount particularly in Pusa 12.

All the wheat cultures in the Botanical Area and the local varieties in the vicinity of Pusa were examined for rust and the observations made have been duly recorded for future reference.

At Karnal thirty-seven cultures of a cross between Pusa 52 and Federation were grown and out of these, twelve had yellow rust ranging from 1·9 to 21, twenty cultures had none or only traces of yellow and orange rust and five were altogether free from rust. Black rust was rare in these crosses. Out of the forty-four cultures of Pusa 4 and Federation, twenty were free from rust and the rest had traces of orange and black rusts while there was no trace of the yellow. The last observation made before harvesting showed that all the crosses had traces of rusts and none were free.

(11) *Hibiscus Sabdariffa.* A disease of this plant in which auxiliary buds and side shoots are infected was noticed. In severe cases the development of leaf is checked and the leaves drop off and ultimately the plant dies. A species of *Helminthosporium* very much like *H. tetramera* McKinney and also *Acrothecium lunatum* Wakker were isolated. An inoculation experiment to determine the organism responsible for the disease is in progress.

IV. Systematic work.

During the year under review thirty-two calls were received from different places to examine diseased crops and to give advice. Besides these, seventy-seven specimens of diseased betel-vine from places in Bengal were examined. Sixty foreign specimens were added to the herbarium, besides a collection that was made by the staff and also presented by the Forest Mycologist, Dehra Dun. Eighty-five half named specimens were sent to Prof. H. Sydow, Germany, for identification A large number of specimens were identified for the Forest Mycologist, Dehra Dun, Professors of Botany in the Allahabad, Punjab, Calcutta and Agra Universities. Thirty-nine specimens of Indian fungi were sent abroad. Thirteen cultures of various fungi on different hosts were sent to the Imperial Bureau of Mycology, London and other specialists for identification. Some of these have been identified and are mentioned in the text. A species of *Physoderma* very much like *P. Zea Maydis* Shaw was observed on *Euchlaena mericana* and a species of *Synchytrium* on *Launca asplenifolia*. These two were observed for the first time in Pusa and probably have not been previously recorded on these hosts.

V. Programme of work for 1930-31.

1. *Research work.* New diseases of Indian crops that come to the notice of the section will be investigated. The following crop diseases will receive special attention :—

(*a*) Diseases of cereals.

(*b*) Diseases of sugarcane.
(*c*) Diseases of *rahar*.
(*d*) Diseases of betel-vine.
(*e*) Diseases of cinchona.
(*f*) Diseases of gram.

2. *Training.*—Students and assistants will receive training on the lines indicated in the prospectus.

3. *Routine work.*—Advice and assistance as required will be given to other departments and the general public.

VI.—PUBLICATIONS.

Mitra. M. . . . *Phytophthora parasitica* Dast. causing "Damping Off" Disease of Cotton Seedlings and "Fruit-rot" of Guava in India. *Trans. Br. Myc. Soc.*, Vol. XIV, Parts III and IV, pp. 249-54, 1929.

Mohendra, K. R., and Mitra, M. On the Cultural Behaviour of *Sphaeropsis malorum*, Pk. *Ann. Bot.* Vol. XLIV, pp. 541-55, 1930.

Sydow, H., und McRae, W. Hyphomycetes Indiae orientalis, Pars I. *Annales De Cryptogamie Exotique*, Tome II, Fasc. 3-4, pp. 262-71, 1929.

REPORT OF THE IMPERIAL ENTOMOLOGIST.

(P. V. ISAAC, B.A., D.I.C., M.Sc.)

I. ADMINISTRATION.

Mr. T. Bainbrigge Fletcher was in charge of the Section until the 21st April 1930, when he proceeded on seven months' leave and I assumed charge.

Rai Bahadur C. S. Misra returned from leave and joined duty on the 12th August 1929 till which date Mr. G. R. Dutt acted as First Assistant in addition to his own duties.

II. TRAINING.

Mr. Karam Singh Lamba, M.Sc., Post-graduate student, finished his training on the 30th April 1930. He collaborated with Rai Bahadur C. S. Misra in preparing a bulletin on " The Cotton Aleyrodid " (*Bemisia gossypiperda*, n. sp.) which was published as Bulletin No. 196 of the Agri. Res. Inst., Pusa. He also submitted a paper on " A Contribution towards our Knowledge of the Aleyrodidae (White Flies) of India " which has been accepted for publication as a Memoir, Entomological series.

Mr. Biseshwar Dayal Gupta, M.Sc., Post-graduate student, was admitted on the 14th November 1929, for training.

Mr. K. R. Sontakay, B.Sc., deputed by the Department of Agriculture, Central Provinces, finished his training on the 25th August 1929.

Mr. N. K. Ganguli, a post-graduate student from the Punjab University, worked in the laboratory on the identification of a collection of moths from Simla.

III. INSECT PESTS.

Sugarcane.—The bionomics of *Aphis sacchari*, Zehnt., on sugarcane, as well as the parasite of this insect were studied. From two years' observations it is evident that maximum parasitization is reached by the middle of October. The Syrphid. *Parasus* sp., and the Coccinellid, *Scymnus* sp., appeared in large numbers among colonies of the Cane Aphid. *Geoica spatulata*, Theo., appeared in large numbers on roots of sugarcane during November-December. The alate viviparous females appeared by the beginning of January 1930. *Lepidosaphes* sp. and *Aspidiotus* sp., which are under observation, appeared in isolated colonies on ratoon canes, together with *Pseudococcus sacchari*, Zehnt., which was heavily parasitized during October. The latter was specially bad on ratoon canes, especially Co. 205 and Co. 210. Large numbers of

Scirpophaga nivella, Fb., emerged from ratoon canes during April and May and laid eggs profusely on the newly planted canes. But from a count of a large series of egg masses at various periods of oviposition, it was seen that only a very small percentage of borers entered the newly planted canes. By the end of June *Emmalocera depressella* and *Diatraea* spp., especially *Diatraea venosata*, Wlk., were the predominant borers. The bionomics of these, and an intensive study of their egg-parasites were under investigation. A series of examinations with a view to ascertain the relative immunity of Co. canes was made and it was found that Co. 205 was more susceptible than others to the attack of the borers. A series of experiments was laid down to test the efficacy of the treatment of setts by immersion in water at ordinary temperature before planting. The Termites, which were specially bad in the Sectional cane experimental area, were kept in check by charging the irrigation water with Crude oil Emulsion at 8 lbs. per acre. These, together with the borers, were found to take a toll of 34·9 per cent of the total crop of sugarcane in the sectional experimental plots. Special attention was given to observations of the parasites of the cane White Fly, *Dialeurodes barodensis*, Mask., which was abundant on certain varieties of Co. canes. A study was made of the alternative hosts of cane borers, specially wild grasses like *Saccharum spontaneum*, *Imperata arundinacea* and *Saccharum arundinaceum*.

Rice.—An Aleyrodid not observed since 1907 again occurred in some numbers on rice in Pusa. Rice Hispa was reported from Backerganj in East Bengal during April 1930 and, at the request of the Director of Agriculture, an Assistant was sent to investigate and recommend preventive measures. Specimens of *Leptocorisa varicornis*, Fabr., were sent to Dr. Kuwana of Japan for comparison with the Japanese species.

Cotton.—Further observations on the parasitization of *Bemisia gossypiperda*, Misra and Lamba, were made throughout the year. It was found that the parasitization locally was very low. *Empoasca* sp. appeared on broad leaved varieties of cottons at the beginning of the season. Parasites on *Pseudococcus corymbatus*, Green, were reared for despatch to Egypt to Mr. E. Ballard, but as suitable arrangements could not be made in time this work was kept in abeyance. *Platyedra gossypiella*, Saund., was again bred from seeds of *Hibiscus abelmoschus*.

Study of fruit pests was continued. *Theretra clotho*, Drury, on grape vines and *Indarbela tetraonis*, Moore, on *Mangifera indica*, *Psidium guyava*, *Eugenia jambolana* and *Zizyphus jujuba* were particularly studied. The latter insect proved to be very destructive to grafted *Zizyphus* trees planted for lac experiments. *Acrocercops syngramma*, Meyr., did much injury to mango grafts in the vicinity of Pusa. *Myzus persicae*, Sulz., suddenly appeared in large numbers in April on peach and it was feared that the entire peach crop would be affected

adversely, but when the maximum day temperature rose it disappeared as suddenly as it had appeared. Fruit-pests collected by Rai Bahadur C. S. Misra in Quetta, Baluchistan, were sent for identification. Among these, *Aspidiotus prunorum*, Laing, was extremely bad on almond, cherry, damson and plum. This has been figured and described by Mr. Laing in a paper which is in the press as a Memoir in the Entomological series. *Protaetia neglecta*, Hope, a Cetoniad beetle, damaged apples and peaches in Kumaon. *Nephantis serinopa*, Meyr., damaged coconut leaves at Cuttack. *Nephele didyma*, Fabr., was bred on leaves of *Carissa carandas*. Eggs of this insect were laid in the first week of December 1929 and adults emerged by the middle of March 1930.

Rhyncolaba acteus, Cram., was bred on the leaves of *Typhonium trilobatum*. *Deilephila nerii*, L., was bred from eggs collected from *Nerium odorum* in November 1929. The larval period occupies about eighteen days and the pupal stage lasts for about a month. The different stages are shown on Plate I. The full-grown larva prior to pupation acquires a characteristic colouration. The adults continued to emerge from the end of December to the third week in January 1930. *Papilio aristolochiae*, Fabr., was bred on *Aristolochia indica* : it passed the winter in the pupal stage. Caterpillars found within the webs of the spider, *Stegodyphus sarasinorum*, on *Pithecolobium dulce* were collected and from these three different moths, *Herculia suffusalis*, Wlk., *Nephopteryx atrisquamella*, Hmp., and *Odites spoliatrix*, Meyr., were reared. Drawings of these have been made. During the year *Argyroploce leucaspis*, Meyr., was bred from the leaves of *Sapindus mukorossi*. *Acherontia styx*, Westw., was reared on the leaves of *Clerodendron siphonanthes* and *Prodenia litura*, Fabr., was bred on the leaves of *Nicotiana plumbaginifolia*. *Lobesia fetialis*, Meyr., was bred on the dried inflorescence of *Sapindus mukorossi*. *Eriophyes gossypii*, Banks, was specially bad on Aligarh varieties of cotton grown for observations in a small area at Pusa. *Diacrisia obliqua*, Wlk., did much damage to Cruciferae and *Canna indica* during the winter. *Hypera variabilis*, Hbst., again damaged the lucerne crop. Roses were badly affected with Thrips, while *Cephonodes hylas*, L., damaged flower buds of *Gardenia* spp. A Micro-lepidopteron predaceous on *Icerya purchasi*, Maskl., was determined as *Stathmopoda* sp. *Hieromantis ioxysta*, Meyr., appeared as a pest of *Schleichera trijuga* at Pusa and Namkum, Ranchi. A larva of *Gastrophilus pecorum*, Fabr. var. *zebrae*, Rodhain and Bequaert, was taken from the stomach of a zebra which died in the zoo at Lucknow. This latter was presumably imported from South Africa or Europe, as *G. pecorum* seems to be doubtfully a native of India. It has been bred at Deesa from a horse without history as to whether this horse had been imported, and also at Meerut from a Chinese mule, which had been imported from North China sometime in the previous June. Thus it is obviously very difficult to detect

EXPLANATION OF PLATE I.

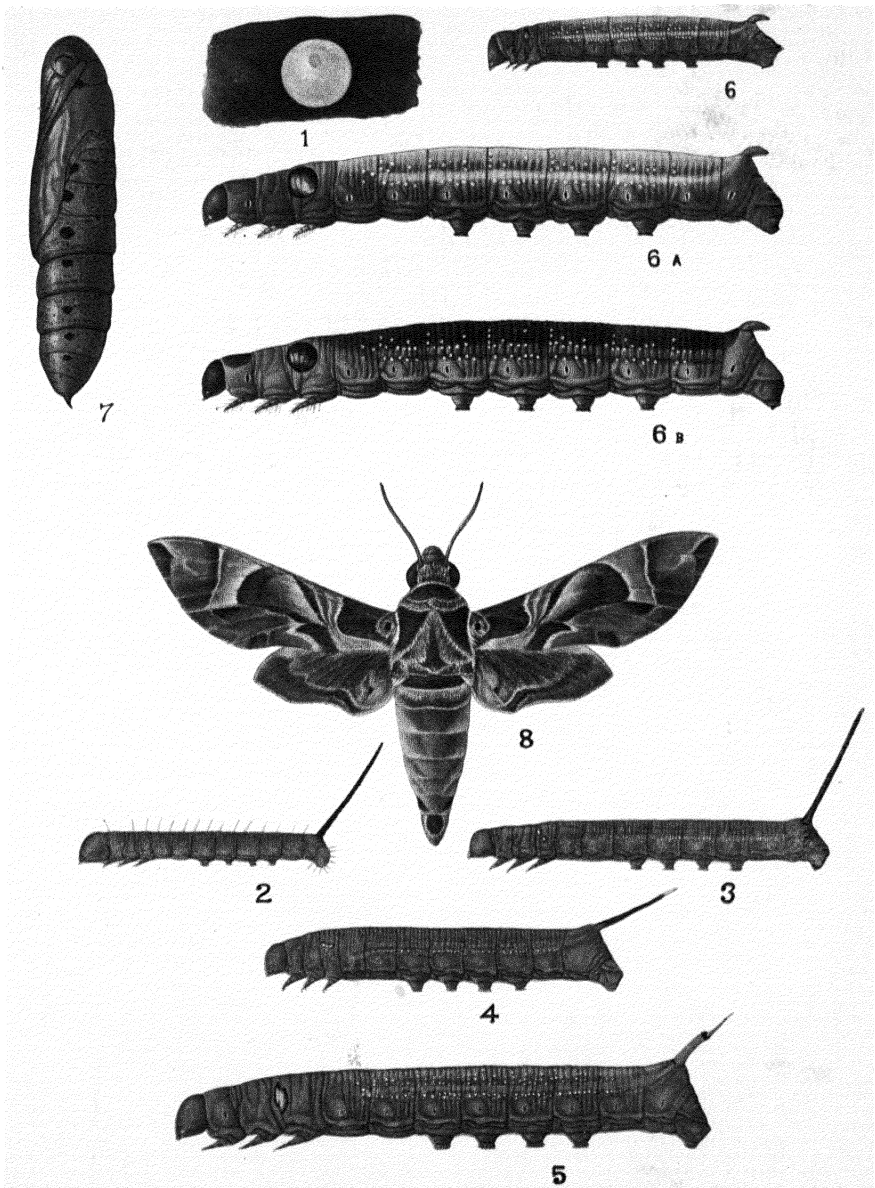
Deilephila nerii, Linn.

1. Egg ×8.
2. Caterpillar, first instar, ×6.
3. ,, second instar, ×4.
4. ,, third instar, ×2
5. ,, fourth instar, ×2.
6. ,, fifth instar, (natural size).

6A. ,, fifth instar, fully developed larva (natural size).

6B. ,, fifth instar, larva showing changed colouration prior to pupation (natural size).

7. Pupa (natural size).
8. Moth (natural size).



DEILEPHILA NERII , LINN.

the presence of such " inside passengers " in imported livestock. The Dipterous parasites bred from the skin of an elephant in Burma were identified by Major Austen as a Calliphorine representing a new genus and species.

The Braconid parasite, *Dinocampus mylloceri*, Wilkinson, of the weevil, *Myllocerus undecimpustulatus* var. *maculosus*, Faust, was noticed on 11th November 1929, and the first adult specimen, after April 1929, emerged in the laboratory on 28th November 1929.

Gram, Tur, and Peas stored in gunny bags with " Amalgam tiles " in the Farm godown in May 1929 were examined during the month of November and were found to be in good condition. A few Bruchid eggs were noticed on the grains but no damage was noticeable. In bags which contained no " Amalgam tiles " the grains were damaged but the damage was not severe. It is believed that the damage to grains on the whole in that room this year was much less than that of previous years ; and this may be ascribed to the presence of " Amalgam tiles " in the room. Gunny bags containing tiles could not have kept the mercury vapour entirely within them. The vapour would have escaped and influenced insect life in other bags also, which were in the same room. The gram out of a gunny bag stored in another room was examined and found to be severely damaged. To test the efficacy of storing grain with mercury on a large scale, experiments were started at the Indian Mental Hospital, Kanke, Ranchi. 470 maunds and 35 seers of sun-dried rice were stored on 8th-9th August 1929 in a damp-proof bin with "mercury-tin amalgam tiles." The bin containing this rice was opened on the 2nd January 1930 when a very large number of *Tribolium castaneum*, Hbst., were noticed on the top layer of the rice, but the damage to the rice was not so great as would otherwise have been the case. These beetles appeared to have gained access to the bin through the opening at the lower end of the bin, which had not been securely sealed with wax. The actual quantity of rice recovered as healthy from this bin was 461 maunds 37 seers 11 chitaks which works out to a 1·9 per cent loss, which is negligible. It was further observed that a large number of *Silvanus surinamensis*, L., both in adult and larval stages were present in the bottom layer of rice, showing that breeding of this insect had taken place at and near the bottom of the bin. This insect does not feed on sound and dry grain but feeds on debris resulting from the feeding of actual rice pests. Its presence was thought to be due to the defective porosity of the tiles and the insufficient quantity of tin-amalgam enclosed in each pair of tiles. To remedy this defect, it was proposed that tin boxes with perforated ends, as receptacles for the tin-amalgam should be used. Two ounces of the amalgam were put in each tin. An ounce of tin-amalgam, it was thought, would be required for protecting every maund of rice stored. In the next experiment 96 maunds 25 seers and 9 chitaks of fine rice and 487 maunds of coarse rice

were stored in two different bins on the 16th and 17th March with 50 of the tins of tin-amalgam mentioned above in the first bin. 200 tins of amalgam were placed in the second bin. Equal quantities of fine and coarse rice were also stored without amalgam as controls. These bins will be opened at a time of the year when insect pests of stored grain attain their maximum activity, *i.e.*, in August 1930.

The life-history of *Periplaneta americana*, L., was worked out. There are six to seven moults during a complete life-cycle, the period of each nymphal stage varying considerably. It was also noticed that nymphal periods of nymphs of the same instar varied much. During the winter no moultings took place and the nymphs fed very little and became quiescent. The adults emerge either between March and June or during August to October. The time taken for development from the time the egg is laid to adult stage varies from eleven months to twenty months. The heaviest mortality among the nymphs was during the winter. Experiments are under progress to determine if parthenogenesis prevails among House Cockroaches. Attempts to breed *Evania* sp., a parasite on the egg-capsules, proved abortive.

A small swarm of locusts, *Schistocerca gregaria*, Forsk., visited Pusa on the 7th November. It settled for a short time on the bare ground and on *Cajanus indicus* bushes. Very little damage was done. The swarm arrived at 11 A. M. and left at 1 P. M. in a northward direction. Crickets of the species *Schizodactylus monstrosus*, Dr., were seen to come out, capture and drag down locusts as large as themselves to their burrows. A number of locusts were caged and kept alive. They ate little and the few survivors showed no signs of sexual maturity. These lived for a long period in the cage and the last one, a female, died on the 15th April 1930.

An exhaustive note embodying all information hitherto available on Locusts in India, was prepared by Mr. Bainbrigge Fletcher for the use of the Imperial Council of Agricultural Research.

The control of mosquitos was continued as in previous years. *Culex fatigans*, Wied., was found breeding in permanent places throughout the year. *Culex pallidothorax*, Theob., emerged out of the wells and *Culex gelidus*, Theob., from manure pits on the Farm. Before the rains set in all mosquito breeding places were filled to prevent *Stegomyia* breeding in them. Some *Stegomyia* were found breeding in small receptacles and in water collected in plantain leaves in gardens. In cattle-grazing fields *Mucidus scataphagoides*, Theob., *Banksinella lineatopennis*, Ludlow., (reared for the first time at Pusa), *Lutzia fuscana*, Wied., *Culex vishnui*, Theob., and *Anopheles rossi*, Giles, were found breeding. Larvae of *Gastroxides ater*, Saund., were collected from tree holes during February and March 1930. They hibernated in the larval stage, pupated in the beginning of June and the adults emerged by the 20th June 1930. A gravid female Syrphid, *Ceria eumenoides*, Saund., was seen to hover

near the blackish exudation on the trunk of *Albizzia lebbek*. The female was caged. It laid eggs on the 15th April 1930 and the larvae were under rearing. Later on, maggots apparently of the same species were collected from the same tree-trunk. Eggs of *Eristalis quinquestriatus*, Fabr., were collected and the life history is being worked out. Eggs of *Tabanus speciosus*, Ric., were collected at Muzaffarpur and adults were bred from them.

IV. Bees and Lac.

Apiculture.—Numerous inquiries were received from correspondents. These were attended to. Artificial hives prepared by a local carpenter were supplied to several correspondents. There was an increasing demand for artificial comb-foundations for *Apis indica*. These were prepared in the laboratory on the comb-foundation machine. Much difficulty was again experienced in obtaining supplies of pure bees-wax. Some was, however, obtained from a wax merchant at Sadiya through the courtesy of the Assistant Superintendent, Lushai Hills.

Lac.—The emergence of lac larvae from Ber took place on the 21st October 1929 and 20th June 1930. Larvae from Kusum lac emerged from the 9th July to the 20th November 1929. *Eublemma amabilis*, Moore, as well as the *Chalcidoid* parasites damaged the crop considerably. *Indarbela tetraonis*, Mo., damaged young grafted Ber trees to a large extent. Demands, especially from the United Provinces, for the supply of healthy brood-lac continued to grow.

V. Insect Survey.

Collections were sent out for identification to the following specialists and their help is gratefully acknowledged.

A small collection of Acrididae, Coccidae and Aphididae to the Imperial Institute of Entomology.

Ichneumonidæ to Dr. Cushman, Washington.
Microlepidoptera to Mr. E. Meyrick, England.
Copridæ to Mr. Arrow, London.

The following collections were received back identified :—
Noctuidæ from Miss Prout, England.
Geometridæ (mostly from the Andaman Islands) from Mr. L. B. Prout.
Culicidæ from Capt. Barraud.
Copridæ from Mr. Arrow, England.
Scarabaeidæ some, *Orthoptera* and *Hymenoptera* (Parasitica) and an Eurytomid from apricots from Imperial Institute of Entomology London.
Calliphorinæ (bred from the skin of an elephant) from Major Austen
Fleas and Ticks from Mr. H. Shariff, Indian Museum, Calcutta.

Paussids from Mr. S. Ribeiro, Indian Museum, Calcutta.

Specimens of *Diploptera dytiscoides* from Mr. F. K. Williams, Honolulu.

Fifty parcels of specimens from correspondents were received for identification and these were named as far as possible. A consignment of live larvæ and pupae of *Aedes* sp. was sent to Muktesar for experimental work. Two specimens of *Pterorthacris subcollosa*, Uv., were sent to the British Museum, London. Specimens of *Anthrenus fasciatus*, Hbst., *Lasioderma serricorne*, Fb., *Setomorpha insectella*, Fabr., male and female, were sent to Prof. Poulton, Oxford. An *Aeshnid* was sent to Lt.-Col. Fraser. A consignment of Indian Tabanidæ named by Mr. P. V. Isaac was sent to the Veterinary College, Punjab. *Tabanidæ* collected by the Camel Specialist, Sohawa, were brought over for incorporation in the Pusa collection.

VI. Catalogue of Indian Insects.

Steady progress continued to be made under this heading. The following catalogues were submitted for publication during the year :—

(1) Gyrinoidea, by George Ochs.

(2) Lycidæ, by Richard Klein.

These, as well as the catalogue of Carabidæ by Andrews accepted for publication during the previous year, are in the press.

VII. Programme of work for 1930-31.

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 grains.

Minor.

Results in various lines of work require to be written up and published as far as possible. New insecticides and insecticidal methods will be 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 entirely or partly on material sent from Pusa have been issued during the year ended 30th June 1930:—

Fletcher, T. Bainbrigge.	A List of the Generic Names used for Microlepidoptera. (*Ind. Agr. Ent. Mem.*, Vol. XI.)
Fletcher, T. Bainbrigge and Sen, S. K.	A Veterinary Entomology for India, Part IX. (*Jl. Anim. Husb. Ind.*, III, pp. 50-57, plates I-III, July 1929.)
Ditto .	A Veterinary Entomology for India, Part X. (*Jl. Anim. Husb. Ind.*, III, pp. 95-100, October 1929.)
Ditto .	A Veterinary Entomology for India, Part XI. (*Jl. Anim. Husb. Ind.*, IV, pp. 1-5, plate I-III, April 1930.)
Misra, C. S. and Lamba, K. S.	The Cotton White-fly (*Bemisia gossypiperda*, n. sp.). (*Bull. I. I. of A. R. Ind.* No. 196.)

REPORT OF THE IMPERIAL AGRICULTURIST.

(WYNNE SAYER, B.A.)

I. CHARGE.

Mr. G. S. Henderson, N.D.A., N.D.D., Imperial Agriculturist took over charge of the office of the Imperial Agriculturist on the 14th October 1929 on return from leave. He was transferred to Bihar and Orissa as Director of Agriculture on the 1st November 1929. Mr. Wynne Sayer, B.A., officiated as Imperial Agriculturist throughout the year under review except for the period from 15th October to the 1st November 1929.

II. TOURING AND ADVICE.

The Offg. Imperial Agriculturist toured to Bangalore to examine the results of the analyses of herd records. He toured extensively in the North Bihar sugar tract to give advice to the sugarcane growers and to Calcutta to consult various leading firms regarding designs of threshers and tractors.

Advice by correspondence was also given to a large number of enquirers from Government and private bodies on varied agricultural subjects. A large number of visitors, of whom 122 were of note, from all parts of the country were shown round the Farm.

A demonstration of various makes of motor tractors was arranged during the period of the Board of Agriculture at Pusa and several different makes of tractors with various implements were demonstrated. A large number of members of the Board and visitors attended the demonstration.

III. TRAINING.

Four students of the Animal Husbandry and Dairying course finished their training on the 5th April 1930. Two post-graduate students, one from Bihar and Orissa and the other from the United Provinces were admitted to a course of general agriculture. One student from the Punjab is being trained in sugarcane work from December 1929.

IV. SEED DISTRIBUTION.

Indents were received from all parts of the country for the supply of improved varieties of seed. 298 maunds of wheat, 100 maunds of oats, 5 maunds of maize and 45 maunds of fodder crop seeds were distributed and 662 maunds of sugarcane setts were sent out.

V. Farm Cultivation and Crop results.

Season.—The total rainfall from June 1929 to May 1930 amounted to 50·17 inches as compared with 54·02 inches in the corresponding period of the previous year, rain being recorded on 85 days as against 87 days in the previous year. The rainfall was well distributed and very favourable for the growth of the maize crop. Owing to almost half the rainfall falling at short intervals during September and October, considerable difficulty was found in stripping and storing maize cobs, and in consequence of the heavy rain, preparation of the land for *rabi* sowing was delayed. 2·87 inches fell between December and February and benefited the *rabi* crops with the exception of gram, the flowers of which were damaged, resulting in a bad outturn.

Arhar.—Types A and G of *arhar* grown on a field scale in the ordinary rotation gave 18 mds. and 12·57 mds. respectively as highest yields per acre in spite of wilt occurring in the lowland plots. A block of 8 acres divided into 32 plots of one-quarter acre each was set apart for the trial of eight *arhar* varieties sown in four plots each. Their results are given below :—

Arhar Varieties.	Average yield per acre.
	mds. srs. ch.
1. A2., B.S. Variety	14 35 0
2. A. „ „	20 18 0
3. G. „ „	16 11 8
4. S. „ „	22 37 4
5. T. „ „	24 32 8
6. P. F. 2, Pusa Farm Variety	23 31 4
7. P. F. 4, „ „ „	17 19 0
8 P. F. 10, „ „ „	15 2 0

Maize.—The crop was as usual both grown alone and mixed with *arhar*. The season was very favourable and the crop gave an average yield of 12·76 mds. an acre from an area of 176·84 acres. The highest outturn however was 19·7 mds. per acre from a field of 27 acres of maize alone. Three Farm selections were grown in a field of 30 acres to test the green fodder yielding capacity of each variety. Maize No. 1 gave 208 mds. green stuff per acre, maize No. 2, which is an early variety, gave 179 mds. while the yield of maize No. 3 was 150 mds. only.

Oats.—The oat crop was excellent. The average outturn per acre from an area of 212·25 acres was 21·44 as against 20·53 maunds last year.

A large scale trial of B. S. 1 oats was conducted against P. F. 1 oats. The net result of these experiments is to show that as far as yield is concerned there is nothing in it between the two varieties. The B. S. 1 grain is superior, but it is far more liable to damage through lodging and this evens up matter over a large area. The average outturn of B. S. 1 oats per acre from an area of 87 acres was 20·9 mds. against 20·2 mds. per acre of P. F. 1 oats from 84 acres. Varietal tests of oats B. S. 1 against P. F. 1 were carried out in Bhograsan and Punjab fields, the comparative yields of which are given below :—

Area of each plot = ·50 acres (Bhograsan plots).

Oats P. F. 1.			Oats B. S. 1.		
Plot No.	mds.	srs.	Plot No.	mds.	srs.
1 . . .	14	2	3 . . .	15	22
2 . . .	13	3	4 . . .	14	11
5 . . .	13	30	7 . . .	14	19
6 . . .	14	0	8 . . .	14	32
9 . . .	14	26	11 . . .	16	1
10 . . .	15	22	12 . . .	16	6
13 . . .	16	7	15 . . .	15	33
14 . . .	16	29	16 . . .	16	34
17 . . .	16	0	19 . . .	17	1
18 . . .	17	5	20 . . .	16	25
21 . . .	14	19	23 . . .	14	31
22 . . .	14	21	24 . . .	15	27
25 . . .	15	16	27 . . .	14	27
26 . .	16	0	28 . . .	15	29
29 . . .	14	16	31 . . .	15	11
30 . .	14	28	32 . . .	14	10
33 . . .	15	1	35 . . .	13	23
34 . . .	13	7	36 . . .	13	39
37 . . .	14	20	39 . . .	14	2
38 . . .	15	30	40 . . .	13	34
20 plots . .	299	2	20 plots . .	303	17

Punjab Field D. Block. Area of each plot = 0·25 acre.

B. S. 1 Oats.			P. F. 1 Oats.		
Plot No.	mds.	srs.	Plot No.	mds.	srs.
2D . . .	15	0	1D . . .	14	28
4D . . .	20	36	3D . . .	16	20
5D . . .	16	36	6D . . .	15	4
7D . . .	23	20	9D . . .	28	36
8D . . .	24	24	12D . . .	25	4
	100	36		100	12

Wheat.—Three standard varieties of Pusa wheat were grown in Brickfield I. The yields were as follows :—

Varieties.	Area.	Yield per acre.
	acres.	mds.
Pusa 4	20·00	12·83
Pusa 12	10·00	20·00
Pusa 52	12·50	18·76

The average outturn per acre from 42·50 acres was 16·28 mds.

Berseem.—Berseem (*Trifolium alexandrinum*) as a cold weather green fodder crop followed by early hot weather maize sown with *meth* (*Phaseolus aconitifolius*) was grown in the *dhab* area as in previous years under irrigation. A full supply of green fodder for live-stock was available from December. The total area under berseem was 125·55 acres from which 16,084 mds. were cut for fodder and 952 mds. for silage. The rest of the crop was utilised for grazing. As mentioned in last year's report, two small pits were filled with 952 mds. of green berseem silage to ascertain the feeding quality of the stuff if kept siloed throughout the rainy season. These pits will be opened after the cessation of the monsoon in October.

Maize and *meth* which followed berseem are continuing to supply green fodder to-date and the silage pits are being filled with the surplus over and above feeding requirements. During the season of growth, berseem required 15 irrigations and maize and *meth* 3 irrigations. The cost *per irrigation per acre by means of centrifugal pumps* from the river was Rs. 2-2-6.

Sugarcane.—Thirty acres each year is devoted to cane in the New Area and here the main experimental work is done. Ten acres of land in the main Farm area is also placed under cane each year for the purpose of testing varieties on an estate scale in a 3-year rotation. The New Area is now being placed under a 4-year rotation and four equal blocks of land have been set apart, the final felling and levelling to complete the fourth block being now in progress. The lengthening of the rotation has been decided upon owing to the very light soil of a portion of the New Area being unable to stand a 3-year rotation with cane as the principal crop. The main cane crop in the New Area stood over Block III-A and III-B in the year under report. The northern portion of III-A being extremely light in parts, the yield of the cane upon it was affected to a considerable extent. Another three years should see this land brought into more even condition.

The testing of new varieties was continued in the nursery and the mosaic experiments in collaboration with the Imperial Mycologist were conducted in the bamboo block.

On the main Farm the varieties for estate trial were planted in old Jhilli and those for the mosaic experiment of the Imperial Mycologist in North Pangarbi. All cane varieties were as usual analysed by the Imperial Agricultural Chemist, the increasing number of varieties under trial making this a task of considerable magnitude. Owing to a very severe and continued outbreak of cholera, harvesting of cane was continued until 24th April, when the factory closed down. Extreme difficulty was experienced in obtaining labour to cut and strip and a certain quantity of cane had to be left over.

The following experiments were carried out during the year under report :—

1. Tonnage experiments.
2. Manurial experiments.
3. Variety tests, estate scale.
4. Variety tests, nursery.
5. Mosaic experiments in collaboration with the Imperial Mycologist.

Tonnage experiments.—Co. 223 was tested against Co. 210 for tonnage. These canes are very similar and while Co. 223 has proved a success in the Punjab, Co. 210 has a very good record locally and in the Central Provinces. In the trial however under Pusa conditions Co. 223 only averaged 169 mds. per acre against Co. 210, 406. This year the experiment has been repeated, the canes being interstripped in rows of 4. Todate Co. 210 is showing a clear superiority, coming away much more rapidly and showing a stronger growth upto the break of the rains. Co. 205 having been rejected by the mills, it has become a matter of urgent importance to replace this cane by one of better class while main

taining to a great extent the same agricultural characters. Co. 285 and Co. 295, which have been successfully multiplied up, have been planted out on an estate scale interstripped with Co. 205 to secure a definite decision, on low land.

To replace Co. 205 successfully we have first to consider the question of sucrose linked to tonnage and the capacity of doing well on land which will not hold ordinary cane. This narrows down the field considerably and three new canes in this class, Co. 317, Co. 318, and Co. 319, have now been obtained from Coimbatore to test against Co. 285 if necessary. Co. 285 possesses one agricultural quality not found in Co. 205 which is of great value in low land. This is the capacity for making rapid growth in the early months of the hot weather. This removes any fear of a July flood destroying the cane which was the great risk with Co. 205 which was a very slow starter. Co. 281 though improving on last year again proved disappointing when grown on Block III A, as it still continued to show signs of drying out. During the year under report fresh seed was imported from Bhopal, where Co. 281 grows well, and our own seed was selected only from heavy tillering stools. The Bhopal seed arrived at the end of September, and owing to the heavy rain, had to be kept in trash for six weeks—a record I imagine for seed cane in the open. It was then planted, germinated well and is doing excellently, while our own seed under estate trial is also growing on well. I am convinced Co. 281 can be grown, and once we have solved this problem the sugar industry in North Bihar will not need another cane, as this cane is not only early, but also stands on. Compared with Co. 281 at its best we have no other Coimbatore cane to touch it, and the results we are now receiving from other parts of the cane growing world confirm this statement.

Co. 290 has todate not come up to expectations. It makes excellent progress up till September and then goes to pieces. It seems unable to stand against the climatic conditions and is very badly damaged when laid. Experiments are now in progress to overcome this failing.

P. O. J. 2696 has shown the 'tegallan' characters referred to last year and will now be tried out on an estate scale.

B. S. Varieties.—Fifteen varieties were received for trial from the Botanical Section. Out of these, four only, B. S. 4, 11, 14 and 15 have been taken for further trial. Eight of the original numbers, that is Nos. 1, 2, 7, 8, 9, 10, 12 and 13 have been rejected as too thin for free growers; while B. S. 3 was discarded for bad lodging and splitting and low sucrose, B. S. 5, a Co. 210 class of cane, was rejected for low sucrose and a root system unsuitable for North Bihar conditions and B. S. 6, almost a Co. 213 type, was discarded for being too low in sucrose for the tract. All these canes failed to come up to our standard varieties, Co. 210, Co. 213 against which they were tested.

In addition to the above B. S. varieties, the following canes were also rejected on account of bad agricultural habit :—

P. O. J. 2714, 2727, B. H. 10(12) :—Unable to stand unirrigated conditions.

Co. 280 and Co. 282 :—Fail in tonnage over an average of years.

Co. 205 :—Rejected by the mills on account of excess in fibre.

Co. 287 :—Low sucrose and too late ripening.

Co. 248 :—Definitely inferior to Co. 210. This cane has had several good years, but its average tonnage is not up to Co. 210 with which it was competing.

Co. 297 :—Unable to give the tonnage under Estate conditions.

Co. 306 :—Unable to stand our conditions and not good enough for irrigation.

The following varieties go on for further trial :—

B. S. 4, 11, 14, 15 ;

Co. 223, 270, 281, (Pusa) 281, (Bhopal) 285, 290, 295, 296, 298, 299, 300, 301, 302, 303, 304, 305, 307, 308, 310, 312, 313, 315, 316, 317, 318, 319 ; and

P. O. J. 2696.

Mosaic Experiments.—These Experiments which were conducted in collaboration with Imperial Mycologist advanced a further stage. The yields are as under :—

Yield per acre of Mosaic Tonnage (one-tenth acre) plots in New Area Bamboo Block.

Variety Co. 205.

Healthy.	Mosaic.	Healthy.	Mosaic.	Healthy.	Mosaic.	Healthy.	Mosaic.	Healthy.	Mosaic.
mds.	mds.	mds.	mds.	mds.	mds.	mds.	mds.	mds.	mds.
400	490	550	560	540	570	480	520	530	470

The experiment is being continued with Co. 213 as well in 1930-31.

Variety tests.—A Table of the yields of canes under test in small plots in North Pangarbi is given :—

Serial No.	Variety and Particulars.	Acreage..	Outturn per Plot.		
		acre.	mds.	srs.	ch.
1	Co. 219	0·01	2	0	0
2	Co. 223	0·01	4	12	0

Serial No.	Variety and Particulars.	Acreage.	Outturn per plot.
		a re	md. srs. ch.
3	Co. 237	0·01	3 37 0
4	Co. 243	0·01	6 0 0
5	Co. 244	0·01	5 0 0
6	Co. 275	0·01	5 10 0
7	Co. 285	0·01	10 27 0
8	Kathé	0·01	4 0 0
9	Saretha	0·01	4 20 0
10	Chinia	0·01	4 10 0
11	Uba	0·01	3 0 0
12	Hemja	0·01	3 20 0
13	Co. 210	0·01	6 30 0
14	Co. 213	0·01	10 7 0
15	Co. 214	0·01	5 0 0
16	Co. 248	0·01	4 0 0
17	Co. 281	0·01	1 36 0
18	Co. 287	0·01	5 20 0
19	Co. 290	0·01	5 3 0
20	Co. 299	0·01	7 0 0
21	Co. 300	0·01	7 10 0
22	Co. 301	0·01	8 0 0
23	Co. 302	0·01	8 10 0
24	Co. 303	0·01	12 10 0
25	Co. 205, Healthy	0·01	6 10 0
26	Co. 205, Mosaic	0·25	144 20 0
27	Co. 213, Mosaic	10 plots of 1/10th acre each.	619 9 8
28	Co. 213, Healthy	10 plots of 1/10th acre each.	630 27 8
		TOTAL .	1,538 9 0

It is interesting to note from this Table—

I. The difference in yield between Co. 213 and the local canes which it was introduced to replace;

II. The yield of Co. 285 and the positions occupied by Co. 210 and Co. 214 in the tonnage Table;

III. The outstanding position of Co. 303 in a small plot experiment. The damage from lodging, which is the worst feature of this cane, is not apparent in a small plot.

The following are the acre yields of the canes tested at Jhilli on the main Farm :—

Serial No.	Variety.	Outturn per acre.
		mds.
1	Co. 205	744
2	Co. 210	583
3	Co. 213	588
4	Co. 214	431
5	B. S. 3.	673
6	B. S. 4.	560
7	B. S. 5.	543
8	B. S. 6.	534
9	B. S. 11	663
10	Co. 248	484
11	Co. 270	709
12	Co. 287	661
13	Co. 296	244
14	Co. 297	512
15	Co. 298	501
16	Co. 299	583
17	Co. 300	506
18	Co. 301	660
19	Co. 302	595
20	Co. 303	841
21	Co. 306	300
22	Co. 310	347
23	Co. 312	655
24	Co. 313	661

Manurial Experiments.—These experiments were carried out in collaboration with the Imperial Agricultural Bacteriologist at the New Area on an area of 3 acres divided into 30 plots of 0·10 acre each. The variety used was Co. 213 and each treatment had five replications, arranged in a chess-board system. Equivalent quantities of manures regulated on price basis were applied to plots D, E, F with a view to compare the combined effect of sulphate of ammonia and superphosphate against Diammonphos, Lennaphos and others.

The results of the experiments are given below :—

Plot.	Treatment.	Yield in Maunds per acre.
A	Basal Dressing (10 Mds. cake per acre) . . .	370
B	10 mds. cake *plus* 2 cwt. $NaNO_3$, per acre . . .	379
C	10 mds. cake *plus* 2 cwt. $(NH_4)_2SO_4$, per acre . .	450
D	10 mds cake *plus* 2 cwt $(NH_4)_2SO_4$ *plus* 1 cwt double super per acre.	400
E	10 mds. cake *plus* 1½ cwt. Diammonphos per acre . .	346
F	10 mds. cake *plus* 2 cwt. Lennaphos per acre . . .	362

Another experiment to find out the effect of Potash in conjunction with Ammonium Sulphate and Superphosphate on the quality of the juice was also laid out and the results of analyses from these plots month by month are given below :—

Serial No.	Manure applied.	Percentage of Sucrose.				
		Octr	Nov.	Decr.	Jany.	Feby.
1	Ammonium Sulphate @ 2 cwt. per acre .	11·63	14 36	15 72	16 87	18 14
2	Ammonium Sulphate @ 2 cwt per acre *plus* super @ 2 cwt per acre.	10·93	13 46	16 75	16 34	18 04
3	Ammonium Sulphate @ 2 cwt., *plus* super @ 2 cwt., *plus* sulphate of potash @ 2 cwt per acre.	12 09	14 80	15 21	15 53	18 69

The cost of growing cane.—Below is given the usual table of the cost figures for one acre of cane under standard cultivation and manuring worked out on the figures for blocks III-A and III-B, 33·43 acres at New Area :—

Average yield of standard varieties Co. 205, Co. 210 and Co. 213 per acre. . . . . 457 mds.

Cost Table.

Serial No.	Particulars.	Average Cost per acre.
		Rs.
1	Preparation, 5 ploughings and 6 harrowings . . .	14·4
2	Planting labour	8·1
3	Intercultivation, 8 hoeings and 1 ridging . . .	6·8
4	Manuring, 10 mds. Oil cake and 1 md. Super, with labour	44·3
5	Seed 67 mds. per acre at mill rate 5½ as per maund . .	23·0
6	Miscellaneous, (Roguing, analyses, etc.) . . .	1·8
7	Harvesting charges	1·5
	TOTAL .	99·9*

* Costing a shade over 3·5 annas per maund.

A ten-acre interstripped experiment was laid down this year to collect definite data as to the correct type of cane for the light soils of the tract, Co. 210 and Co. 213 being the canes employed. The experiment will be carried on for a period of ten years.

The 1930-31 crop todate is making excellent progress.

Fodder Pulses.—The trial of fodder pulses was continued as before in the Punjab field, B. block, and the yield of various pulses per acre is given in the following statement :—

Yield of green fodder for kharif *pulses in quarter-acre plots in the Punjab field B. block.*

Serial No.	Name of pulses.	Average yield per acre.	Highest yield per acre.
		mds.	mds.
1	*Meth* (*Phaseolus aconitifolius*) . .	79	128
2	Cowpeas (*Vigna Catiang*) . . .	123	160
3	*Guar* (*Cyamopsis psoralioides*) . .	87	100
4	Velvet Bean	104	128
5	Soybean No. 1, yellow, (*Glycine hispida*)	40	56
6	Soybean No 2, chocolate, (*Glycine hispida*).	70	78

These pulses are now being tested for their green manuring value from this year.

VI. Field Experiments.

Wilt experiments on *arhar* crops were carried on in the first eight plots of one-quarter acre each of Punjab field B. block for the Imperial Mycologist.

From 1923-24 to 1926-27 *arhar* was continuously grown in the above plots. Plots Nos. 1B, 2B, 7B and 8B were grown by the Mycological Section with treated seed and infected with wilt fungus in the middle, while plots Nos. 3B, 4B, 5B and 6B were grown by the Farm. The Mycological Section plots Nos. 2B and 8B had one cwt. of superphosphate each as well. As the deaths in plot 8B, the artificially infected plot with super and plot 4B, the natural infected plot, had reached 97 and 85 per cent. respectively, it was decided to stop growing *arhar* in all these plots for two seasons and to grow it again in the third without superphosphate and with no artificial infection to see to what extent the disease can survive over an interval of time equal to that between one *arhar* crop and another in the Farm rotation. The yields of these plots are given below :—

Plot No.	Yield of *arhar* in lbs. per acre	Remarks
1B	706	
2B	862	
3B	312	
4B	*Nil*	All plants died of wilt.
5B	1445	
6B	378	
7B	172	
8B	*Nil*	All plants died of wilt.

Green Manuring Experiments for the Imperial Agricultural Chemist were continued and the following are the results :—

Plot No.	Treatment.	Yield of oats in lbs. per acre.
1	No manure	431
2	Green manured with sunhemp alone grown outside the plot	1,016
3	Superphosphate alone @ 50 lbs. P_2O_5 per acre	339
4	Green manured with sunhemp grown outside the plot with superphosphate @ 50 lbs. P_2O_5 per acre.	1,216
5	No manure	354
6	No manure	246

The green manure and superphosphate plot again gave a markedly high outturn of oats, as compared with the other plots. The rise in the green manure alone plot is also noticeable as compared with last year. These experiments have now been discontinued under the instructions of the Imperial Agricultural Chemist.

Varietal tests of *rabi* pulses were carried out in B. block of Punjab field and the Imperial Economic Botanist's gram varieties were grown in comparison with the Pusa Farm grams. The yields are given below :—

Serial No.	*Rabi* pulses (Gram and Peas).	Average yield per acre.
		mds. srs.
	Gram.	
1	Gram T. 17, B. S. variety	12 28
2	Gram T. 25, B. S. variety	12 32
3	Gram P. F. 3, Pusa Farm variety	12 12
4	Gram P. F. 11, ,, ...	12 0
5	Gram P. F. 16, ,, ...	4 36
6	Gram P. F. 17, ,, ...	4 16
	Peas.	
7	Peas P. F. I, Pusa Farm variety	15 24
8	Peas P. F. II, ,, ...	9 18
9	Peas P. F. III, ,, ...	14 24
10	Peas P. F. IV, ,, ...	12 14

The Permanent Manurial and Rotation Experiments were continued in C. block of the Punjab field as before. A wilt resistant variety of *arhar* A2 was grown in these plots for trial. The number of wilted plants was much less than in previous years, but it was not free from wilt disease.

A Sub-Committee of the Board of Agriculture held in December 1929 examined the question of the continuance of the Permanent Manurial plots at Pusa and made certain proposals regarding the system of cropping to be adopted in future. These will be carried out from '*Kharif*' 1930-31.

The results are given below and the average figures for 20 years from 1908-09 to 1927-28 are given below those for the year under report :—

Results of Permanent Manurial and Rotation Experiments for 1929-30.

Plot No.	Treatment.	A-Series			B-Series b.		
		Maize grain per acre.	*Arhar* grain per acre.	Peas grain per acre.	Maize grain per acre.	*Arhar* grain per acre.	Barley grain per acre.
		lb	lb	lb.	lb.	lb.	lb.
1	No manure	755 676	616 652	.. ..	268 510	721 959	.. ..
2	Farmyard manure to supply 10 lbs nitrogen per acre.	1,092 825	1,027 737	.. ..	591 710	723 1,070	.. ..
3	Farmyard manure to supply 20 lbs. nitrogen per acre.	1,347 985	1,174 852	.. ..	616 832	944 1,128	.. ..
4	Farmyard manure to supply 30 lbs. nitrogen per acre	1,503 1,096	1,371 908	.. ..	747 905	844 911	.. ..
5	Rape cake to supply 20 lbs. nitrogen per acre	1,191 948	979 624	. ..	632 795	698 886	. ..
6	Sulphate of ammonia to supply 20 lbs. nitrogen per acre.	599 599	460 472	. .	308 504	636 868	..
7	Sulphate of potash to supply K_2O as in plot No 3	673 554	419 432	. ..	304 428	523 776	.. ..
8	Superphosphate to supply P_2O_5 as in plot No 3	1,133 923	1,224 895	.. .	624 783	860 836	.. .
9	Sulphate of potash to supply K_2O as in plot No 3	1,215 864	1,218 844	.. .	760 753	905 823	. ..
10	Sulphate of ammonia to supply nitrogen, sulphate of potash to supply K_2O and superphosphate to supply P_2O_5 as in plot No. 3.	1,215 984	1,347 908	. ..	854 990	834 798	.. ..
11	No manure or leguminous crop	230 402	509 404	.. ..	271 506	.. .	337 357
12	Green manure in a cereal rotation	Green manure	673 617	. ..	797 744	.. .	476 459
13	Deep rooted leguminous crop in a cereal rotation	468 598	542 467	..	271 519	554 698	.. ..
14	One deep rooted and one shallow rooted leguminous crop in the rotation.	591 636	550 336	8 143	419 582	547 639	.. ..
15	Leguminous crop and green manure in the rotation.	Green manure	985 653	.. .	1,141 774	620 617	.. ..
16	Green manure and superphosphate to supply P_2O_5 as in plot No. 3.	Green manure	2,004 1,288	.. ..	1,642 1,242	768 596	.. ..

In the year under report, the green manure and superphosphate plot continued to give the highest outturn of oats as before. The yield of peas in plot No. 14 has reached the vanishing point. It was 8 lbs. as against 20 lbs. last year.

The general fertility experiment was continued as usual on an area of 413 acres according to the rotation mentioned before. Crop results for the last 18 years are :—

Yield of 13 fields (413 acres) for the last 18 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	31,971
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	1,064	719	4,262	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
1924-25 . .	57·00	5,816	467	1,234	7,517	20,936
1925-26 . .	48·67	4,611	343	1,030	5,984	22,906
1926-27 . .	38·74	4,131	540	512	5,183	21,293
1927-28 . .	37·17	4,283	957	649	5,889	26,459
1928-29 . .	54·02	5,519	351	1,023	6,893	11,593
1929-30 . .	50·17	5,244	2,057	1,139	8,440	15,549

The maize crop on two fields, Chhonia and Mysore, which was to be cut green for silage, was kept for cobs as the silage pits were already full. There is therefore an increase in the grain outturn of maize and decrease in the amount of green fodder from the general average.

VII.—Implements and Machinery.

Tractors.—The 15-30 H.P. International Tractor continued to give satisfactory service during the year. After two years work, a few replacements were required to be made. Full cost details of the work are given below.

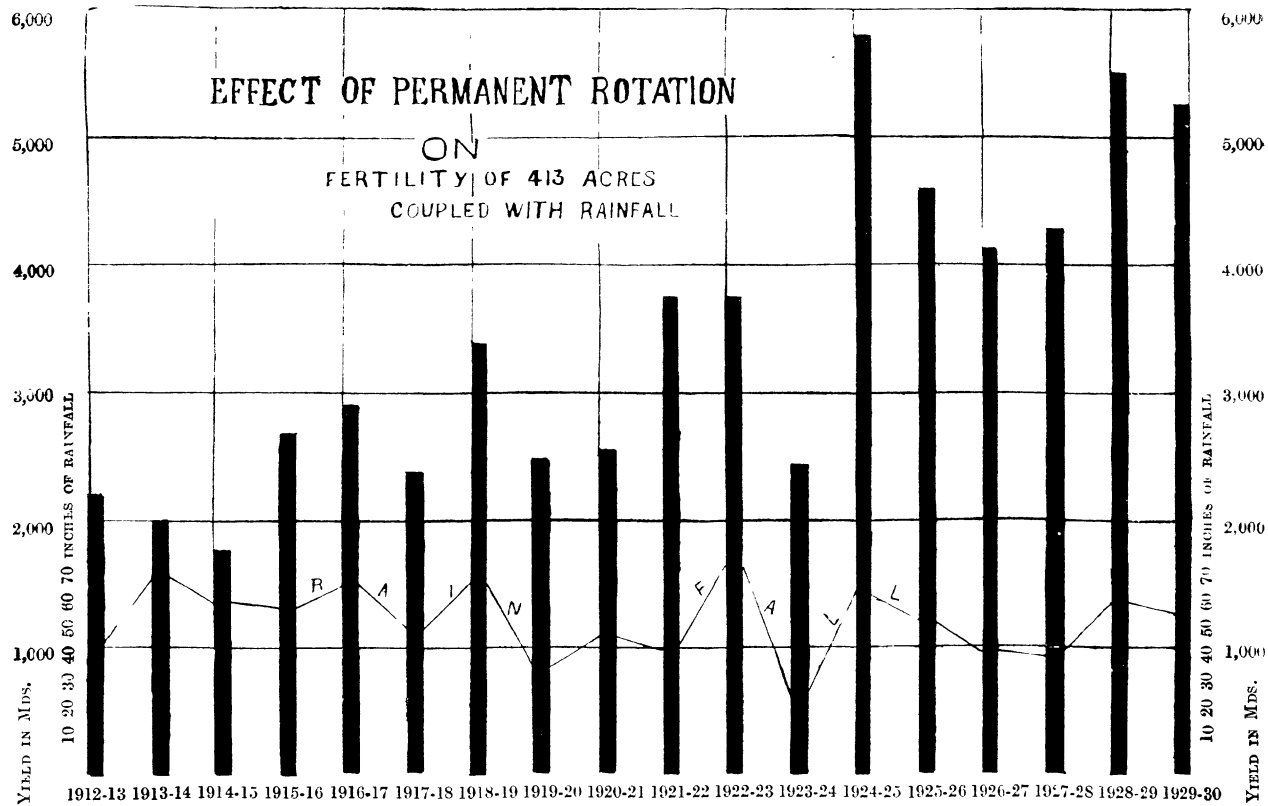

EFFECT OF PERMANENT ROTATION
ON
FERTILITY OF 413 ACRES
COUPLED WITH RAINFALL
6,000
5,000
4,000
3,000
2,000
1,000
YIELD IN MDS.
10 20 30 40 50 60 70 INCHES OF RAINFALL
RAIN FALL
1912-13 1913-14 1914-15 1915-16 1916-17 1917-18 1918-19 1919-20 1920-21 1921-22 1922-23 1923-24 1924-25 1925-26 1926-27 1927-28 1928-29 1929-30

PLATE III.

A new ' Little Genius ' 4-furrow mould board plough was purchased and did excellent work behind the International Tractor.

Statement showing Output, Consumption and Cost of Cultivation by McCormick Deering, International Tractor for 1929-30.

Year	Working hours	SUMMARY OF WORK DONE FOR 1929-30										Total Acres
		Ploughing		Disc harrowing		Grubbing		Drilling		Rolling		
		Hours	Acres	Hours	Acres	Hours	Acres	Hours	Acres	Hours	Acres	
1929-30 .	397 5	67·75	56 23	223	380·5	101	195·5	5 75	10	.	..	642 23
Average of 1927-29.	614·6	73 5	63·5	245 9	420 5	202 3	324·5	.		93	116 4	924 89

Acres per Hour.

Year	Ploughing	Disc harrowing	Grubbing	Drilling	Rolling
1929-30 . .	0 83	1 70	1 93	1 74	.
Average of 1927-29 . .	0 86	1 71	1 60	.	1 25

Consumption.

Year	Working Hours	Fuel, kerosine oil and gasoline		Engine and Gear oil		Grease		Waste	
		Total gallons	Per hr. gallons	Total gallons	Per hr gallons	Total lbs.	Per hr. lbs.	Total lbs.	Per hr. lbs.
1929-30 .	397·5	K. oil 773 11 Gasoline 32 25	K. oil 1·94 Gasoline 0 08	68 62	0 17	58 62	0 15	24 99	0 06
Average of 1927-29.	614 6	K. oil 1,074·25 Gasoline 46 5	K. oil 1 74 Gasoline 0 07	107 07	0 17	86 5	0 14	0 35	0 05

Cost.

Year	Working Hours	ANALYSIS OF TOTAL COST						
		Labour	Kerosine oil and Gasoline	Lubricants, etc.	Spare Parts	Miscellaneous Wages	Total	Per hour
		Rs. as.	Rs. as.	Rs as.	Rs as	Rs as.	Rs. as.	Rs.
1929-30	397·5	73 14	604 10	154 3	310 2	59 11	1,202 8	3 02
Average of 1927-29.	614·6	176 10	869 11	270 13	62 14	..	1,380 0	2 25

Cost per acre.

Year	Ploughing	Disc harrowing	Grubbing and hangering	Drilling	Rolling
	Rs	Rs	Rs	Rs	Rs.
1929-30 .	3 71	1 77	1 56	1 73	
Average of 1927-29	2·61	1 31	1 40	..	1 80

Belt Work.

Year	Hours of work	Kerosine oil consumed	Kerosine oil per hour	Gasoline consumed	Gasoline per hour	Lubricating oil consumed	Lubricating oil per hour	Renewals	Total expenses	Expenses per hour
		Galls	Galls.	Galls.	Galls.	Galls.	Galls.	Rs.	Rs.	
1929-30	326	248 75	0 76	14	0·04	34·75	0·10	153 56	563	1·72
Average of 1927-29	446	318 47	0 71	18 5	0·04	22 34	0·05	.	574 65	1·29

Fowler's Steam Ploughing Tackle worked during the year for 71 days of 10 hours each.

The details of work and working expenses are given in the following statement : —

The Cost and Output of working the Fowlers Steam Ploughing Tackle during 1929-30.

Year	Cost					Ploughing			Grubbing			Disc harrowing			Rolling			Total Number of working days
	Labour	Fuel	Oil	Renewals Miscellaneous stores	Total working cost	Total work	Work per day	Cost per acre	Total work	Work per day	Cost per acre	Total work	Work per day	Cost per acre	Total work	Work per day	Cost per acre	
	Rs.	Rs	Rs	Rs.	Rs	Acres	Acres	Rs	Acres	Acres	Rs.	Acres	Acres	Rs	Acres	Acres	Rs	
1929-30 .	1,129	1,161	231	2,941	5,462	266	9 48	8 06	375 5	21·74	3 5	520·5	19·94	3 83		..	..	71 4
Average for 10 years 1920-30.	1,272	1,573	365	1,950	5,160	367	8 6	6·05	404	21·5	2 3	504	17 2	3·0	238	19·6	1·6	108

Note —The increase in renewal costs is due to the replacement of 2 new cables.

INSTITUTE, PUSA, FOR 1929-30

The Ransome's Vickers Tractor, mark 3, mentioned in the last Annual Report was found defective in many respects. On this being reported to the Home manufacturers, Messrs. Vickers Ltd., agents for this tractor, took back the model No. 3 and replaced it with another mark 4 tractor without any extra cost to the Farm. This mark 4 tractor is working satisfactorily and details of working cost are being kept. To date there are no spare parts in the country for this tractor and no organisation to supply them, but it has the distinct advantage in that International spare parts will fit, and this will probably enable a number of people who have a desire to support British industries and a distinct dislike of waiting for spare parts to purchase and work this tractor.

The tractor problem has assumed a different aspect with the introduction of crude oil tractors and the consequent reduction of working costs associated with the use of a lower grade fuel.

A crude oil tractor has been purchased and is being tried out against the leading kerosine oil tractor with a view to collect reliable data regarding work done, upkeep and working costs over a number of years.

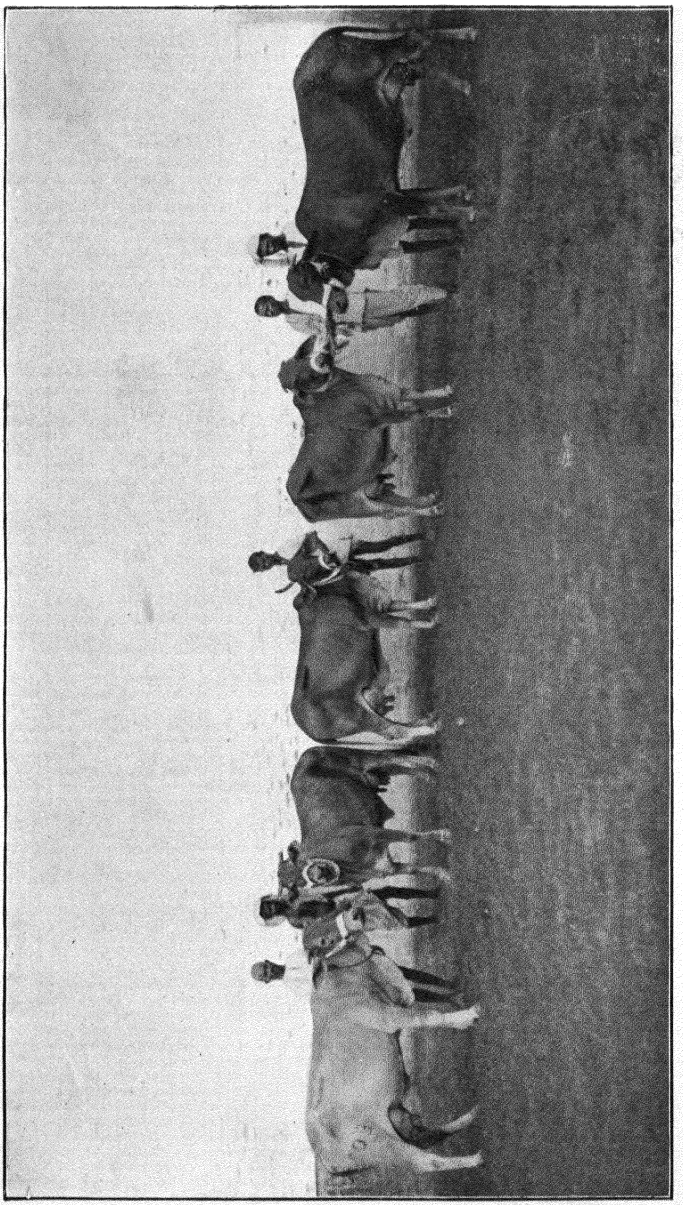
Thresher.—The new Consul Thresher was used for threshing wheat and over 800 Mds. of wheat grain was threshed out during the threshing season. It worked very satisfactorily without giving any trouble, and fine ' bhusa ' was made of the stalks.

VIII.—Pedigree Dairy Herd.

The Sahiwal and cross-bred herds numbered 294 head at the end of the year under report and kept up excellent condition throughout.

A mild form of foot and mouth occurred among the young male stock, which are kept at the New Area, some two miles from the main herds. The source of infection was traced out and the infected animals were strictly segregated and treated within a wire fenced enclosure. The infected stock and the work cattle which were in close proximity to the segregated area were all given liberal doses of Iodine in their drinking water during the period the outbreak lasted, with the result that none of the incontact animals were attacked and the affected stock recovered without any serious complication their convalescent stage being very short. The Iodine doses maintained the metabolic balance in the system and thereby lessened the severity of the outbreak. Two cases of Hemorrhagic Septicemia, both of which proved fatal, occurred among the young male stock at this period, but the remainder were immediately protected by serum and no further cases occurred. A severe outbreak was raging, at this time among the local cattle in the immediate vicinity.

PLATE III.



FIVE BEST SAHIWAL COWS IN MILK.

Pure Sahiwal Herd.—The selective breeding of this herd was continued and the following are the six best cows who completed their lactation during the period under report. :—

Serial No.	Name and No. of cow	No. of calving	Lactation	
			lb.	days
1	Bendi 467	3	6,646	304
2	Nasoorti 427	5	5,692	295
3	Hanumati 399	6	5,649	304
4	Bhagti 369	8	5,469	306
5	Tutia 318	8	5,196	304
6	Roopbati 508	2	5,044	304

Kamli No. 312 one of the best Sahiwal cows in the herd unfortunately died from pneumonia and cerebral apoplexy on 4th September, 1929.

We have now 30 cows in the select herd and 35 under trial.

A point worthy of note about the Sahiwal herd has been the marked decrease in the sterility ratio among the milch stock, during the year under report. During the last few years this has been rising at an alarming rate and many excellent cows in their prime have had to be cast, and serious doubts as to the effect of the heavy feeding and the damp climate on the reproductive capacities of the breed began to be entertained.

A drastic alteration in the ration and general treatment of the dry stock has brought about a complete change and the ratio is now well below normal. Out of 200 adult female stock 15 animals which appeared to be sterile were kept under observation and treated with the result that only two proved permanently sterile, and the ratio has now come down from 7·5% to 1%. At the same time there is a marked tendency among the young male stock to go dull at an early age and few Sahiwal bulls at Pusa can be relied upon to serve for the length of time a half bred will.

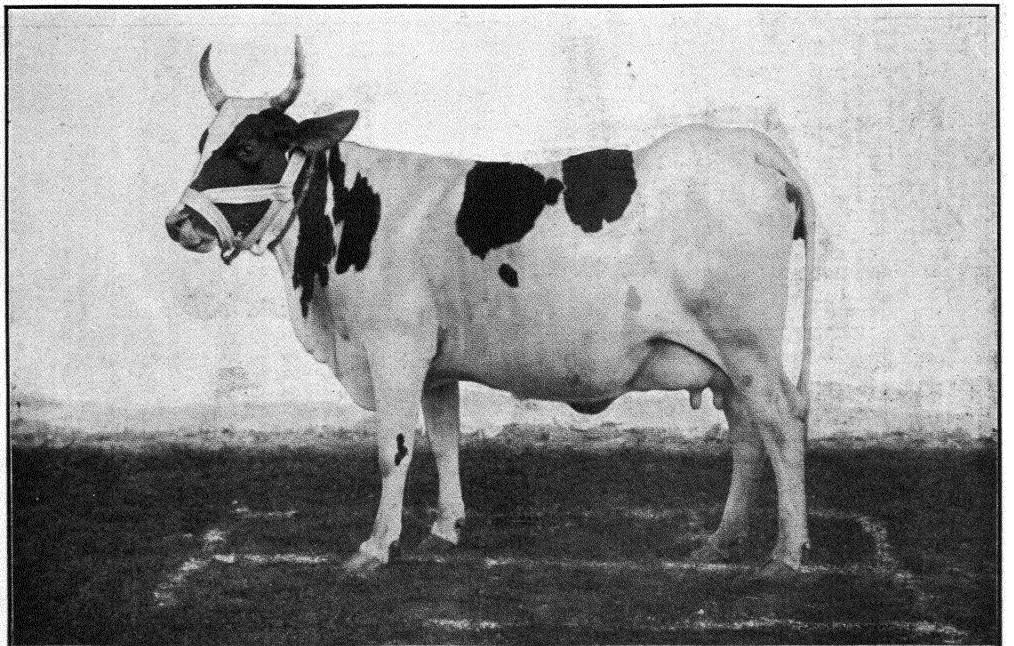
Cross-bred herd.—Under the orders of the Government of India the experiments in cross breeding were discontinued and the herd dispersed in the months of April and May, 1930.

The following were the yields of the six best half-breds and six best miscellaneous crosses during the year : –

Serial No.	Name and No. of cow	No. of calving	Quantity of milk given	
			lb.	days
	Half-bred Ayrshire-Sahiwal cows.			
1	Tomina 123	4	12,010	304
2	Lassie 65	7	8,033	304
3	Letitia 125	5	8,003	304
4	Maudie 40	7	7,920	304
5	Liela 99	5	7,807	304
6	Verney 164	2	7,709	304
	Miscellaneous cross cows.			
1	½-Holstein-Sah. Pearl 130	4	13,299	304
2	¾-Sah.-Ayr. Cissy 167	2	7,591	304
3	¾-Sah.-Ayr. Rhoda	4	6,704	304
4	¾-Sah -¼-Hols. Mildred 196. . . .	1	4,718	303
5	¾-Sah.-Ayr. Roxy 194 . . .	1	4,230	303
6	¾-Sah.-Ayr. Meggy 197	1	4,010	304

As this terminates the work done in this connection at Pusa, it will not be out of place to review the progress made since this experiment was started in 1914.

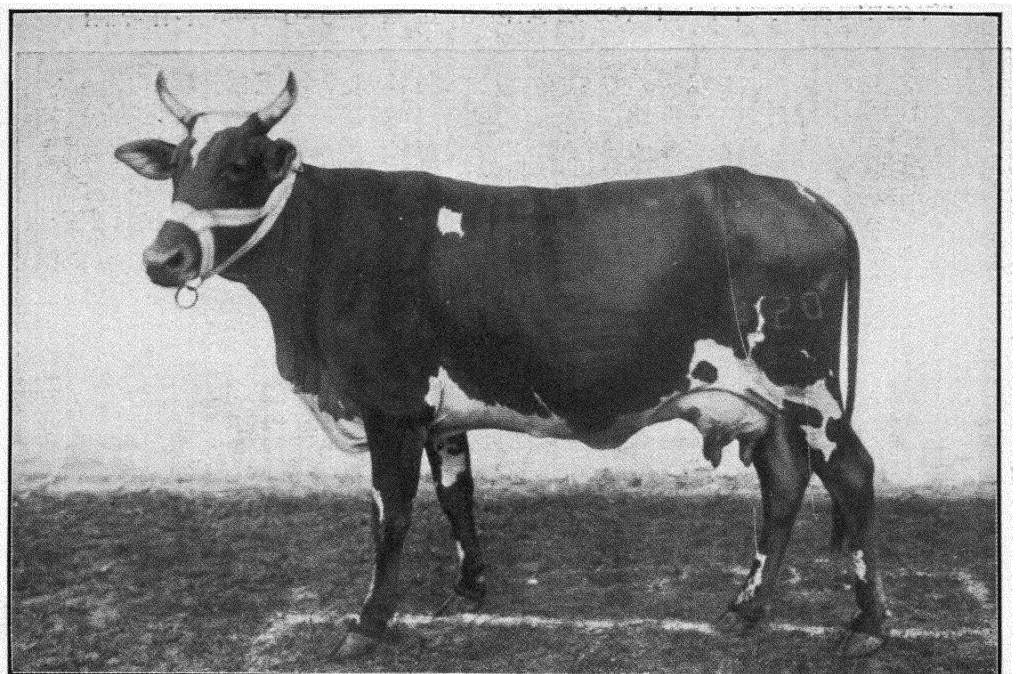
In 1914, a pedigree Ayrshire bull was purchased and put over the poorest milkers in the Sahiwal herd—some of which gave under 1,000 lbs. in ten months. The results of the first cross, Ayrshire bull over Sahiwal cow, averaged over 50 per cent more milk than their dams and in many cases the percentage is far higher. The average yield of half-bred Ayrshire cow per lactation period was 6974·2 lb. while that of their Sahiwal dams averaged only 2543·2 lb. per lactation period (as shown in Appendix I).



Half Ayrshire-Montgomery Cow Candida No. 217. Date of birth 25th October 1926. 1st lactation 8245 lbs, in 303 days.

PLATE IV.

PLATE V.



Half Ayrshire-Montgomery Cow Cordelia No. 220. Date of birth 18th November 1926. 1st lactation 6691 lbs. in 303 **days.** Calved again on 18th September 1930 and is giving 28 lbs. of milk a day at present.

The very best Sahiwal cows in the herd give about 7,000 lbs. in 300 days lactation period, while up to 12,000 lbs. has been produced in similar period by first crosses off inferior milkers.

The first crosses have undoubtedly proved good dairy animals. They are strong, healthy, and good doers, calve regularly and are singularly free from throw-backs, either on the sires side, in which case they keep bad condition and suffer from the heat, or on the dams side with the consequent lessening of milk yield and tendency to stand off.

The male stock are active and good workers with heart and pace, a complete contrast to the Sahiwal bullock, whose only qualification from the draught point of view is that he is fool-proof, no one can overwork him or knock the feet off him, as is so frequently the case with real draught stock. First cross Ayrshire-Sahiwal bullocks have been working on the Farm for the past 14 years and their record is good.

On the other hand the further crosses, Ayrshire bull over Ayrshire-Sahiwal cow, have proved much inferior. The female stock are bad doers, suffer from the heat, run heavy coats and lack all the sturdiness of the first cross. Their milk yield is also distinctly inferior. The male stock are a nasty weedy type unfit for really hard work.

The double cross, ½-Ayrshire-Sahiwal bull over half-bred cows has also proved unsatisfactory, a very large percentage of the female stock reverting to the original Sahiwal milk yield and showing little or no improvement on their grand mothers. The bulls again fail to transmit their fathers' qualities while the double cross bull is equally negative.

These criticisms apply solely to the Ayrshire-Sahiwal cross on which this work has been done.

The last experiment was to put pure Sahiwal bull over half-bred cows, the resulting stock being quarter-breeds, ¼-Ayrshire and ¾-Sahiwal. Here it appears that the Sahiwal bull, if of thoroughly good milking strain, can produce a class of animal which is of extremely good milch type and is a distinct improvement in certain points on the Sahiwal stock. There is less loose skin and the udder is a better shape, while the male stock are lively and hard.

Percentage of cows in milk.—A statement of the percentage of cows in milk is given in Appendix II. The variation commencing from the dispersal of the cross-breds will be noticed in the month of June. The percentage was 45% Sahiwal and 66·8% cross-bred, both figures showing a drop from last year.

Calf rearing.—The calf mortality table is given (Appendix III) showing the marked difference in stamina at birth between the cross-breds and the pure Sahiwal calves.

Milk production.– The average yield of the pure Sahiwal herd went down from 14·3 to 12·4 lb., the number of calvings from October to February being very low, while the cross-bred yield went up from 19·7 to 20·1 lb., a rise attributably to some good $\frac{3}{4}$-Sahiwal crosses coming into milk during the year (Appendix IV).

Sales.—At auction 59 animals fetched Rs. 5,185-12 and the dispersal sales at valuation figures realised Rs. 10,725 for 90 animals (Appendix V).

IX.—Programme of work for 1930-31.

1. The practical treatment of a pedigree dairy herd of pure Sahiwal cattle for milk production.

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

(*a*) Rotational experiments.
(*b*) Trial of new varieties of crops, especially leguminous fodder crops.
(*c*) Manurial experiments especially seasonal and quantitative tests with phosphates.
(*d*) Trial of sugarcane varieties suitable for growth without irrigation, along with the S. B.
(*e*) Crop experiments in collaboration with the sectional Officers

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.

APPENDIX I.

Statement showing the average lactation of 10 half Ayrshire cows comparing with their Sahiwal dams.

Serial No.	Name and No. of cow	Average milk yield per lact. period	Name and No. of dam	Average milk yield per lact. period
		lbs.		lbs.
1	Naomi 1 . . .	6,689	Thoombri 60 . .	3,424
2	Alibi 3 . . .	10,206	Sajni 79 . . .	3,324
3	Pansy 4 . . .	5,857	Gauri 165 . .	424
4	Daisy 5 . . .	7,556	Gujri 30 . . .	2,833
5	Patty 8 . . .	7,081	Rangeli 145 . .	2,318
6	Peggy 9 . . .	5,519	Phekni 200 . .	2,409
7	Kitty 10 . . .	5,884	Makdi 193 . .	No milk. Calf sucked.
8	Polly 18 . . .	6,668	Punia 216 . .	3,582
9	Dollie 20 . . .	5,737	Ketki 184 . .	2,989
10	Laura 98 . . .	8,545	Krishni 303 . .	1,586
	Average .	6,974·2	Average .	2,543·2

APPENDIX II.

Percentage of cows in milk and dry in Pusa Herd during 1929-30.

Month	NUMBER OF COWS IN MILK AND DRY																	
	½ AYRSHIRE COWS				MISCELLANEOUS COWS				TOTAL OF C. B. COWS				SAHIWAL COWS				TOTAL OF C. B. AND SAHIWAL COWS			
	Total	In milk	Dry	P. C in milk	Total	In milk	Dry	P. C. in milk	Total	In milk	Dry	P. C. in milk	Total	In milk	Dry	P. C. in milk	Total	In milk	Dry	P. C. in milk
1929—																				
July	37	24	13	64·9	23	11	12	47·8	60	35	25	58·3	61	30	31	49·2	121	65	56	53·7
August	37	21	16	56·8	23	9	14	39·1	60	30	30	50 0	61	29	32	47·5	121	59	62	48·8
September	39	24	15	61·5	23	6	17	26·1	62	30	32	48·4	61	28	33	45·9	123	58	65	47·1
October	39	29	10	74 4	23	7	16	30·4	62	36	26	58 1	60	26	34	43 3	122	62	60	50 8
November	40	27	13	67·5	23	11	12	47·8	63	38	25	60·3	62	26	36	41 9	125	64	61	51·2
December	40	22	18	55 0	20	14	6	70 0	60	36	24	60 0	62	27	35	43 6	122	63	59	51·6
1930—																				
January	42	26	16	61·9	20	16	4	80 0	62	42	20	67·7	60	29	31	48·3	122	71	51	58·2
February	42	31	11	73 8	24	17	7	70 8	66	48	18	72·7	63	26	37	41·3	129	74	55	57·3
March	43	36	7	83·7	24	21	3	87·5	67	57	10	85 1	64	27	37	42 2	131	84	47	64·1
April	44	38	6	86 4	27	22	5	81·5	71	60	11	84·5	66	29	37	43·0	137	89	48	64·2
May	44	34	10	77·3	27	20	7	74 0	71	54	17	76·0	65	29	36	44·6	136	83	53	61·0
June	32	26	6	81·2	13	10	3	76·9	45	36	9	80·0	64	31	33	48·4	109	67	42	61·5
Average	40	28	12	70 4	22	14	9	61·0	62	42	21	66·8	62	28	34	45·0	125	70	55	55·8
Average for 1928-29	37	28	9	75·1	25	15	10	61·3	62	43	19	69·4	55	28	27	50·8	118	71	47	60·5

APPENDIX III.

Table showing the mortality amongst the calves during the years 1928-29 and 1929-30.

Year.	BIRTHS			DEATHS			P. C. in mortality	REMARKS
	Sahiwal	Cross-bred	Total	Sahiwal	Cross-bred	Total		
1928-29 .	42	54	96	6	1	7	7 3	Two calves born in the previous year which died of Haemorrhagic Septicemia are not included here.
1929-30 .	40	68	108	7	1	8	7·4	

APPENDIX IV.

Statement showing milk yield in lb. for 1929-30.

Month	MILK YIELD OF					AVERAGE YIELD PER DAY AND PER COW PER DAY									
	CROSS-BRED COWS			Pure Sahiwal cows	Total of cross-bred and Sahiwal cows	CROSS-BRED COWS						SAHIWAL COWS		TOTAL OF CROSS-BRED AND SAHIWAL COWS	
						½-Ayr cows		Misc cows		Total of C B cows					
	½-Ayrshire cows	Misc cross cows	Total of C B cows			Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day
1929—															
July . .	13,176	5,802	18 978	12,607	31,585	425	17 7	187	17 0	612	17 5	407	13 6	1,019	15 9
August . .	12,695	5,448	18,143	12 169	30 312	409	19 5	176	19 5	585	19 5	393	13 6	978	16 6
September .	13,358	4,158	17,516	10.758	28,274	445	18 5	139	23 2	584	19 5	358	12 8	942	16 2
October .	16 755	3,792	20,547	8,927	29,474	541	18 7	122	17 4	663	18 4	288	11·0	951	15 3
November .	14 707	5.305	20,012	8 112	28 124	490	18 1	177	16 1	667	17 6	270	10 4	937	14 6
December	15,039	7,491	22,530	8,529	31 059	485	22 0	242	17 3	727	20 2	275	10 2	1.002	15 9
1930—															
January .	21,090	9.561	30,651	9.385	40 036	680	26 1	309	19 3	989	23 5	303	10 4	1 291	18 2
February .	21,989	8 983	30,972	8,440	39 412	785	25 3	321	18 9	1,106	23 0	301	11 6	1.408	19 0
March . .	30,023	11,494	41,517	11.039	52,556	968	26 9	371	17 7	1 339	23 5	356	13 2	1 695	20·2
April . .	25,384	10,748	36,132	11,474	47,606	846	22 3	358	16 3	1,204	20 0	382	13 2	1,587	17 8
May . .	23,545	9,456	33,001	12.726	45,727	760	22·3	305	15 2	1,065	19 7	411	11 2	1,475	17 8
June . .	16 894	3,258	20.152	13 931	34,083	563	21 7	108	10 8	672	18 7	464	15 0	1,136	17 0
TOTAL .	2 24,655	85,496	3.10,151	1.28,097	4,38,248	..	..	..		.	.	..		..	
Average . .	18,721	7,125	25,846	10 675	36 521	616	21·6	235	17 4	851	20 1	351	12·4	1,202	17 0
Average for 1928-29.	18,614	7,417	26.031	12,128	38.159	613	21·8	244	16 1	857	19 7	398	14·3	1.255	17·6

APPENDIX V.

Statement showing the number of cattle sold by public auction and on valuation price during the 1929-30.

Descriptions	SOLD BY					
	PUBLIC AUCTION			VALUATION PRICE		
	No. of animal	Total price	Average per head	No. of animal	Total price	Average per head
		Rs. A.	Rs. A. P.		Rs.	Rs. A. P.
1. Sahiwal cows	5	288 0	57 9 7	..	..	.
2. Cross-bred cows	6	810 0	135 0 0	34	6,970	205 0 0
3. Cross-bred heifers	22	1,531 12	69 10 0	33	1,705	51 10 8
4. Sahiwal bulls and young bulls.	16	2,070 0	129 6 0	19	1,850	97 5 10
5. Cross-bred steerlings	4 pairs	410 0	102 8 0 per pair	2 pairs	200	100 0 0 per pair
6. Sahiwal bullocks	1 pair	76 0	..	..	..	..

4 Cross-bred bull calves sold for nominal prices (for Rs. 2) at 0-8-0 each.
3 Animals sent to Samastipur Pinjrapole free of cost.

REPORT OF THE IMPERIAL DAIRY EXPERT.

(WILLIAM SMITH.)

I. INTRODUCTION.

I was in charge of the office of the Imperial Dairy Expert throughout the year 1929-30.

The more or less acute political situation prevailing in India during the year has to some extent diverted public opinion from purely economic questions like the cattle breeding and dairying industry, but notwithstanding this the demand made on this office for technical advice from all parts of the country has not fallen off and there is probably no phase of Indian economics which figures so much in the public eye to-day as the cattle question. The Indian press in particular throughout the year appeared to be devoting ever increasing space to cattle rearing and milk production and practically all the Provincial Governments and the larger of the Indian States continue to increase their activities in the direction of the improvement of the draught and milch cattle of their districts.

The question of the improvement of city milk supplies has made some progress during the year. The new Central Co-operative Dairy Factory erected by the Darjeeling Co-operative Societies Milk Union has been completed and co-operative dairying in the direction of the improvement of city milk supplies has made further progress in Dacca, Chittagong and Calcutta under the guidance of the dairy section of the department of the Registrar of Co-operative Societies, Government of Bengal. The Co-operative Department of the Government of Mysore have during the year completed a comprehensive and thorough survey of the conditions of milk supply to Bangalore city with a view to the erection of a modern co-operative milk factory in that city.

The farms and creamery controlled by this Section exist for the purpose of providing the educational facilities which the country needs and for the carrying out of research and experimental work. Details of the educational and experimental work done are given in this report and the research work conducted by this Section during the year under review included the development of the milk yielding powers of the Thar-Parkar and Hariana herds at Karnal in order to find out if the giving of reasonably heavy milk yields by the females will adversely affect the draught efficiency of the males. Experimental work was also carried out in the manufacture of cheddar cheese by means of a purely vegetable coagulant, the neutralisation of sour cream for butter

making, the pasteurisation of milk by various types of machines, the loss percentage in milk pasteurisation, the manufacture of *ghee*, the manufacture of rennet, acid and lactic casein and the long distance transport of pasteurised milk. Investigations were carried out concerning the percentage composition of milk yielded at different milking periods, and the quality of milk yielded at different stages during the process of milking. Researches into available records were made to determine average dry periods of various types of Indian dairy cattle under varying conditions, quality of Indian cows' milk at different periods of the lactation, merits of different cross-bred types, prepotency of Indian bulls, relation of the season of the year of calving date to milk yield and the effect of mineral feeding on calving regularity. In the carrying out of this experimental work the farm staff have been in many cases ably assisted by the Post-graduate students.

The reports of the Superintendents of the farms at Bangalore, Karnal and Wellington and the Creamery at Anand published herewith call for little comment. They indicate the progress made and the work done at each station. The continuance of outbreaks of foot and mouth disease at Wellington is largely responsible for the loss on the working of that farm, but this is more than counterbalanced by the greatly improved financial position at Anand. The usefulness of the Anand Research Creamery is hampered through the want of new machinery and buildings, particularly milk drying plant and a students' hostel. Indian dairying like that of all other small holding countries will only be developed in the future on co-operative village factory lines and it is of great importance that the creamery at Anand should take up now the solution of the many problems confronting the dairy industry regarding the manufacture, storage and transport of milk products made from village milk such as is dealt with by the Anand Creamery.

The calf mortality indicated by the Karnal report is high and is due in some measure to improper housing which is being remedied and for which Government have already provided the necessary funds.

The animals comprising the Bangalore herd continue to be utilised by the Physiological Chemist to Government for nutrition experimental work, something like 50 per cent. of the herd being used for this purpose throughout the year. These experiments naturally affect the milking qualities of the cattle and this fact should be borne in mind when the yields of the Bangalore herd are compared with those of cattle not used for feeding experiments.

Central Bureau of Animal Husbandry. The increasing interest evinced by the Public in cattle breeding and dairying matters resulted in numerous enquiries from cattle breeders in and outside India. Pure Indian-bred cattle were supplied to several breeders from the farm herds at Karnal, Bangalore and Wellington. Several private owners were

advised as to the class of cattle suitable for their local conditions and actual selections of suitable animals were made in many instances.

Propaganda work continued throughout the year and dairy films were supplied on loan to the Co-operative Societies Milk Union, Calcutta; the Manager, State Dairy Farm, Nabha; the Chief Publicity Officer, Indian State Railways, Delhi, for demonstration to the general public. A public lecture was arranged in Bangalore in the Globe Theatre presided over by Hon'ble the British Resident in Mysore, where the cinema pictures of this Section depicting the working of the farms under this Section were shown to the public. Photographs and lantern slides were lent to interested parties in all parts of India throughout the year.

II. Training.

The third batch consisting of 27 Dairy Diploma students who commenced their term on 16th October 1927 appeared for the examination held in November 1929 after completion of their two years' course. The examination was conducted by Mr. F. J. Gossip, Livestock Expert to the Government of Bengal. Of the 27 students who appeared for the examination 22 were successful and of these one passed with honours.

During the year four Post-graduate students also completed their 15 months' course and were awarded the usual certificates for their training.

Short courses of practical training varying in periods from 3 to 6 months were also given at our training farms at Bangalore, Wellington and Karnal and at the Anand Creamery, to 45 candidates from private organizations, Provincial Governments and the Allahabad Agricultural Institute, and in addition to this 4 British soldiers were also given vocational training in dairying at the request of the Military authorities.

New admissions made during the year were 25 students for the 4th batch of Indian Dairy Diploma course which commenced at the Imperial Cattle Breeding Farm, Karnal, on the 17th October 1929. As the number of applications for admission to the course was far in excess of the number which could actually be taken due to the limited hostel accommodation, etc., for the first time, since the commencement of the course, during this year, students were interviewed at various centres by the Assistant to the Imperial Dairy Expert before making a final selection. Applications for admission were received from candidates from all provinces and many Indian States, and it shows that the desire for this class of training is widespread and is on the increase.

During the year under review a second lot of four students were admitted for the post-graduate course.

Mr. F. J. Warth, Physiological Chemist, and his staff continued their co-operation in the matter of training the students and the ana-

lysis of the feeding stuffs for all the farms. I thank Mr. Warth for his help and advice given from time to time.

III. Work done for Local Governments, Indian States, Municipalities and advice given to the General Public in India, also to persons and Governments outside India.

Bombay. At the request of the Registrar of Co-operative Societies of Bombay Presidency, Poona, this office gave the necessary advice regarding the method of treatment of milk to be despatched from Anand to Bombay by train. It was also suggested that a co-operative society on a large scale should be started which would be beneficial to both the producers and the consumers of milk.

At the request of Mr. J. De Silva, I S.O., Superintendent, office of the Military Secretary to the Governor of Bombay, I visited his lands consisting of about 104 acres near Palghar for starting a dairy farm and furnished him with a complete scheme consisting of plans and estimates of buildings, specifications of plant and machinery, detailed list of livestock and establishment together with probable cost of each item. A profit and loss account showing the approximate result of the first year's working was also furnished.

At the request of Mr. Darookhanawalla of Poona this office examined the detailed working scheme furnished by him for opening a dairy farm at Nasik, and suggested improvements in various directions connected with the scheme.

At the request of Khan Bahadur V. P. Bhiladwalla of Bombay this office prepared a scheme for the opening of a dairy farm by Mr. Irani at Chintupada Palghar on his own lands consisting of 500 acres with a starting capital of Rs. 1,50,000. The scheme comprised of plans and estimated cost of buildings, specifications of plant and machinery with their cost, list of livestock with their cost, note of capital expenditure and list of establishment and an estimated trading account showing the profit for the first year's working.

At the request of Mr. Mukhi Harikishindas Gurudinomal, M.L.C. of Hyderabad, Sind, this office submitted a detailed scheme for a dairy farm to be established on his lands at "Kali" with layout plans of buildings with cost, estimates of capital expenditure, list of livestock and establishment and estimated cost of working the farm for the first year and cost of milk production. This scheme was submitted after Mr. Kothavala had visited the site and supplied the necessary information for drawing up the scheme.

The Editor and Manager of "Gorakshan Karyalaya" of Poona was supplied with a list of instructive books on dairying and cattle breeding. Later on, in reply to a specific enquiry made by him this

office furnished him with information of sale prices of Danish, Cork and Siberian butter in London with the sale price of butter in India. Also the high prices paid for pure milk in India were explained as compared with the cheaper rates paid for it in England.

At his request Mr. Mahadeo Dasai of Mr. Gandhi's Ashram at Sabaramati was supplied with a list of books dealing with dairying and cattle breeding for his use in managing the Ashram Dairy.

Pooj Panchayati Gaooshalla Society of Shikarpur, Sind, were supplied with a list of books considered useful for the management and handling of cattle.

Mr. Kothavala while on tour at Karachi interviewed the Health Officer, Karachi Municipality and advised him regarding their scheme for the re-organization of the city milk supply.

Mr. Kothavala while on tour at Bombay in September interviewed and discussed with the Municipal Commissioner and Health Officer, Bombay, questions relating to the re-organization scheme for the milk supply for the city of Bombay.

Jodhpur. Mr. Kothavala visited Jodhpur in June 1929 and advised the Milk Improvement Association regarding their scheme for the supply of clean milk for the city of Jodhpur.

Baroda. The Superintendent, Palace Dairy and Cattle Breeding Farm, Makarpura, was supplied with information on the system of rationing animals of various ages.

Kolhapur. At the request of the Secretary, Kolhapur Agricultural Exhibition held in November this Section took part in the Show by sending exhibits and samples of dairy products from Karnal and Anand to popularise our dairy products.

In addition to the foregoing work specific advice and information on dairying and cattle breeding matters were supplied to firms, public bodies and individuals at Bombay, Baroda, Karachi, Dakor (Kaira District) and Jogeswari (Bombay, Baroda and Central India Railway).

Bengal. I advised Mr. Narayan Das Bajoria of Calcutta, at his request as to the class of cows which gave the highest yields and the prices at which they could be purchased for a small dairy farm near Calcutta.

I discussed with the Superintendent, Sewage Farm, Jamshedpur, the necessity for introducing an appropriate form for recording cattle census figures and other matters in connection with the supply of milk on a co-operative basis.

I advised Mr. K. Sinha, I.D.D., as to where Hariana cows and Murra buffaloes could be purchased and also as to the best class of animals suitable for the climate of Calcutta.

The Manager of the Birla Dairy Farm, Ranchi, was advised on various technical matters connected with dairying and cattle breeding

throughout the year. His proposed scheme for a dairy at Ranchi was criticised by this office and he was advised as to the best class of cows suitable for that area and also as regards the financial aspect of the undertaking.

At the request of the Hon'ble Mr. Justice Lort-Williams of Calcutta this office submitted a detailed scheme for starting a cattle farm and dairy near Calcutta with estimated cost of buildings, livestock, plant and machinery and establishment.

The Superintendent, Co-operative Milk Societies Union, Calcutta, was advised as to the best type of refrigerating plant to be installed at Darjeeling in the proposed Co-operative Central Milk Factory for which detailed plans and estimates were prepared and submitted by this office.

At the request of the Secretary, Shridham Mayapur Nabadvip Exhibition this Section co-operated by sending dairy products from the Anand Creamery and Karnal Farm for exhibition purposes with a view to popularise the dairy products of our farms and to educate the public in general.

While on tour at Calcutta I discussed the proposed village milk experiment scheme with the Registrar of the Co-operative Societies and the officials of the local milk union. Also, Mr. Kothavala while in Calcutta in August, inspected the city milk depôt of the Co-operative Milk Societies Union and offered advice on the spot regarding working of the plant, treatment of milk and its sale. He also discussed with the Deputy Registrar of the Co-operative Societies some local problems connected with the milk supply in Calcutta.

Mr. S. L. Gupta, Veterinary Assistant Surgeon, Tippera, Bengal, was advised as to the best type of milking cows, their cost and the addresses of sellers of such cattle.

In addition to the foregoing, specific advice and information on dairying and cattle breeding matters were supplied to firms, public bodies and individuals at Calcutta, Dacca and Jamshedpur.

Madras. At the request of the Deputy Director of Agriculture, Livestock, Hosur Cattle Farm, a suitable plan of dairy buildings was furnished for the use of the General Hospital, Madras.

Mr. Kothavala, while at Madras in August visited the butter depôt of the Polson Manufacturing Company, at the request of the manager, and advised him on the spot regarding the method of grading and controlling the moisture contents of butter and also regarding the tinning and packing of butter for long distances.

Messrs. K. Rajamannar Chetty & Co., dealers in *ghee* and butter, Madras City, were advised as to the best method of preserving *ghee* and tinned butter.

At the request of Mr. H. M. S. Khoyee, owner of a dairy farm at Vizianagaram, I assisted him in purchasing half-bred cattle available for sale at Pusa.

Samalkot. At the request of Mr. R. Venkata Rao of Samalkot this office submitted a complete scheme for the establishment of a dairy farm with plans and machinery specifications, a note of capital cost, list of livestock and establishment with their cost and an estimated trading account for the first year's working.

Bangalore City. At the request of the President, Mysore Co-operative Propagandist Institute, I supplied a complete scheme for a proposed co-operative milk factory in Bangalore City with a plan of dairy buildings, specifications of plant and machinery with their estimated cost for economically dealing with 2,000 to 10,000 lb. milk per day.

At the request of the Secretary, S. P. C. A., Bangalore, I acted as one of the judges at the Animal Show held in Cubbon Park, Bangalore on the 7th September, 1929.

At the request of the Bangalore District Board Park Committee, Mr. Kothavala acted as one of the judges for the Cattle Show held in December, 1929.

At the request of the South Indian Science Association, Bangalore, I delivered a public lecture in Bangalore on the 23rd August on " the Economic Aspect of Cattle Problem in India " which was presided over by Dr. Leslie Charles Coleman, Director of Agriculture in Mysore. The lecture was largely attended by educated Indians.

Coorg. At the request of the Shri Ramakrishna Muth Authorities, a demonstration of cinema films depicting the working of modern dairy farming was arranged for by this Section at Ponnampet, at the time of the annual fair in April 1930, where some 3,000 agriculturists of Coorg had assembled. It was greatly appreciated.

Mysore. In August 1929, at the request of Dr. Coleman, Director of Agriculture in Mysore, I visited the Palace Dairy Farm and the Mysore Pinjrapole with that officer and submitted notes on the working of the above two institutions with suggestions for the improvement of those concerns. A complete specification of modern pasteurising plant suitable for installation in the Palace Dairy was sent to the State Huzur Secretary. In July 1929, I attended a meeting held at the office of the Director of Agriculture assembled to discuss the report of the Livestock Improvement Committee and gave my suggestions.

At the request of the Director of Agriculture, Mysore, I accompanied that officer to visit some of the Amrit Mahal Kavals which are vast areas of State-owned grazing lands on which some 7,000 head of cattle known as the " Mysore " cattle are bred in a semi-wild state on the ranching system. After the visit I submitted to the Director of Agriculture a workable scheme whereby the cattle may be bred to better

service by training and management. To breed milch cattle, breeding bulls or work-bullocks for agricultural operations, it was suggested that a central breeding farm be started under a capable Livestock Expert with the object of domesticating the present semi-wild animals, and in this connection specifications of buildings, plant and machinery, cost of establishment, and a water supply scheme were supplied by this office.

In April, 1930, at the request of the Director of Agriculture, Mysore, I acted as a joint examiner for the L. Ag. Examination of the Hebbal Agricultural School, in theory and practice in the subject " Livestock".

In addition to the foregoing, specific advice and information on dairying and cattle breeding matters were supplied to firms, public bodies and individuals at Mysore, Bangalore, Oorgaum, Madras, Kulitalai (Trichy District) and Angalura (Kistna District).

Punjab. Mr. P. Mangtram, a merchant of Amritsar, was supplied with a detailed dairy scheme for starting a small dairy with a capital of Rs. 10,000.

The Manager, Montgomery Dairy Farm, Montgomery, was advised as to the manufacture of casein on a factory scale, and was also supplied with the addresses of the firms who are large buyers of this article.

The Superintendent, Government Farm, Hissar, was supplied with a list of the latest publications on genetics of cattle, sheep and goats.

Mr. Shambhudial Kagzi, Manager of Rewari Gaushala, was supplied with pamphlets to enable him to start a co-operative cow preserving and breeding society in his district.

Delhi. Mr. P. P. Gupta, I.D.D., Manager, Gopal Dairy and Cattle Farm, Ltd., Delhi, sent to this office a complete scheme of a dairy farm for scrutiny and remarks. I visited the place in January 1930 and after inspecting the site and dairy, approved of the plan of buildings, inspected the cattle and arable lands and examined the financial position and gave him advice on the spot wherever it was necessary. This is one of the concerns launched out by an I. D. D. student of our Institute which testifies to the credit of tuition imparted therein.

Jammu and Kashmere. At the request of Colonel Jung, Personal Secretary to the Maharaja Bahadur of Jammu and Kashmere, this office submitted detailed schemes of dairy farms consisting of layout plans of dairy buildings with estimated cost, total estimated cost of capital expenditure, list of livestock with their cost, list of establishment and specifications of plant and machinery for both the farms at Jammu and Srinagar.

At the request of Mr. N. N. Kaul, I.D.D., of Srinagar, this office supplied him with a plan for a central milk factory with cold storage, specification of a complete pasteurising plant to handle 20,000 lb. milk

per day, estimated cost of capital expenditure, list of establishment and a trading account showing the probable profit of the first year's working.

Bhopal State. At the request of the Member for Public Health and Education, Bhopal, I submitted a complete dairy scheme consisting of layout plan of dairy buildings with their cost, estimated cost of live-stock, establishment and specification of plant and machinery, with their estimated cost.

Dhar. This office assisted the Remount Officer, Dhar State, in purchasing cattle for the State at Karachi.

United Provinces. Mr. Prem Sarup Caprihan of Agra was advised as to the places worth visiting on the continent of Europe in search of information regarding dairy industry.

Mr. Hunter of Barielly was supplied with the names of books dealing with breeding, feeding and management of goats.

The Upper India Dairy Supply Co., Bashirganj, was advised as to the modern method of manufacturing *ghee* on a large scale and the machinery required for the purpose.

Mr. S. C. Das Gupta of Lucknow was advised as to the best market for casein and casein glue in India.

Mr. M. D. Johnson of the Johnson Butter Factory, Aligarh, was advised to visit the Government Creamery, Anand, and observe the working of the various machinery there before purchasing a pasteurising plant, to enable him to turn out a uniform quality of butter.

At the request of the Secretary, Agricultural and Industrial Exhibition, Allahabad, Mr. S. Cox, Superintendent of the Imperial Cattle Breeding Farm, Karnal, was deputed to proceed to Allahabad to act as a judge at the Cattle Show.

Central Provinces. At the request of the Deputy Director, Animal Husbandry, Nagpur, I assisted him in selecting 20 cows and 15 heifers of the Hissar breed, in January, 1930.

Bihar and Orissa. At the request of the Director of Agriculture, Bihar and Orissa, I inspected the dairy plant which was installed in the dairy of the Civil Veterinary Department at Patna, on the advice of this office and found that it had been erected according to specifications. I also discussed cattle breeding and dairying matters with the Director while there in February 1930.

Central India. The Director of the Institute of Plant Industry, Indore, was advised as regards feeding sterilized bone-meal and ground lime to the work cattle, also where the bone-meal could be had from. He was also advised as to the feeding value of *chooni*.

Andaman Islands. At the request of the Chief Commissioner, Andaman Islands, the writer visited the Dairy Farm at Port Blair and submitted a detailed note suggesting improvements in the work of the various

branches of the farm. I also selected a number of cattle and arranged for their shipment to Port Blair for the dairy farm there.

Foreign Countries. At the request of the President, International Dairying Federation, Hague, Holland, the writer opined that " the method of taking samples from cheeses of different kinds " and the " chemical examination of cheese samples " advocated by the Federation were found suitable in so far as they related to Indian cheese products.

At the request of the Director, Imperial Bureau of Animal Genetics, Edinburgh, this office furnished a complete list of all the breeds of cattle in India, details of breeding work done by the Agricultural Departments and Indian States, control of breeding experiments, milk records and method of exchange of ideas in this connection.

Mr. Justin Kotelawala of Colombo was supplied with a complete scheme for starting a dairy with 160 acres of land near Colombo with a foundation stock of 50 cows and 2 stud bulls for the production of 500 lb. milk daily. The scheme indicated breeding policy, maintenance of records, detailed plans and specifications of buildings, pipe lines and plant and machinery required for the dairy.

Mr. David C. Kretzes of Manila (Philippine Islands) was supplied with a list of breeds of Indian cattle and a copy of the *Journal of Central Bureau for Animal Husbandry and Dairying in India.*

Articles written and reviewed. I contributed an article on " Hariana " cattle, and Mr. Kothavala the second instalment of the article on " City Milk Supply " in the *Journal of Central Bureau of Animal Husbandry and Dairying.* The following articles were edited by this office before being sent for publication :—

(1) A note on " Shrinkage of milk in pasteurisation " by Messrs. C. N. Dave and Harbans Singh, Post-graduate students.

(2) " An Investigation into the variation of fat and solids-not-fat, in cows' milk drawn at different times during the process of milking " by Mr. Z. R. Kothavala assisted by Messrs. Lal Chand Sikka, N. S. Iyengar, Karam Rasool and Kartar Singh, Post-graduate students.

" Methods of Livestock Improvement in Europe " by Mr. T. Murari, Superintendent, Hosur Cattle Farm, was submitted to me for opinion and the same was returned to the author with my remarks.

" A Laboratory Manual of Milk Inspection " by Mr. A. C. Aggarwala, Professor of Veterinary College, Lahore, was also reviewed by me.

IV. General.

During the year under review a scheme for the establishment and working of an experimental milk factory in Bengal was submitted to the

Imperial Agricultural Research Council. This scheme provides for the working of a village milk factory for one year by officers of this section for the purpose of solving milk transport and surplus milk disposal problems. The scheme was drawn up in consultation with the Agricultural and Co-operative Departments of the Government of Bengal which Departments are to co-operate in the carrying out of the work.

At the request of the Imperial Economic Botanist, this office supplied him with a detailed plan and estimates of buildings for the proposed Botanical Sub-station at Karnal Farm.

During the year research and investigation work was carried out by this Section as follows :—

(1) The manufacture of cheddar cheese with the use of vegetable rennet in place of animal rennet. (Imperial Institute of Animal Husbandry and Dairying, Bangalore.)

(2) Investigations into the neutralization of cream for butter-making (Imperial Institute of Animal Husbandry and Dairying, Bangalore, and Government Research Creamery, Anand).

(3) Experiment to ascertain the effects of interval between the morning and evening milkings on the quantity and quality of milk drawn (Imperial Institute of Animal Husbandry and Dairying, Bangalore).

(4) Investigation into the loss of milk during the process of pasteurisation (Imperial Institute of Animal Husbandry and Dairying, Bangalore).

(5) Investigation into the efficiency of two types of pasteurisation, *e.g.*, swing coil and glass lined pasteurisation (Imperial Institute of Animal Husbandry and Dairying, Bangalore).

(6) Investigation to determine the average period in days required for conception after calving in Scindi cows (Imperial Institute of Animal Husbandry and Dairying, Bangalore).

(7) Investigation to determine the variations in the milk yield and fat percentage of cows during a lactation (Imperial Institute of Animal Husbandry and Dairying, Bangalore).

(8) Investigation carried out with Montgomery and cross-bred animals to determine the best lactation period and the maximum yield that the animals of these two breeds give during their life time (Pusa).

(9) Comparison of the merits of different classes of cows bred at the Dairy Farm, Pusa (Pusa).

(10) Investigation into the prepotency of bulls used in the Pusa herd.

(11) Investigation into the village method of making *ghee* out of cream (Government Research Creamery, Anand).

(12) Comparative study of the cows of the Thar-Parkar and Hariana breeds as regards breed characteristics and milking quality (Imperial Cattle Breeding Farm, Karnal).

(13) Some observations regarding the relation of the season of the year to calving and milk yield of cows (Imperial Cattle Breeding Farm, Karnal).

(14) Some observations regarding the relation of feeding of minerals to regularity in calving (Imperial Cattle Breeding Farm, Karnal).

V. Karnal, Bangalore and Wellington Farms and Anand Creamery.

Karnal.

Mr. F. E. Traynor was in charge from 1st April to 24th April on which date he proceeded on one year's leave *ex*-India, and Mr. Cox took over and remained in charge for the remainder of the year.

The Farm has 2,154 acres of land of which 353 were under direct cultivation and 886 under *batai* (share system) and 242·5 on cash rental. The remaining 672·5 acres are for buildings and grazing areas. The chief crops grown were wheat, gram, rice and *jawar* and the outturn will be seen in Appendix I enclosed. On the rice lands small areas of peas, gram, berseem and linseed were tried. The peas gave a big outturn but the other three gave practically nothing. A larger area is being sown to peas on this rice plot during 1930-31. The Sugarcane Expert conducted some experiments with different varieties of cane and Pusa Institute also used some land for experimental purposes. It will be seen from Appendix I that the outturns have again slightly increased.

The Farm possesses the usual farm machinery and the following additions were made during the year :—1 Chaff-cutter, 1 Horse Mower, bullock draft, 1 Steam Engine with D. C. Motor, 1 Thrasher with Bhoosa Brusier and 1 Tractor complete with its accessories.

The strength of the herd at the commencement of the year was 787 and the total at the end was 890. 177 calves were born. 38 heifers calved. 110 cattle of all classes died (of which 85 were calves under 1 year) and 88 animals were sold. The calf mortality is the highest ever known on this farm, but it is hoped to reduce this considerably by making the pens sanitary. There was a very serious outbreak of foot and mouth disease, occasional cases of Black-quarter and some cases of Johne's disease.

The policy of the breeding of the Farm still remains the same. It still has 3 breeds of cattle, Thar-Parkars, Harianas and Murra buffaloes, and these breeds are kept pure and stud bulls of known pedigree are

used. At the end of the year there were 99 Thar-Parkar, 76 Hariana and 30 buffaloes. 116 completed a lactation during the year of which 49 were Thar-Parkar, 51 were Hariana and 16 were buffaloes. The strength of the sheep and lamb has increased from 153 to 195.

The average milk yield of the Thar-Parkar was 2,426 lb., of the Hariana 2,329 lb. and of the buffalo 3,763 lb., against Thar-Parkar 1,800 lb., Hariana 1,950 lb. and buffalo 3,600 lb. for 1928-29 and Thar-Parkar 1,965 lb., Hariana 1,905 lb. and buffalo 3,278 lb. for 1927-28, which shows a steady rise all over.

The following table shows the yield of 6 principal cows of the Thar-Parkar and Hariana breeds and Murra buffaloes which completed their lactation period during the year :—

Thar-Parkar Cows.

No. of animal	Approximate age	Milk yield 1929-30	Days in milk	Remarks
	years	lb.		
241	6½	5,523	430	Farm bred.
149	9	4,326	297	
247	5	4,155	329	Farm bred.
208	7	4,093	401	
266	3	3,993	339	Farm bred.
231	5	3,875	380	Farm bred.

Hariana Cows.

No. of animal	Approximate age	Milk yield 1929-30	Days in milk	Remarks
	years	lb.		
186	7	5,188	250	Hissar Farm bred.
108	10½	4,865	384	Cawnpore Farm bred.
157	8	4,707	460	
Sahiwal				
260	5	4,638	293	Ferozepore Farm bred.
142	9	4,456	319	Hissar Farm bred.
270	8	4,442	234	

Murra Buffaloes.

No. of animal	Approximate age	Milk yield 1929-30	Days in milk	Remarks
	years	lb.		
19	9	7,618	421	
16	10	5,660	301	
1	10	5,247	291	
10	9	4,749	258	
26	10	4,626	311	Farm bred.
28	9	4,496	279	

During the year 4 Post-graduates, 26 Indian Dairy Diploma, 8 Short Course and 14 students from the Allahabad Agricultural Institute were given instructions. The health of the students was good and they had the honour of winning the Volley Ball Tournament in the Karnal District Tournament.

Bangalore.

Lands and Cultivation. The rains during 1929 were very satisfactory with the consequence that the outturn of green fodder from irrigated land (mainly Guinea grass) was 57 per cent. over that of the previous year and the monsoon crop 47 per cent. in excess, although the area cultivated was slightly less. The overall production cost was Re. 0-3-8 per hundred lb. green against Re. 0-4-8 of the previous year.

Buildings and Plant. During the financial year under review a sum of Rs. 5,777-1 was expended for repairs to Buildings and Machinery. This included further extensions of steel pale fencing in replacement of old wire fencing. No new buildings were built this year, but a sum of Rs. 1,319-15 was expended in connection with the completion of buildings erected last year. The details are as follows :—

	Rs.	A.	P.
1. Drinking bowls purchased for the new cattle shed built last year (including Railway freight) . .	752	10	0
2. In full settlement of the bill for erecting new cattle shed last year	334	13	0
3. Electric light fittings to the Supervisor's quarters built last year	160	8	0
4. Conveyance allowance paid for supervising the new buildings built last year	72	0	0
	1,319	15	0

The following new machinery was purchased :—

1. One " Elin " Electric combined pumping set at a cost of Rs. 619-10-0.
2. One " Milwauke " milk filler and capper at a cost of Rs. 558-8.
3. One Cheese Vat at a cost of Rs. 745.

Buildings and machinery were maintained in good order.

Herd. 32 male calves and one female calf not required by the Institute were given away at birth.

During the previous year two very good milking cows (one half-bred and one three-fourth-bred) from a number which had been vaccinated against the disease in 1925 developed symptoms of Johne's Disease and became very emaciated. They were sent to Madras Veterinary College in April 1929 for examination. There was an out-break of Black-quarter in January 1930 at Bangalore Farm resulting in the death of one calf. Foot and Mouth broke out among the dry stock and young stock herd at Bommanpally in February 1930, but there were no casualties. One death during the year was that of an Ayrshire bull which suffered for 4 months from the after-effects of Foot and Mouth disease which broke out in the herd during March 1929. One casualty of more than normal interest was the death in April 1929 of " JILL," the famous Half-bred Ayrshire Hariana cow which, born on the farm in 1909, had 18 calves and produced 154,779 lb. of milk. Her average days in milk per lactation were 295 and her dry periods averaged 52 days each. From the date of her first calving in November 1912 to the date of her dropping her 18th calf in January 1929, her daily milk yield averaged 25·8 lb. calculated over the whole period.

The following table shows the yield of 6 principal cows which completed their lactation period during the year :—

Cross-bred cows.

Serial No	No of cows	Date of birth	No of calving	Quantity of milk given in lb.	No of days in milk	Remarks
1	523	24th Jan 1916	10	11,746	362	Half bred.
2	420-A	2nd Oct 1925 .	2	8,908	395	,, ,, (2nd lactation).
3	766	25th Sept. 1916 .	9	7,841	352	Three-fourth-bred.
4	388-A	27th Aug 1923 .	4	7,770	392	Half-bred.
5	975	4th Feb 1919 .	8	7,619	299	,, ,,
6	903	23rd Mar. 1918 .	9	7,098	339	,, ,,

Scindi cows.

Serial No	No. of cows	Year of purchase and present approximate age		No. of calving since arrival	Quantity of milk given in pounds	No. of days in milk	Remarks
		Year	Age				
1	11	1923	13½	5	5,316	355	
2	70	.	6¼	2	4,909	361	Farm bred
3	148	1928	9½	1	4,321	305	
4	125	1928	7	2	4,260	282	
5	110	1927	9¾	2	4,074	277	
6	93		4¾	1	4,041	435	Farm bred

During the year the Farm herd produced 5,4 8,815 lb. of milk which was supplemented by a purchase of 30,238 lb. mainly for feeding to calves. 3,63,276 lb. of new milk were sold to British and Indian Military hospitals, officers, civilians and troops at the two rates, *i.e.*, 2½ annas and 3 annas per lb., average being 0-2-11 per lb. 1,24,269 lb. were separated, 9,906 lb. cream and 4,073 lb. butter were manufactured from milk produced at the Institute. 14,615 lb. milk were used for the manufacture of cheddar cheese, the outturn being 1,198 lb. Of 1,14,4 50 lb. separated milk produced, 1,04,24 3 lb. were issued as feed of calves and 4,525 lb. were sold. The majority of the balance was wasted but certain quantities were used for experiment, cheese making and starter.

During the year there was no alteration in the price of milk and the Institute was able to meet fully the requirements of the Military besides many civilian customers. No purchased milk however was utilised for resale.

Breeding Policy. Still remains the same, *i.e.*—

(*a*) Best Scindi cows bred to selected Scindi bulls.

(*b*) Other Scindi cows bred to imported bulls either Ayrshire or Fresian.

(*c*) Half or three-quarter bred cows are crossed by Indian bulls of a known milking strain, generally a Sahiwal bull.

Education and Research work. At the beginning of the period there were 8 Post-graduate and other special course students and 1 short course student. Forty other students joined the Institute during the year.

The final examination of the Indian Dairy Diploma students was held at this Institute in November 1929 and out of the 27 students examined 22 were successful.

Wellington.

Farm lands. The Farm consists of 115·25 acres of land, excluding 6·08 acres of building site as detailed below :—

	Acres
Arable	35
Grazing	20·71
Leased land	52·54
Forest land for fuel	7
	115·25

Of the above land, 8 acres were put to potatoes with a view to clearing the land, 1 acre to lucerne and 52 acres to maize, *Jowar* and oats. The manure used was chiefly farm-yard manure with the addition of lime, bonemeal, sulphate of ammonia and concentrated super phosphate.

The rainfall during the monsoon as compared with last year was as detailed below :—

——	1928-29	1929-30
June	·79	5·48
July	2·70	2
August	3·82	2 38
September	·33	10·29
	7·64	20·15

As a result of this, and more land having been brought under cultivation, there was an appreciable increase in the outturn of green fodder and potatoes during this year as compared with last year as detailed below :—

——	1929-30	1928-29	Comparative Increase
	lb.	lb.	lb.
Green Fodder	6,63,120	5,53,187	1,09,933
Potatoes	1,18,214	36,458	81,756
TOTAL	7,81,334	5,89,645	1,91,689

The yields of different crops obtained during this and the previous years are as shown below :—

——	1929-30	1928-29
	lb.	lb.
Maize	134,675	115,590
Jowar	88,075	41,050
Oats	191,420	151,902
Lucerne	7,595	22,615
Green Mustard	1,410	..
„ Grass	170,400	154,415
„ Bedding	61,270	67,615
Oat Hay	8,275	..
TOTAL FODDER	663,120	553,187
Potatoes	*118,214*	*36,458*
Total Outturn	*781,334*	*589,645*

The policy of the Farm is to produce as much fodder as possible to supplement purchases and not to depend upon Grass Farm Department for our supply.

The Farm buildings consist cheifly of Dairy with office and Boiler room, Superintendent's and Supervisor's bungalows and Rest House. Additions were made during the year to New Model Cattle Shed and Milk Recording Room at a cost of Rs. 3,559-3-0. A pucca hospital for cattle is badly needed. This was asked for in the Budget for 1930-31, but was not sanctioned. This is an item of urgent necessity. Electrification of the Institute is most desirable, especially as all other Buildings in the vicinity have been installed with electric lights. The Dairy Institute is the only Government building not lit by electricity.

The chief items of machinery are :—

Horizontal Steam Engine, Portable Steam Engine, Two Vertical Boilers, Refrigerator, Cooler, Hydraulic Ram, Pasteurizer, Retarding Vat, Bottles soaking and washing machine and Chaffcutter, hand power and belt driven.

Herd. The different classes and breeds of animals maintained in the herd were as under :—

	No.
Ayrshire cows	15
Jersey cows	1
Ayrshire Jersey	1
Ayrshire Scindi	17
Ayrshire Hansi	2
Ayrshire Sahiwal	5
Ayrshire Tharparkar	1
Ayrshire Scindi Sahiwal	4
Half bred × Half bred	1
¾ Ayrshire Jersey	1
¾ Ayrshire Scindi	1
¾ Ayrshire Hansi	1
¾ Ayrshire Jersey Scindi	1
Holstein Hansi	2
Scindi	4
Hariana	13
Sahiwal	2
	72

The condition of the herd was not satisfactory, as most of the animals were suffering from the after-effects of foot and mouth disease, which had broken out twice during the previous year. For replacing casualties and condemnations during the year, 16 cows were acquired by purchase from Karachi, and 6 cows by transfer from Karnal Farm at an average cost of Rs. 4 82 and Rs. 313-8-0 respectively per each head.

The yields of six Pure-bred and six Cross-bred cows obtained during the year are as under :—

Pure breds.

Number and Name of cow.	Quantity given	In what period days
	lb.	
25 Kirk Christ Salley 9th	6,031	387
5 Priestlands Audry 5th	5,706	289
12 Priestlands Lucette	5,149	314
9 Cortachy Patiffa 2nd	4,211	396
22 Straith White Rose 14th	3,593	279
6 Priestlands Miss Alberta 2nd	3,560	312

Cross breds.

Number and Name of cow.	Quantity given	In what period days
200 Barbara	9,746	443
709 Dolly	7,598	327
199 Tulip	5,938	379
924 Poppy	5,215	384
838 Butterfly	4,486	327
706 Bess	4,470	388

The yields noted above are no comparison with those of the two preceding years, due to the animals in question being subject to the after-effects of foot and mouth disease.

The financial result of working of this Institute for the year under review shows a net loss of Rs. 14,725 against a net loss of Rs. 19,150 in the previous year. The loss is chiefly due to the substantial decrease in milk yield of the Farm herd, owing to the after-effects of foot and mouth disease which had broken out twice during 1928-29, the last outbreak being in March 1929 when every animal in the herd was affected just at a time when most of them were due to calve. This not only affected the yield of most of the animals by 50 per cent. but also caused the loss of many calves at time of birth, which might have been a valuable asset at the end of the year.

The yield of the herd for the first six months of the year 1929-30 was 1,14,349 lb., against 1,46,818 lb. for the same period during 1928-29 as detailed below, which shows a decrease of 32,469 lb. This decrease had to be supplemented by purchase in order to meet the demands for the station :—

——	1929-30	1928-29
	lb.	lb.
April	16,817	29,198
May	22,529	31,668
June	19,456	29,402
July	20,094	24,149
August	18,899	16,891
September	16,554	15,510
	114,349	146,818

Apart from the excess expenditure under "Purchase of Dairy Produce" incurred for the purchase of outside milk, increased expenditure will be found under the following heads also :—

(*a*) Repairs to buildings . .	For fencing the extra lands taken up' reroofing and overhauling fodder shed.
(*b*) Feed of dairy cattle . .	For feeding extra animals during the year as compared with the previous year.
(*c*) Pay of establishment . .	Extra temporary labour employed for cultivating more lands taken up and the increments to staff.
(*d*) House-rent and other allowances	Due to increments to staff.
(*e*) Miscellaneous contingencies .	On account of a new charge taken on as a liability for Stationery and Printing and supply of Books and Forms by Government of India Press, not charged for in previous years.

The following figures also account for the loss during the year :—

	Rs.
Casualties of livestock	2,326
Condemnation of livestock less sale proceeds . . .	4,970
Revaluation of livestock	490
Depreciation on buildings	1,120
Depreciation of plant and machinery	1,875

The value of dairy produce sold during 1929-30 was Rs. 76,222 against Rs. 77,708 during 1928-29, as detailed below. It may however be noticed that inspite of the increased sales of 5,635 lb. milk and 107 lb. butter during this year as compared with last year the value realised was lower owing to the reduction in sale rates :—

	1929-30		1928-29	
	Quantity	Amount	Quantity	Amount
	lb.	Rs.	lb.	Rs.
Milk	239,865	46,525	234,230	46,971
Butter	19,286	28,271	19,179	28,986
Cream	619	1,084	785	1,374
Cheese	85	146	75	131
Separated milk . . .	111	6	36	2
Butter milk	2,613	41	1,314	33
Sundry credit for sale of odd ounces of milk and butter.	..	149	..	211
TOTAL .		76,222		77,708

Anand.

The Creamery's working during 1929-30 was more successful than in the past years and has resulted in a profit of Rs. 13,807-7-0 on the commercial side against a loss of Rs. 225-2-3 in the preceding year.

A good deal of inconvenience was being felt on account of certain machinery which had become very old and useless owing to long usage; and efforts are being made to replace all such machinery gradually. The following were purchased and installed in the dairy during the year in replacement of the old condemned ones :—

(1) Two spiral coil cream ripening vats in replacement.

(2) An Alfa-Laval power separator type 4 2 direct belt driven of capacity 330 gallons was received during the year. This is to replace the old one which requires some repairs and replacements of certain main parts.

(3) A new electric motor was installed in place of the old unserviceable one to run the milk condensing plant at a cost of Rs. 388.

(4) A motor well pump run by electricity was newly installed in place of the old steam pump. This has resulted in a great saving of steam and oil and also prevents any lubricating oil dropping and affecting the purity of water to a great extent. The steam pump is also kept as a stand-by.

(5) D. C. Electric Dynamo (Compound wound) erected at a cost of Rs. 1,857 for generating electricity and a complement to the electric installation, in place of the old one which is now used to run the motor pump in the well.

(6) An electric meter was newly fitted up in the Superintendent's bungalow for recording the amount of energy consumed.

The question of accommodation to the students on their visit for training continues to be a problem, owing to the difficulty to secure comfortable rooms in the near vicinity of the creamery. Hence the urgent necessity for a hostel building inside the creamery premises is greatly felt. Creamery staff are also experiencing very great trouble in getting accommodation outside ; and residential quarters for staff, whose presence is always needed, may be constructed.

The trade of the creamery was greatly increased during the year under review as the comparative statement of sales will show :—

——	1928-29			1929-30		
	Rs.	A.	P.	Rs.	A.	P.
Butter	71,073	5	0	80,340	12	0
Separated milk	3,37,796	0	0	45,625	0	0
Yellow ghee	2,331	7	0	5,690	4	0
White ghee	845	6	0	785	14	0
Casein	15,756	4	0	13,915	4	0
Cream	23	10	0	44	7	0
Cheese	49	4	0	38	12	0
Milk	415	0	0	360	0	0
Butter "C"	611	0	0	55	0	0

The whole lot of cold stored butter which was held in stock at the beginning of the year was gradually disposed of during the period under report. A part of it was sold as such and the rest after turning into *ghee*. The demands from the Military Department greatly increased during the year. Just at the close of the year the creamery had taken in hand to supply butter both bulk and in small tins to almost all the Military Dairies in the Southern Circle and to the Supply and Transport Department.

Though the sales effected month by month throughout the year have remained nearly constant, the purchase rates of milk have periodically varied and were favourable and hence the trading results from the commercial side are encouraging. The creamery has been working a single shift from May 1929, thereby great savings have been effected in general stores, such as chemicals, oils and coal, etc.

Experiments and demonstrations. During the year under review experiments in the transportation of pasteurised whole milk to Bombay city were made through the agency of Messrs. R. Ramaniklal & Co. Trial cans were sent for some time to see if the milk would keep when thoroughly pasteurised. But certain difficulties such as the difference in taste of pasteurised milk, late deliveries due to irregular arrivals of Mail trains at Bombay were experienced. To avoid cream coming to the top and forming a hard cake, the milk will have to be homogenised and so a modern homogenising plant may be installed.

Trials in the manufacture of Rennett casein were also undertaken during the year and the samples of the resultant product have been sent to England for analysis, and a report about its quality and usefulness is awaited.

The creamery participated in the Agricultural Shows held at Allahabad, Kholapur and Dhubulia by sending its exhibits of dairy products.

Training. Five Post-graduate students from different provincial Governments and 3 Short Course students attended courses at this creamery during the year. Every possible assistance in their training was given them to study the conditions of village dairy industry in Gujerat. They were also taken to the Chharodi and Baroda Dairy Farms where they were shown the study of Gir and Jafarbadi cattle.

Twenty-seven I. D. D. students from Allahabad Agricultural College in charge of their Professor stayed at the Creamery for a fortnight during which period they were given a short course of practical training in butter making on a factory scale, casein making and the manufacture of condensed milk.

A party of 70 agricultural and dairy students belonging to the Poona Agricultural College paid a visit to the dairy during the year. They were shown round all the working here including the process of butter

manufacture in large power churns and the making of casein, etc. They evinced a lot of interest in what all was shown to them.

Experiments in the manufacture of casein are also conducted here. The drying of curd during monsoon is much disturbed and a keen necessity for a casein drying machine is felt which would increase the quality of the stuff thereby fetching a reasonable price for the quality.

General. The existing buildings, plant and furnishing were maintained in perfect condition throughout the year with periodical petty repairs and renewals. The creamery during the year was attended by several interested visitors.

Throughout the period under review Mr. M. C. Rangaswamy, I.D.D., was in charge of the institution.

The combined receipts and expenditure statement of Karnal, Bangalore, Wellington Farms and Anand Creamery for the year 1929-30 will be found in Appendix IV.

APPENDIX I.

Outturn of Grain and Fodder from the Imperial Cattle Breeding Farm, Karnal, during 1929-30 as compared with two previous years.

Particulars	1927-28	1928-29	1929-30	Difference	
				Plus	Minus
	Mds. sr. ch	Mds sr. ch	Mds. sr. ch	Mds. sr. ch.	Mds. sr. ch.
Grains.					
Gram	2,114 7 0	3,986 34 8	3,941 31 0	..	45 3 8
Barley	381 32 8	127 10 0	666 20 0	539 10 0	
Wheat	4,207 26 0	6,222 19 0	8,139 15 0	1916 36 0	..
Zirt	2,816 2 4	4,701 27 2	4,237 0 14	..	464 26 4
Toria	155 36 8	..	.	..	..
Gur	274 36 8	.	..	..	..
Sugarcane Seed	3,110 15 0	..	..	..	.
Sanee seed	42 0 0	..	.	..	..
Masri	21 19 0	0 25 0	1 7 0	0 22 0	..
Sanee Fibre	8 30 0	..	..	..	.
Linseed	..	26 30 0	3 37 0	..	22 33 0
Peas seed	..	..	10 7 0	10 7 0	..
TOTAL	13,133 4 12	15,065 25 10	16,999 37 14	2,466 35 0	532 22 12
	lb.	lb.	lb	lb.	lb.
Fodders.					
Charri Green	878,176	37,200	289,260	252,060	..
Charri dry	3,600	111,600	72,800	..	38,800
Feeding Hay	112,840	41,600	40,950	..	650
Green grass	1,215,824	..	13,600	13,600	..
Green oats	28,020	4,600	..	..	4,600
Rice straw	281,200	230,000	250,000*	20,000	..
Bhoosa mixed	800,560	1,066,577	1,419,514	352,937	..
Green gram	..	..	62,800	62,800	..
Charri silage	..	3,000,000	3,697,920	697,920	..
Green Barley	..	1,000	..	..	1,000
TOTAL	3,320,220	4,492,577	5,846,844	1,399,317	45,050

* Estimated—as it was sold standing.

APPENDIX II.

Statement showing outturn of fodder grown on the farm lands during the year from 1st April 1929 to 31st March 1930 at the Imperial Institute of Animal Husbandry and Dairying, Bangalore and Dry stock farm attached to it.

Where grown	Kind of fodder	Acreage	Outturn in lb.	Total cost	Cost per 100 lb.	Remarks
				Rs. A. P.	Rs. A. P.	
Bangalore	Green guinea grass	8·30	1,058,310	2,591 5 11	0 3 11	
	Green lucerne	1·14	81,739	755 1 1	0 14 10	High cost due to preparation of a new plot.
	Green *Jowar* and Maize	57·78	1,470,870	2,869 0 1	0 3 2	
	Green grass	..	256,505	343 1 8	0 2 1	
	TOTAL	..	2,867,424	6,558 8 9	0 3 8	
Bommanpally	Green *Jowar*	..	174,600	388 8 8	0 3 7	
	Green guinea grass	..	15,730	30 14 4	0 3 2	
	TOTAL	..	190,330	419 7 0	0 3 6	
	GRAND TOTAL	..	3,057,754	6,977 15 9	0 3 8	

APPENDIX III.

Statement showing outturn of grain and fodder crops of the Imperial Institute of Animal Husbandry and Dairying, Wellington, during the year 1929-30.

Name of Dairy	Total area of the land in possession of the Farm			1929-30							Remarks
	Arable	Grazing	Building site, etc	Total area of land under cultivation	Total outturn in green	Total expenditure incurred on cultivation	Production rate per 100 lb.	Total fodder purchased in green	Total amount paid for purchased fodder	Average rate per 100 lb.	
	Acres	Acres	Acres	Acres	lb	Rs A P.	Rs A P	lb.	Rs A. P.	Rs. A. P	
Imperial Institute of Animal Husbandry and Dairying, Wellington	35	20 71	6·08	35	663,120	7,540 8 0	1 2 2	964 512*	7,398 0 0	0 12 3	* Purchased as dry fodder, 3,85,805 lb. and reduced in terms of green as 1 : 2 ½ lb.
	Leased		forest land		Potatoes						
	26	26·54	7	26	118,214	..	.	34 960	186 1 0	0 8 6	Purchased as green fodder.
	Land		for fuel								
	61-0	47·25	13·08	61-0	781,334	7,540 8 0	1 2 2	999,472	7,584 1 0	..	

APPENDIX IV.

Statement showing receipts and expenditure of the Imperial Institutes of Animal Husbandry and Dairying, Bangalore and Wellington, Imperial Cattle Breeding Farm, Karnal, and the Government Creamery, Anand, for the year 1929-30.

APPEN

Statement showing receipts and expenditure of the Imperial Institutes of Cattle Breeding Farm, Karnal, and the Govern

Heads of Receipts	Total receipts (cash and book debit combined)			
	Karnal	Bangalore	Wellington	Anand
	Rs	Rs.	Rs	Rs
Dairy Produce				
On credit	17,610	64,027	58,301	1,09,187
On cash	2,385	9,546	6,728	4,151
On coupons	.	31,025	9,416	.
Total	19 995	1,04,598	74,445	1,13,338
Capital Receipts.				
Livestock, dairy	4,784	3,105	1,521	..
Livestock, draught	190	79	55	.
Plant and machinery	.	13	..	467
Total	4,974	3,197	1,576	467
Miscellaneous Receipts.				
Grain and fodder	54,655	857	538	..
Fees from students	2,563	3,694	17	270
Other Miscellaneous—				
Receipts	4,071	3,742	6,294	19,783
Sale of skins	60	14	.	..
Total	61,349	8,307	6,849	20,053
GRAND TOTAL	86,318	1,16,102	82,870	1,33,858

DIX IV.

Animal Husbandry and Dairying, Bangalore and Wellington, Imperial ment Creamery, Anand, for the year 1929-30.

Heads of Expenditure	Total Expenditure (Combined cash and book debit)			
	Karnal	Bangalore	Wellington	Anand
Supplies and Services.	Rs.	Rs.	Rs.	Rs.
Lands, buildings and accessories	..	1,320	3,809	..
Plant and machinery	29,990	2,182	..	8,928
Purchase of dairy cattle	7,195	14,301	7,718	..
Purchase of draught cattle		.	..	..
Total of Capital items	37,185	17,803	11,527	8,928
Rent and repairs to buildings	18,041	2,966	1,732	1,090
Repairs to plants, machinery and workshop	3,639	2,811	1,698	3,670
Feed of dairy cattle including grazing charges	34,879	54,103	26,470	..
Hire of cattle and purchase of dairy produce	.	26,785	34,566	72,091
Ice, salt, acid preservatives	1,127	559	100	1,098
Production of grain and fodder, cultivation charges	14,806	1,569	4,483	..
Fuel, light, water and miscellaneous stores	8,312	18,689	3,983	11,821
Freight on stores	672	1,840	1,341	9,750
Medical stores	1,071	..	678	..
Refund of coupons and deposits	6	..	206	90
Contingencies	2,339	2,539	2,128	2,489
Establishment	41,366	35,967	22,548	14,723
Allowances	1,828	2,609	594	776
Total of Revenue items	1,28,686	1,50,437	1,00,527	1,17,598
GRAND TOTAL	1,65,871	1,68,240	1,12,054	1,26,526

REPORT OF THE PHYSIOLOGICAL CHEMIST.

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

I. CHARGE, STAFF AND TOURS.

Charge. I held charge of the Section throughout the year.

Staff. Mr. A. Viswanatha Iyer, First Assistant to the Physiological Chemist, was on privilege leave for two months and thirteen days from the 19th May 1930 and Mr. N. C. Das Gupta was appointed to officiate as First Assistant during that period. Mr. N. S. Sankaranarayanan, Fieldman, was deputed temporarily for one year to carry out feeding tests at the Military Dairy Farm, Kirkee.

Tours. I visited (1) Hosur Cattle Farm and the Imperial Institute of Animal Husbandry and Dairying, Wellington, in connection with the feeding experiments to be carried out at these two stations; (2) Pusa, to attend the meeting of the Board of Agriculture; and (3) Dehra Dun, to inspect the X-ray Institute for the purpose of drawing up a scheme for the establishment of an Animal Nutrition Institute there.

Mr. A. V. Iyer, First Assistant, and Mr. T. S. Krishnan, Laboratory Assistant, attended the meeting of the Indian Science Congress held at Allahabad in January 1930. Mr. A. V. Iyer visited Dehra Dun also, to inspect the X-ray Institute and to submit proposals as to how best to utilise the present buildings there for the proposed Animal Nutrition Institute.

II. LABORATORY WORK.

The following is a list of analyses completed during the year :—

Complete analyses :—		
1. Fodders	106	
2. Fæces	105	
		211
Partial analyses of fodders		12
Dry matter in fæces, urine, fodders, etc.		2,095
Single Nitrogen determinations :—		
1. Fresh fæces	185	
2. Fresh fæces after pepsin treatment	158	
3. Milk	142	
4. Urine	132	
5. Fodders	55	
		672
Mineral analyses of soils, urine and fodders		131
Complete analyses of urine		221
Miscellaneous analyses :—		
1. Hippuric acid in urine	73	
2. Paracresol in urine	72	
3. CO_2 in urine	110	
4. PH in urine	140	
5. NH_3 in urine	150	
6. Chlorides in urine	96	
7. Silage extracts	18	
		659
TOTAL		4,001

III. Plans for the Establishment of a New Animal Nutrition Institute.

At the request of the Government of India, I inspected the X-ray Institute at Dehra Dun to report on its suitability as an Animal Nutrition Institute. This Institute was found to be admirably suited for the proposed purpose, and, acting on orders of Government, I have prepared and submitted new detailed plans with full estimates for the conversion.

IV. Work of the Section during 1929-30.

1. *Experiments on nutrition of growing animals.* An experiment on the nutritive value of gram husk showed that this food could be used as a substitute for wheat bran under certain circumstances. With the rations used both foods improved the consistency and palatability of the ration, both brought about approximately parallel increases in food consumption and in live weight. Digestion experiments showed that gram husk possesses a distinctly lower Starch Equivalent value than wheat bran, and, in contrast to wheat bran, it provides no digestible protein whatever. Comparing Starch Equivalent values of the mixed rations with the observed nutritive effect it was concluded that the relatively higher American values correspond more closely to the effect observed in this experiment. The data obtained have been issued in the form of a Memoir, " The Nutritive Value of Gram Husk ", Vol. XI, No. 5, Chemical Series (In the press).

The Hosur calf feeding experiments yielded some definite results of interest. The enhanced value of early cut hay is shown by the following figures :—

	Food consumption in lbs. Dry Matter per day.		Average live weight increase in 100 days.
	Fodder.	Concentrate	
Early cut hay	9·24	3·41	66·5
Mature hay	8·01	3·34	20·5

The better productive power of early cut hay is due partly to better consumption and partly to its high digestibility. These experiments with early cut hay indicate a line along which the nutrition of cattle in India can be improved. The starch equivalent values of the rations consumed in tests made during three consecutive years have been calculated (*a*) according to European standards, (*b*) according to American standards. The figures are given in the accompanying table.

Starch Equivalent Values of Rations.

Experiment.	Nutritive effect from live weights.	Kellner's Starch Equivalent value of ration.	Excess of Kellner value over live weight value.	American Starch Equivalent value of ration.	Excess of American value over live weight value.
1926.					
Hay and concentrate . .	3 40	3 29	—·11	3 62	+·22
Silage and concentrate . .	3·95	4 14	+·19	4 44	+·49
1927.					
Hay and concentrate . .	4 00	3·46	—·54	3·86	—·14
Silage alone	3·25	2 82	— 43	3·49	+·24
1928.					
Low concentrate and young hay	4·97	4·74	—·23	5·70	+·73
Low concentrate and mature hay.	4·21	4·09	—·12	4 58	+ 37
Low concentrate and silage .	5 22	4 86	—·36	5·75	+ 53
High concentrate and young hay.	5 58	5 20	—·38	6·15	+ 57
High concentrate and mature hay.	4·43	4·38	— 05	4·85	+·42
High concentrate and silage .	5·69	5·59	—·10	6·53	+·84
AVERAGE .	4·470	4 257	— 213	4·897	+·427

The evidence from this table can be stated very briefly. In nine tests out of ten the European estimate is lower and the American estimate higher than the value obtained from live weight data. The Hosur experiments have been summarised up to date in a Memoir (Vol. XI, No. 3, Chemical Series). Further experiments have been commenced at Hosur.

At Bangalore an interesting experiment on the comparative values of two fodders for growing heifers is in progress. Three groups of animals are under trial, one group on each of the two fodders and the third group on a mixed ration of the two fodders. On theoretical grounds the mixed ration should give better results than the mean of the two

fodders fed singly. At present there is no evidence of an enhanced value in this particular mixture.

An experiment on Iodine feeding to young calves has also been undertaken at Bangalore. At this stage a positive statement cannot be made but there are distinct indications that Iodine is producing beneficial effects.

2. *Experiments on milk production.* The tests undertaken in 1928 to compare the values of some common oil cakes were continued and brought to a conclusion during the year under report. The results obtained have been published in two papers in *Journal of the Central Bureau for Animal Husbandry and Dairying in India* (Vols. III and IV, Parts 3 and 1 respectively).

An extensive experiment on rationing for milk production has been organised in collaboration with Lt.-Col. J. Matson, Assistant Controller of Military Dairy Farms, to be carried out at the Government Military Dairy Farm, Kirkee. The work has now been in progress for about three months and is proceeding satisfactorily. The splendid live stock resources of this dairy (we are using over 100 cows and 80 buffaloes in our tests) offer a unique opportunity for experiments on a large scale from which data can be procured for statistical treatment. In this experiment it is hoped also to determine the relative efficiency of cows and buffaloes for milk production.

An experiment has been commenced at Bangalore to determine the relative merits of high and low silage feeding. It appears from these trials that, for periods extending up to two months, cows can make up for a shortage of silage by eating more *ragi* straw. This experiment is bringing out a number of important points and will be continued to the end of the lactation period.

3. *Indian coarse fodders.* The examination of typical hays has been continued on the lines already indicated. The results obtained during the past three years on this subject have been collected together and published as a Memoir. The most striking fact in this summary is the observed range of protein content which has been found to fluctuate between 18·0 per cent. and 1·9 per cent. These wide variations are attributable mainly to (*a*) characteristics of species, (*b*) the stage of maturity. Graphic representation of the data has revealed the fact that the digestibility of all ingredients is related to the protein content of the fodder. Based on these results a graphic method has been developed for estimating the nutritive values of fodders. The graphic method has also shown that the digestibility of carbohydrates is at times seriously depressed through unknown causes. A means is thus provided for studying the causes of depressed digestibility. In the course of this work efforts were made to study the effect of maturing on nutritive value. The following results are instructive.

Effect of maturing on the nutritive value of hay.

Source of hay.	Stage	DIGESTIBLE NUTRIENTS PER 100 LBS. DRY MATTER.			
		Crude Protein.	Carbo-hydrates	Total Organic matter.	Starch Equivalent Kellner.
Hosur spear grass hay	Early	2·9	51·4	55 1	38 0
	Ripe	..	50 2	50·1	30·7
Bolarum Rukh hay	Early	2·5	48 7	51 6	32 9
	Prime	1·2	49 7	51·7	33 0
	Ripe	..	47 0	46·9	26·0
Kolukattai hay, Hosur	Early	10 7	47 6	59 4	44 2
	Prime	5 5	49 6	55·8	39 0
	Ripe	3 0	49 5	52·7	34·8

It is seen that with advancing maturity the amount of digestible protein and the Starch Equivalent value decrease steadily in every case. These figures are highly significant for the cattle feeding problem in India.

4. *Experiments on maturing of crops.* A few experiments were carried out during the year under report to complete a preliminary enquiry into this subject. All the necessary data have now been procured. Further developments must depend upon the conclusions arrived at from the work that has been done.

5. *Mineral requirements of cattle.* Physiological studies carried out by the Nutrition Section on the acid-base balance of cattle urine indicate that urine reaction and urine composition may at times possibly influence mineral assimilation. Feeding tests with heifers on two selected fodders have been instituted to test this important point. The experiment is likely to proceed without a break for two years. An experiment on Iodine feeding has been referred to already. Further Physiological studies at Bangalore have indicated that sulphur metabolism is worth studying in certain cases. Accordingly, a feeding experiment has been started to study this question.

6. *Indian pasture grasses.* The work on pasture grasses has been placed on an entirely new footing this year. At the request of the Physiological Chemist, Officers of the Imperial and Provincial departments of agriculture have kindly offered to grow a number of pure species on selected sites. Ten stations scattered in different parts of the country and representing the chief soil and climatic conditions are now growing seed distributed from one source. In due course, information rela-

ting to growth, yield, maturing and chemical composition of the crops from each station will be obtained.

7. *Protein digestion.* The experiments on protein digestion were explained at length in last year's report. Proceeding on these lines, data have been obtained for a number of the most common Indian concentrates. The work has been brought to an end, for the time being, and the results will be published shortly.

8. *Silage investigations.* A full examination of *Jowar* silage made from crops at different stages of development and under different conditions of packing have been carried out during the past year. This enquiry is nearing completion.

Silage from cereal straw. During the past year feeding and digestion trials were carried out with *ragi* straw silage. The silage produced from *ragi* straw was of a mildly acid type with the characteristic odour of silage. It was readily eaten by young animals. A comparative feeding test with *ragi* straw and *ragi* straw silage gave practically identical results for these two fodders. Under the conditions of the trial, therefore, the silage offers no advantage whatever. It is desirable to do tests under conditions in which the silage may be expected to be beneficial. This year rice straw silage has been prepared. It will be tested shortly.

9. *Physiological studies.* (*a*) *Diuresis.* In this study a new phase has been reached. During the past three years the diuretic effect of fodders has been recorded systematically and a considerable amount of information has been collected. While this work was in progress it was observed that certain animals gave exceptional results always. A scheme of work has now been organised to study the peculiarities of these animals and to determine how far anomalous urination affects metabolism.

(*b*) *Hippuric Acid excretion.* The work reported last year has been continued and data have been collected relating to a considerable number of typical Indian fodders. A similar enquiry has been instituted into the production of phenolic substances by fodders. It has been found that the yields of Phenol and Benzoic acid generally run parallel to one another, the ratio Phenol-Benzoic acid being almost the same for a number of different fodders. A few fodders, however, have been found to give values which depart consistently from the general average. There is no doubt that the Benzoic acid and Phenol are derived from the lignin and lignin precursors present in the fodders. A study of lignin and its digestion has therefore been commenced. The object of this work is two-fold. In the first place it is desired to study the origin of Benzoic acid and Phenol. In the second place it is intended to determine the effect of lignification upon the digestibility of fodders.

(*c*) *The Acid Base Balance of Cattle Urine.* Experiments have been continued on the lines described in last year's report. A simple and

efficient method has been devised for determining organic acids and alkalis present in urine by one single operation, using potentiometric titration. With this process the urines from three types of fodders, namely green fodders, overripe grass and cereal straws have been examined and characteristics for each type established. The results of these experiments have been embodied in a paper which has been submitted for publication. A subsidiary point revealed in the course of this work is that certain fodders are distinctly deficient in Chlorides.

Feeding experiments have been initiated to determine the influence of certain urine characteristics upon nutrition and growth.

(*d*) *Sulphur Metabolism.* Preliminary observations by the Physiological Chemist have shown that the Sulphur content of many Indian fodders is low and that this low Sulphur content of the food is reflected in the composition of the urine which often contains no more than a trace of free Sulphate. Out of 20 fodders tested only 3 yielded considerable quantities of free Sulphate in the urine. New processes have been developed for this work and metabolism experiments have been initiated to determine the Sulphur requirements and Sulphur supply under certain specific conditions.

V. Training of Post-Graduate Students

During the past year four students went through the post-graduate course. In addition, one special research student went through a course of training. Five students are attending the course this year.

VI. Instruction Provided for Dairy Diploma Students.

The usual courses of lectures on chemistry and animal nutrition were given to the Dairy Diploma students.

VII. Co-operation with Other Departments.

(1) *Madras Department of Agriculture.* Feeding experiments have been commenced again at Hosur Cattle Farm this year. Owing to an outbreak of Rinderpest in the vicinity, the work has been temporarily stopped, but it will be taken up again when inoculation has been carried out. The Madras department has once more helped this section by lending animals for experiments at Bangalore.

(2) *Military Farms Department.* The Section is engaged on a large scale co-operative experiment at the Government Military Dairy at Kirkee.

(3) In the work on pasture grasses the Section is receiving help from the Imperial Institute of Agricultural Research, Pusa, and also from the Madras, Bombay, Bengal and Bihar and Orissa Departments of Agriculture.

VIII. Publications.

The following papers were sent in for publication during the year under report :—

(*a*) *Memoirs of the Department of Agriculture in India, Chemical Series* :—

1. Silage Investigations at Bangalore by T. S. Krishnan, B.A., Vol. X, No. 10.
2. Feeding Experiments at Hosur, 1926, 1927 and 1928, by F. J. Warth, M.Sc., Vol. XI, No. 3.
3. The Nutritive Values of Some Typical Indian Hays by F. J. Warth, M.Sc., Vol. XI, No. 4.
4. The Nutritive Value of Gram Husk by F. J. Warth, M.Sc., and Lal Chand Sikka, B.Sc. (Agri.), Vol. XI, No. 5.

(*b*) Articles in the *Journal of the Central Bureau for Animal Husbandry and Dairying in India* :—

1. Some Difficulties in Assigning Reliable Starch Equivalent or Net Energy Values to Indian Fodders, by F. J. Warth, M.Sc., Vol. III, Part IV, January 1930.
2. The Effect of Some Oil Cakes on Milk Secretion, Part II, by the Post-Graduate students in the Animal Nutrition Section, Vol. IV, Part I, April 1930.

(*c*) The Influence of Food-Stuffs on the Acid-Base Balance of Cattle Urine, by F. J. Warth, M.Sc., and N. Krishna Ayyar, B.A. (Submitted for publication.)

IX. Programme of Work for 1930-31.

Major subjects.

1. Experiments on the nutrition of growing animals. This work involves tests at Bangalore and Hosur.

2. Experiments on milk production, a continuation of the work reported this year.

3. A study of Indian coarse fodders, including determinations of maintenance rations and studies of nitrogen and mineral metabolism. This is a continuation of the systematic work commenced during the past year at Bangalore.

4. Indian pasture grasses, the special enquiry described in this year's report.

5. Silage experiments on the lines laid down.

6. Physiological studies on the lines laid down.

Minor subjects.

1. A study of the chemical methods employed in the above enquiries.

2. Preliminary experiments for the initiation of work on other aspects of nutrition.

Training.

1. The training of post-graduate students, which is an important branch of the work of this Section, will be continued as usual.

2. For the Dairy Diploma students a course in general science, plant chemistry and nutrition will be provided by this Section.

REPORT OF THE GOVERNMENT SUGARCANE EXPERT.

(Rao Bahadur T. S. Venkatraman, B.A.)

I. Charge and Staff.

I held charge of the office of the Government Sugarcane Expert during the year under report except for about a fortnight towards the beginning of the year when I was on deputation in Java attending the Third Convention of the International Society of Sugarcane Technologists. At that Convention I was elected Chairman for the section on "Varieties including propagation and selection" for the next three-year period. Mr. Nand Lall Dutt, M.Sc., held charge of the office of the Second Cane Breeding Officer during the whole year.

The post of gazetted Assistant to the Second Cane Breeding Officer was split up into three posts in the subordinate service, the clerical staff being strengthened by the addition of a store clerk.

II. Sugarcane × Sorghum Hybrids.

(*a*) *Object.* One of the obstacles to a larger extension of sugarcane cultivation has been its long duration, occupying the land as it does for at least a whole year. Again, there would appear to be a definite use for sugarcanes which would mature earlier than any extant kinds, as such varieties would help in increasing the number of working days in a factory, an obvious factor in further cheapening cost of manufacture. The idea was therefore conceived of crossing sugarcanes with shorter duration crops like the cereals. With this object sugarcane (P. O. J. 2725) was crossed with *Andropogon Sorghum* (*Jowar* or *cholam*) and other cereals. P. O. J. 2725 was selected as the mother parent on account of (1) its being a desirable type of cane; (2) its character of free seed setting under Coimbatore conditions; and (3) the practical absence of open anthers and fertile pollen. The cross between P. O. J. 2725 and *Andropogon Sorghum* yielded plenty of germinations, the control, unpollinated P. O. J. 2725 as also the other Sugarcane × cereal crosses, yielding no seedlings. This success would not have been possible but for the unique enthusiasm and application of my chief Botany Assistant, M. R. Ry. R. Thomas, to whom my grateful thanks are due.

(*b*) *Characters of the hybrids* (*chiefly vegetative*). (i) *Shape of first leaf.* The first indication of success was seen in the shape of the first leaves, these being distinctly broader and shorter than those of sugarcane seedlings.

(ii) *Colonization by Aphis maidis.* *Aphis maidis* has not so far been noticed to colonize freely on sugarcane seedlings at the station. Certain of the Sorghum hybrids, however, showed heavy infestations. Alongside of the Sorghum hybrids two sugarcane hybrids—*viz.*, (1) P. O. J. 2725×B. 3412 and (2) P. O. J. 2725×66 White carp—were planted for a proper comparison in respect of various characters.

(iii) *Leaf characters.* In leaf module, surface contour, and presence of wax, the Sorghum hybrids were quite distinct from the other sugarcane hybrids, taking obviously after Sorghum in certain respects.

(iv) *Leaf behaviour on fading.* On fading, the leaves of P. O. J. 2725 and of the hybrids between P. O. J. 2725 and sugarcanes, show a definite inrolling of the two lamina halves. Those of *Andropogon Sorghum* (Periamanjal* of Coimbatore which was used as the male parent), on the other hand, fold on the midrib. The leaves of certain of the Sorghum hybrids behave like those of *Andropogon* on fading. It has been found that this behaviour on fading is correlated with an interesting difference in the structure of the lamina.

(v) *Stem characters.* Certain of the hybrids show but a single row of root eyes on the root zone like the stems of Sorghum, against the two to four rows of root eyes of the sugarcane.

Other characters in the hybrids, obviously derived from the Sorghum, are (1) the characteristic ' stilt ' roots of Sorghum ; (2) the bud grooves extending along the whole length of the internodes ; and (3) the shape and structure of the buds.

(vi) *General.* The hybrids include a very wide range of forms, certain of them showing off more like fodder grasses with a good amount of broad and soft leaves.

(c) *Ripening and juice quality.* (i) *Short duration.* Sugarcane seedlings are planted in the test plots at the Coimbatore station generally between February and April ; and in these plots none of the seedlings shows signs of maturity till December of the year. The great majority of them do not ripen till between ten to twelve months from the time of planting. Certain of the Sorghum hybrids—about half a dozen of them—have already ripened off, *i.e.*, in about five months from the date of planting, and have been planted from setts (cuttings) for multiplication.

(ii) *Character of the juice.* Certain of the hybrids which have ripened off in this short period of five months have shown in the juice over 16 per cent. sucrose and over 85 per cent. purity. There are still other seedlings which are expected to ripen within the next few days.

It would therefore appear possible that certain of these intergeneric hybrids might yield very short duration sugarcanes ripening perhaps

* Recently identified by Kew as *Sorghum Durra*, stapf.

as early as five to six months, but very likely inferior in tonnage to the usual full year crops of sugarcane.

(*d*) *Vegetative propagation of the hybrids.* It needs to be mentioned here that, though the Sorghum hybrids do show distinct characters obviously derived from the Sorghum parent, the general look of the bulk of the seedlings is more like that of the sugarcane. An attempt was made to propagate in the vegetative manner the Sorghum parent employed in this cross. It was found that the Sorghum could be propagated in this manner and that the sett-grown Sorghums flower about a fortnight earlier than seed-grown Sorghums. No difficulty need therefore be expected in the vegetative propagation of any useful types that might result from the hybrids between the sugarcane and Sorghum. About a dozen of these have already grown freely and easily from cuttings.

(*e*) *Future work.* Though certain of the Sugarcane × Sorghum hybrids are of a satisfactory vigour of growth, yet the majority of them are not quite up to the mark in this respect. It is proposed to try and introduce, if possible, a greater general vigour in the hybrid population by employing as parents Sorghums with a greater vigour of growth and attempting hybridization with other vigorous growing cereals.

III. Research and Investigations.

(*a*) *Sugarcane breeding technique.* The Coimbatore isolation method for crossing varieties gave very satisfactory results during the year. This has been the case for some three years now and the method might be taken as well suited to Coimbatore conditions. The Hawaiian method of preserving arrowing sugarcanes in SO_2 solution for crossing purposes was again tried during the year with the same disappointing results in the matter of seed setting.

(*b*) *Controlling time of arrowing.* Experiments to control the time of arrowing yielded fairly satisfactory results during the year, the two factors found useful being differences in times of planting and manurial treatments. Phosphatic manures were found to hasten the flowering and both nitrogenous and organic manures to retard it. An interval of about twenty to thirty days between the usual times of arrowing of parents was bridged by a combination of the two factors mentioned.

Attempts to influence the time of arrowing through injection into the canes of toxic or stimulant chemicals did not yield any definite results during the year.

(*c*) *Possible effect of manuring on the germination of the subsequent crop.* When planting the next year plots for " controlling time of arrowing by application of different fertilizers ", it was thought advisable to obtain the planting material from plots differently manured with a view to try and accentuate the differences in times of arrowing already

obtained from differences in manurial treatment. It was found that material from plots to which organic or nitrogenous manures had been applied, gave a distinctly better germination than those from plots treated with phosphates. The results are interesting and will be repeated for confirmation in subsequent years.

(*d*) *The breeding programme.* The large scale hybridization referred to last year has resulted in a marked increase in the vegetative vigour of the seedlings in the current year test plots. Over 95 per cent. of the Second Ground Nursery consist of selfed seedlings of Co. 214, a cane which has become popular in sub-tropical India on account of its early maturity and its great resistance to mosaic. This cane is not over satisfactory in tonnage and the raising of such a large number of seedlings was intended to secure a cane like Co. 214 but with a better tonnage. During the season over a lakh of seedlings were raised from Co. 214 self, of which about fourteen thousand have been planted for the full year test.

(*e*) *The wild Saccharums.* As mentioned in the previous report there is a fairly good collection of types of wild *Saccharums*, chiefly *Saccharum spontaneums*, at the station. This was recently strengthened through the kindness of the Hawaiian delegation to Java—who spent a couple of days at Coimbatore—by their passing to the station three more types, one from Burma and two others from Sumatra.

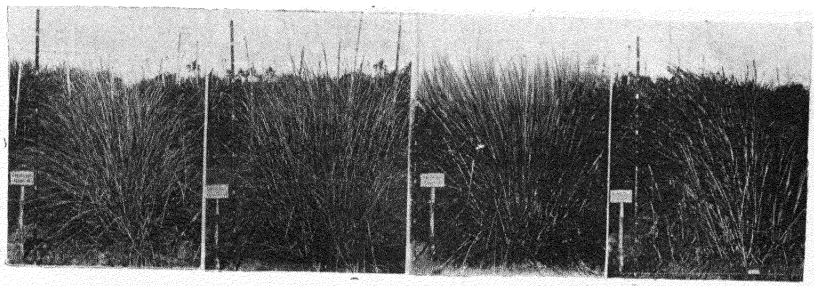
The collection of *Saccharum spontaneums* was again studied for various characters including root dissections ; and it is proposed to try and cross as many forms as possible with *Saccharum officinarum* during the next arrowing season.

(*f*) *Periodic studies of popular Coimbatore seedlings.* The extant descriptions of sugarcane varieties consist largely of morphological characters and, to some extent, of other characters such as period of ripening, resistance to diseases, and suitability to particular soil conditions. In the experience of the station, it was found that it would be a distinct advantage to study periodically the different growth phases of the cane with a view to decide about its suitability to a particular set of climatic and therefore growth conditions. The result of such studies, which have been in progress for some time at the station, was presented in a paper before the Allahabad session of the Indian Science Congress. These studies were extended during the year to seven Coimbatore seedlings and two indigenous varieties on a carefully laid out scheme of periodic observations, shoot weighments and root dissections ; and certain rather interesting results are being obtained.

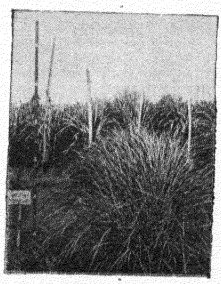
(*g*) *Root dissection technique.* Very often pictures of root dissections of crops consist largely of the older roots and older portions of roots which represent the conducting regions. In the case of the cane, at any rate, with its periodic flushes of new roots, it was thought desir-

Saccharum Spontaneums

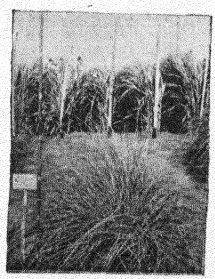
(For use as parents)



Dehra Dun | Coimbatore | Dacca | Glaggah : Java



Godaveri



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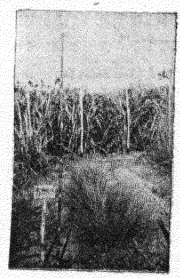
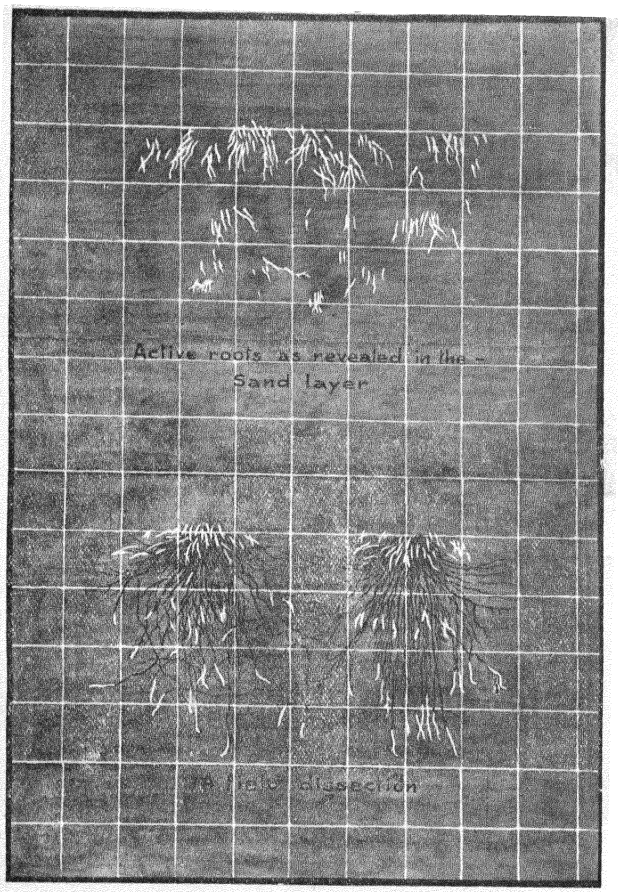


Lahore

PLATE VII.

Method for studying active roots.



able to work out a method for picking out the zones of active roots in the soil at particular periods and a fair amount of success was attained. The method consists mainly in digging a vertical trench on one side of the cane plant, filling it with sand and keeping the sand moist to stimulate root development in the sand layer. When the sand is removed, the region of active roots becomes easily discernable. As a variation of this method a layer of thick soft cloth was placed vertically in the trench and the trench filled up as before. When, after the lapse of a definite period of time, the cloth was removed, it showed the active roots enmeshed in the interstices of the cloth or closely adhering to it by means of the root hairs. It is hoped to try and improve the technique further so as to secure what would practically be an under-ground *in situ* photograph of the active root regions of the plant.

(*h*) *Sub-stations in North India.* The good performance of the Coimbatore seedlings under sub-tropical North Indian conditions has resulted in a desire from the Provinces to secure the Coimbatore seedlings for a test under the conditions of the provinces at an earlier stage than hitherto. This is an advance in the right direction and it is proposed to co-operate with the Provinces to the fullest extent possible. To secure the same object Coimbatore has been trying in the past to develop sub-stations in the Provinces for the complete study of the new productions under the conditions prevailing in the chief sugarcane tracts of India. For the past two years and largely through the kindness of the Imperial Dairy Expert, a whole set of Coimbatore seedlings —even in the first year of their life history—has been grown at the Imperial Cattle Breeding Farm at Karnal; and indications are already to hand that the breeding work at Coimbatore will gain both in efficiency and rapidity of results through the establishment of such sub-stations under Coimbatore control.

IV. Research and Investigations bearing mainly on Thick Cane Breeding under the Second Cane Breeding Officer.

(N. L. Dutt, M.Sc.)

(*a*) *Hybridization and selection.* In all seventy-three combinations were made during the season. Fiji B (Badila) flowered for the first time at the Thick Cane Area and was crossed with P. O. J. 2725, Maur. 1237, Co. 290, B. 6308 and Kassoer. The following varieties also were employed for the first time in crossing, the last five being used for introducing hardier blood into the seedlings :—B. H. 10 (12), P. O. J. 2878, P. O. J. 2364, Co. 214, Co. 281, Co. 285, Co. 317 and Kassoer. It is noteworthy that Fiji B flowered in the arrowing plot, while it reached

only the short blade stage in the varietal plot. The arrowing and the varietal plots were planted in November 1928 and May 1929 respectively. Certain early flowering varieties arrowed comparatively late in the varietal plot, enabling their being crossed with usually late varieties in the arrowing plot.

To safeguard from foreign pollen, the "isolated" arrows of Fiji B, Striped Mauritius and Gestreept Preanger were selfed inside rooms provided with glass windows which were kept closed. The first and second of the above varieties gave five and two selfed seedlings respectively, out of which three and one are now growing in the Second Ground Nursery, while Gestreept Preanger failed to give any selfed seedling.

About 170,000 seedlings were germinated from seed, out of which 17,000 found a place in the Second Ground Nursery. Six hundred and twenty-seven seedlings were selected from nineteen thousand 1928-29 seedlings, based upon growth and habit characters. These were analysed for brix and sucrose, and 231 seedlings were finally selected for further testing.

Certain of the promising thick seedlings were planted in three different plots at the station representing "wetland" and "garden land" soil conditions. P. 275 maintained its lead over the standard varieties in all the three plots.

(*b*) *Inducing better seed-setting.* The arrows of Vellai, Striped Mauritius, Purple Mauritius, P. O. J. 100, P. O. J. 2714, Co. 290 and B. 6308 were sprayed with one per cent. sugar solution before dusting pollen. The treated arrows of the above varieties gave better germinations than the controls, except in the case of P. O. J. 100, P. O. J. 2714 and Striped Mauritius. There are certain varieties, *viz.*, B. S. F. 12 (31) and P. O. J. 2714, which, under Coimbatore conditions, do not set seed freely even though possessing apparently normal stigmas. For inducing better seed setting in such varieties, the details for the spraying of sugar solutions (required concentration, etc.), will need to be worked out.

(*c*) *Germination in thick cane seeds.* Equal quantities of seeds—three grams per seed-pan—of the varieties Co. 285, Co. 290, Co. 243, Purple Mauritius, D. 74, B. 3412, Puri, and Striped Mauritius were sown six and twenty days after collection to find out if sowing twenty days after collection would give better germinations. Except Co. 290 and Puri, in which there were found to be better germinations, all the rest gave less germination when sown twenty days after collection.

The seeds of P. O. J. 2725, Co. 243, Striped Mauritius, Vellai and H. 109 were sown 27 and 47 days after the date of collection, the seed, after drying in the sun for six days, being kept over $Ca\ Cl_2$ for 24 hours and then kept in sealed tins. This was to see if desiccation after collection improves or hinders germination. In all the above the seeds

sown 27 and 47 days after collection gave less germinations than the control.

The seeds of the above five varieties were also given the following treatments to study their effect on germination. (1) Soaking in water for fifteen hours before sowing; (2) Soaking in 0·1 per cent. orthophosphoric acid for fifteen hours before sowing; (3) Dipping in concentrated H_2SO_4 for five minutes and thoroughly washing before sowing; (4) Soil-fluff mixture—for this treatment the fluff was mixed with an equal quantity of potting mixture and spread over the pan, the pan being watered in the usual manner. In the last treatment alone, better germinations than the control were obtained.

(*d*) *Controlling time of arrowing by varying day lengths and by exposure to vapours of Ethylene chlorohydrin.* Certain varieties were artificially rooted and removed to a dark room for subjecting them to six and ten hours daylight. The varieties were removed at the short blade stage and kept in pots. By this treatment two of the varieties flowered four and two days earlier than the canes of the same variety in the field. This suggested that if this treatment were carried out on a suitable scale and under proper conditions the treated canes might flower at a different time than the control. The varieties B. 6308 and Vellai were therefore enclosed in a temporary zinc shed—13′ × 13′ × 10′—in the field for subjecting the canes to six hours of daylight, one half of the rows being inside the shed and the other half as control. The shed was put up in the last week of March 1930 when the plants were four months old.

Another method that was tried to hasten the flowering time was by exposing the canes with the leaves to the vapours of Ethylene chlorohydrin, the canes being enclosed in a fairly air-tight cylinder containing forty per cent. Ethylene chlorohydrin solution at the rate of ten cubic centimetres of the solution per hundred litres of space. The result of both the above experiments will be known during the 1930 arrowing season.

(*e*) *Pollen studies.* The experiments on sugarcane pollen during the season were rather disappointing. Though germinations were obtained by using the usual sugar-agar culture medium (26 per cent. sugar *plus* 0·7 per cent. agar) neither the percentage of germinations nor the length of the pollen tubes was satisfactory. The pollen storage experiments were also discouraging as the pollen stored was found to have been caked. These experiments will need to be continued because of their bearing on sugarcane breeding and attempts will therefore be made to improve the technique for prolonging the viability of sugarcane pollen.

(*f*) *Duration of stigma receptivity.* For this experiment the female varieties Vellai, P. O. J. 100, and P. O. J. 2364 were taken. The "isolated" canes were placed in separate sheds at a distance from the

arrowing and varietal plots so as to be away from the influence of foreign pollen. The flowers were emasculated and then the pollen was dusted at definite intervals. One hour after dusting the pollen, the stigmas were examined under the microscope for observing whether the pollen had germinated. The pollen dusted on seven days old flowers of Vellai and P. O. J. 100 and five days old flowers of P. O. J. 2364 was observed to have germinated on the stigmas.

(*g*) *Hybridization of canes to help other countries.* Certain of the varieties which grow well under Australian conditions, *viz.*, H. 109 and D. 1135, are highly susceptible to gumming disease, while such varieties as Q. 813, B. 147 and Uba which have been found to be resistant to gumming in that country, are not the best as commercial canes. As cane does not usually arrow in New South Wales, thus precluding its utilization for crossing purposes, the Director of Plant Breeding, Sydney, desired to have seed of any controlled crosses between the above two groups of canes. The following crosses were therefore made and the seed—preserved in Ca Cl_2 and CO_2—sent to him :—

H. 109 × Q. 813.

D. 1135 × Q. 813.

and P. O. J. 2725 × Q. 813.

V. Performance of Coimbatore seedlings.

The spread of Coimbatore canes in the Provinces is going on apace ; and on date the total area under these canes is approaching a tenth of the total area in India. The aggregate advantage to the growers would be obvious from the large area under sugarcanes in India and the considerable increase in acre yields—sometimes 100 per cent.—obtained from a cultivation of the Coimbatore seedlings in place of the indigenous varieties. At a conservative estimate the increased money value to the growers may be placed at one hundred and fifty lakhs of rupees per year ; and this practical advantage is bound rapidly to increase with the advance of time.

The practical value of the work above mentioned is at present confined almost entirely to the sub-tropical regions of India. Work on the breeding of the thick type of canes detailed in the previous section is just beginning to take a practical shape ; and it is hoped to be able to send out for trial certain of the Coimbatore-bred thick seedlings during the ensuing year.

It needs further to be mentioned that the cultivation of the Coimbatore canes has been not an unimportant factor in the recent increased efficiency of the Indian factories. In the production of the Coimbatore seedlings, the first and a very important step—a step which obviously

is the basis of all improvements in other directions—has been taken in the placing of the Indian Sugar Industry on a satisfactory footing.

Good reports on the Coimbatore seedlings are being received from outside countries; from the Leeward Islands, Natal, Porto Rico and Cuba. Owing to the comparatively hardier blood in their composition, the Coimbatore canes may have a definite sphere of usefulness in the world's sugar industry of the future.

VI. Receipt and despatch of canes.

Receipt. Through the kindness of the authorities at Pasoeroean the station received planting material of five promising sugarcane seedlings and three species of *Erianthus*. Specimens of three wild *Saccharums* were received through the kindness of the Director, Hawaiian Experiment Station.

Certain canes were released from the quarantine area after examination by the Government Mycologist and the Government Entomologist. These include two rather promising Tucuman seedlings.

Despatch. Thirteen varieties—mostly of Indian forms of *Saccharum spontaneum* and hybrids with the Coimbatore *Saccharum spontaneum*—were sent to Java. Four *Saccharum spontaneum* varieties were sent to Dr. Brandes of the United States of America, and eighteen packets, chiefly of Coimbatore seedlings, were sent to other foreign countries like Saigon and Brazil.

Twenty-one seedlings were raised to the status of Co. canes during the year and distributed for trial to various stations in India. This involved the sending out of over 120 individual packets.

The parentages of the seedlings raised to the status of Cos. during the year are given below:—

No. of the seedling.	Parentage.
Co. 317, Co. 318, Co. 319	Co. 229 Self. (Co. 229 itself was obtained by selfing Co. 205 which is a hybrid between Vellai and *Saccharum spontaneum*).
Co. 320	Co. 213 × Co. 214.
Co. 321	P. O. J. 1547 × Co. 205.
Co. 322	P. O. J. 2688 × Co. 205.
Co. 323, Co. 324, Co. 325	Co. 221 × Co. 229.
Co. 326	Co. 229 selfed.
Co. 327, Co. 328, Co. 329, Co. 330, Co. 331, Co. 332	Co. 213 × Co. 214.

No. of the seedling.	Parentage.
Co. 333 Co. 334	Co. 281 × Co. 223.
Co. 335 Co. 336 Co. 337	Co. 214 selfed.

The usual time for sending out canes from Coimbatore is January to March, which is rather a busy time at the station. An experimental batch of sugarcanes was sent out to North India in September for a subsequent multiplication of the material in the North Indian farms at the usual sowing time for canes ; but the results have been disappointing.

The test plots at the station are periodically visited by the staff of the Imperial Mycologist, Pusa, and by the Government Mycologist and the Government Entomologist at Coimbatore, the latter two officers kindly examining all material arriving at or leaving the station. My thanks are due to all the above officers for their kindness.

VII. Training of Students.

Mr. U. K. Das, Assistant Agriculturist of the Hawaiian Sugar Planters' Association, put in three months at Coimbatore to get himself acquainted with the methods and technique of the station.

Mr. Kidar Lall Khanna, post-graduate student from the Punjab, underwent training till the end of November 1929.

VIII. The Farm.

The rainfall during the early and South-West monsoon periods was satisfactory ; later in the season there was water scarcity at the station.

Lucerne proved a success. Certain of the wheat varieties from Pusa did not do so well as the local wheats on account of, either the prevailing drought during the time or this being the first year of introduction.

IX. Miscellaneous.

Building constructions. An engine and a pump were installed in the well newly constructed in the area devoted to the breeding of medium canes.

Seedling houses were erected in both the main areas of the station.

Visitors. The visitors during the year included the bulk of the Hawaiian delegation to Java in connection with the meetings of the International Society of Sugarcane Technologists, the Vice-Chairman of the Imperial Council of Agricultural Research, the Director of the Agricultural Research Institute at Pusa, and the Indian Tariff Board.

The receipts during the year amounted to Rs. 12,502, of which Rs. 3,834 represent rent from resident officers.

X. Programme of work for 1930-31.

Major.

The breeding of medium canes will be continued with the object of securing further improvements or covering new tracts.

Intergeneric hybridization between Sugarcane and Sorghum as well as with other cereals will be continued to fully exploit the possibilities in this line of work.

The breeding of thick canes to suit the requirements of the thick cane-growing tracts of India will be carried on.

Further attempts will be made to improve the breeding technique and to secure greater germination among thick cane seeds.

Minor.

Studies on sugarcane roots and pollen and seed viability.

Studies on the inheritance of characters.

Periodic studies of the growth phases of sugarcane varieties and seedlings including periodic root dissections and shoot studies.

Morphological studies of sugarcane varieties (including flowering habits and floral characters), seedlings and wild *Saccharums*.

XI. Publications.

Khanna, K. L. and Venkatraman, T. S. } Suggested Method of studying Sugarcanes for Breeding Work. (Forwarded to the Allahabad session of the Indian Science Congress; and accepted for publication in the July 1930 issue of the *Agri. Jour. India.*)

Dutt, N. L. and Gopal Ayyar, K. V. } A preliminary note on the chemical composition and the enzymes of Sugarcane pollen. (*Agri. Jour. India*, Vol. XXV, pt. I, January 1930).

Thomas, R. and Venkatraman, T. S. } Sugarcane---Sorghum Hybrids. (*Agri. Jour. India*, Vol. XXV, part II, March 1930).

Venkatraman, T. S. . Sugarcane Breeding—its chief characteristics. (Prepared for the Madras Agricultural Conference, July 1930.)

REPORT OF THE SECRETARY, SUGAR BUREAU.

(WYNNE SAYER, B.A.)

I. PREFATORY.

I held charge of the office of Secretary, Sugar Bureau, throughout the year under report except for one month and four days from 24th April to 27th May, 1930, when I was on training for the Army in India Reserve of Officers at Dehra Dun. Rao Saheb Kasanji D. Naik, Superintendent of my office, was on leave from 18th March to 17th June, 1930, and Mr. Hardayal Singh, Senior Recorder, was placed in charge of the duties of the Secretary, Sugar Bureau, in addition to his own duties as officiating Superintendent. The subordinate staff remained unchanged. The Bureau, though in the 12th year of its existence, is still on a temporary footing. The question of confirmation, status and administration of the Sugar Bureau is however now under review by the Government of India.

During the year under report the Bureau continued to collect information relative to the Sugar industry both in India and abroad, and made it freely available to the public. The data already in the possession of the Bureau are of the widest and most complete nature and are being freely drawn upon by the public, the provinces and the Imperial Council of Agricultural Research.

II. AGRICULTURAL.

All the practical work on sugarcane at Pusa continued to be carried out by the Imperial Agriculturist, in collaboration with the Secretary, Sugar Bureau and assisted, where necessary, by the Government Sugarcane Expert, Coimbatore. The scheme pertaining to the cane propaganda work as sanctioned by the Bihar Government whereby an overseer was placed at my disposal worked very satisfactorily and proved of considerable utility. The steady increase in the area under improved cross-bred Coimbatore canes and the higher tonnage yields of these varieties as witnessed in the yearly increasing quantities of cane crushed in sugar factories (152 lakhs maunds cane crushed in 13 west Gandak factories in 1929-1930 season as against 121 lakhs maunds in 1928-29) and the steady rise in the recovery percentage of sugar in Indian factories show the excellent work on the agricultural side which has already been accomplished and this augurs well for the future development of the industry.

Co. 213 is the standard mill cane of India at present, over 12½ million maunds of this cane being crushed yearly by the factories and no other cane as yet holds the balance so equally between the mill and growers in unirrigated tracts.

Co. 223, which is reported to have done so well in the Punjab and which is of Co. 210 type, was reintroduced for further trial against Co. 210. To date, however, the latter has maintained its superiority under local conditions.

Co. 214 is now grown chiefly as the early ripening cane in the Darbhanga district of Bihar.

Co. 205 is now being replaced in North Bihar by Co. 285 as the mills here have definitely declined to take bulk supplies of this cane.

Co. 290 continued to show promise and a mill trial was arranged in the month of December, 1929. The cane was found to mill easily and to possess a very low fibre content, a very excellent thing from the milling point of view, but this had the disadvantage of rendering the cane more attractive to wild animals and also probably making it less able to stand well in bad weather. It is proposed to repeat the test over again next season as the field conditions during the period preceding the mill trial were such that the cane used in the test did not have a chance of showing its real merits.

Co. 213, 210 and Co. 214 are now established in the Marhowrah area where previously some difficulty was experienced in growing them. In consequence, the distribution of the Combatore canes is now in progress in this tract and the extension of these cross-bred canes is going on throughout Saran.

In an endeavour to find a suitable cane for replacing Co. 205, five new varieties were put under trial, two of which are showing considerable promise. Experimental plots of Co. 290 have been planted at Dowlatpur and Gongowlie and Co. 285 is also being tested at the latter place. This system of trying out new varieties showing promise in the preliminary trials on different estates is of great value as a similar system is adopted in Java before putting out new seedling canes. Co. 281 has now reached a stage where an outside test will be of distinct value.

A note on cane versus beet and two notes on Co. 221 cane in the Leeward Islands and on the percentage of different cane varieties planted in Java from 1912 to 1929 were published by the present writer in the *Agricultural Journal of India*, September, 1929.

III. Industrial.

The number of sugar factories in India increased by one during the year under report, an additional factory having been put up at Pilibhit. A new factory is also contemplated in Bihar and one already projected in the Punjab was under construction during the year as also a factory

at Doiwala in the Dehra Dun District of the United Provinces. As usual, the Bureau kept in touch with all sugar factories in this country and gave advice when asked for. Figures of output for the working season 1928-29 were obtained from factories as well as refineries in India ; and a consolidated statement of total sugar production was compiled and published in " The Indian Trade Journal " and " The Agricultural Journal of India ". The production of sugar direct from cane in 1928-29 amounted to 68,050 tons as against 67,808 tons in 1927-28 ; the total quantity of sugar refined from *gur* fell from 52,055 tons in the previous season to 31,038 tons in 1928-29. This decrease was principally due to the low price of white sugar rendering *gur* refining unprofitable. Thus the total production of sugar in India was 99,088 tons in 1928-29 as against 119,863 tons in the previous season. It may be mentioned here that this decline in total production is due to the marked decrease in the quantity of sugar refined from *gur*. Reviewing the last five seasons' average percentage recovery of sugar direct from cane in the sugar factories, we find that there is a steady improvement particularly in the white sugar tract of the eastern portions of the United Provinces. The late rains in September-October were responsible for the slight drop in North Bihar figures for 1928-29. This will be clear from the following table :—

Names of Provinces.	1924-25 Recovery.	1925-26 Recovery.	1926-27 Recovery.	1927-28 Recovery.	1928-29 Recovery.
	%	%	%	%	%
Bihar and Orissa . .	7·96	7·98	8·67	8·80	8·61
United Provinces . .	7·23	7·88	7·93	8·07	8·37
Bombay, Madras and Burma	8·14	8·98	10·26	10·09	9·93
Total for India . .	7·81	8·07	8·49	8·62	8·59

Commendable efforts are being made by the Indian Sugar Producers' Association to come to some working arrangement among West Gandak factories for the supplies of cane among themselves so that unnecessary long haulages by rail may be avoided and ruinous competition among factories may not arise. Several meetings were held during the year and it may be hoped that success will finally crown their efforts and the present impossible position be radically altered.

The Imperial Council of Agricultural Research which was created during the year under report also appointed a Sugar Committee which held two meetings. This Committee considered the whole sugar question including the communications received from Local Governments

in reply to the Government of India's letter on the subject of the sugarcane industry in March, 1929. The Council then resolved that the Government of India be requested to refer to the Tariff Board for enquiry the question whether protection is required and if so, in what measure, for the sugar industry in India. The Government of India after carefully considering all the evidence adduced decided in favour of the enquiry by the Tariff Board and issued a resolution No. 127-T-(19), dated the 20th May, 1930 on the subject. The Tariff Board has accordingly taken up for investigation the subject of protection for the Indian Sugar Industry.

During the year under report the Government of India enhanced their revenue duties on all imported sugar by Rs. 1-8 per cwt. for each grade of sugar. The revised duties are as under :—

23 Dutch Standard and above . . .	Rs. 6-0-0 per cwt.
Below 23 Dutch Standard but not inferior to 8 Dutch Standard	Rs. 5-8-0 ,, ,,
Below 8 Dutch Standard and sugar candy .	25% *ad valorem plus* Rs. 1-8-0 per cwt.

It may be added that there is no excise duty on sugar locally manufactured.

The world's sugar position during the year under report was one of overproduction as will be seen from the following figures of total production of beet and cane sugar (raw value) given by Dr. Mikusch.

1927-28	26,675,000 metric tons.
1928-29	28,814,000 ,, ,,
1929-30	28,647,000 ,, ,, (estimated)

While in the pre-war year the world's production was—

1913-14	19,879,000 metric tons.

The world's sugar consumption during 1927-28 and 1928-29 was 26,373,000 and 27,191,000 metric tons (raw value) respectively, while in 1929-30 the first six months' consumption in Europe and America showed a decline. The stocks on 1st April in Europe (11 countries), North America (all ports), Cuba and Java as given by Herr F. O. Licht are as under .—

1st April, 1928	6,000,701 metric tons.
1st April, 1929	6,895,195 ,, ,,
1st April, 1930	7,817,293 ,, ,,

which shows that stocks this year are unduly high ; in short, in spite of the decrease in production during the campaign year 1929-30 the sugar statistical situation can hardly be said to look promising.

British India imported 939,584 long tons sugar valued at 15,51 lakhs of rupees during the year 1st April, 1929 to 31st March, 1930, as against

868,800 tons valued at 15,86 lakhs in the preceding year and 725,800 tons valued at 14,50 lakhs in 1927-28.

The significant item in these three years' imports is that imports from Java increased from 698,000 tons in 1927-28 to 851,000 tons in 1928-29 but fell to 781,000 tons in 1929-30. This drop in the figure of imports from Java was due to the competition of beet sugar of which 131,000 tons were imported in 1929-30 as against 8,400 tons in the preceding year and 18,000 tons in 1927-28. Some 45,000 tons of beet sugar were imported from the United Kingdom during the year under report as against 3,400 tons in 1928-29 and only one ton in the preceding year.

For the reasons explained above, the price of sugar showed no improvement during the year except in the months of March, April, May and June when the increase in the rate of import duty, fair demand for ready sugar and the low level of stocks enabled a slight appreciation to take place.

The following table shows the wholesale price per maund of ready Java white sugar in Calcutta from July, 1927, 1928, 1929 to June, 1930:—

	Rs.	A.	P.		Rs.	A.	P.
1st July, 1927	10	11	0	1st January, 1929	9	2	0
1st August, 1927	10	6	0	1st February, 1929	9	5	0
1st September, 1927	11	0	0	1st March, 1929	9	1	6
1st October, 1927	10	8	6	1st April, 1929	9	9	0
1st November, 1927	10	0	6	1st May, 1929	9	8	0
1st December, 1927	10	6	0	1st June, 1929	9	5	0
1st January, 1928	10	0	3	1st July, 1929	9	3	0
1st February, 1928	9	12	0	3rd August, 1929	9	2	0
1st March, 1928	9	13	6	2nd September, 1929	9	3	3
1st April, 1928	10	9	0	2nd October, 1929	9	5	3
1st May, 1928	11	2	0	1st November, 1929	9	4	0
1st June, 1928	10	15	6	2nd December, 1929	8	15	0
1st July, 1928	9	15	0	1st January, 1930	8	10	6
1st August, 1928	9	11	0	1st February, 1930	8	5	3
1st September, 1928	9	9	6	3rd March, 1930	8	10	0
1st October, 1928	9	10	6	3rd April, 1930	9	1	6
1st November, 1928	9	0	0	3rd May, 1930	9	2	0
1st December, 1928	9	6	0	2nd June, 1930	9	1	0
				30th June, 1930	8	13	0

A statement giving quotations per cwt. c. i. f., Calcutta, for Java white sugar is also given below which will show to what extent the price of sugar has declined during the last two years.

Date.	Quotation.	Shipment.
	s. *d.*	
5th July, 1928	12 11	July—August—September.
1st August, 1928	12 8	August—September.
6th September, 1928	12 9½	September to December.

Date.	Quotation.	Shipment.
	s. *d.*	
4th October, 1928	12 7	October—November—December.
1st November, 1928	12 7	November—December.
6th December, 1928	12 3	December.
3rd January, 1929	12 5½	January—February—March.
7th February, 1929	13 1	February—March.
7th March, 1929	14 1½	March—April.
8th April, 1929	13 0	May.
6th May, 1929	12 10½	May.
3rd June, 1929	12 0	June.
1st July, 1929	11 5	June.
29th July, 1929	11 10½	July—August—September.
2nd September, 1929 . . .	11 11	September.
30th September, 1929 . . .	12 3	October.
4th November, 1929 . . .	11 10	November—December.
2nd December, 1929 . . .	11 5	December.
2nd January, 1930	11 0	January.
6th February, 1930	10 4	February.
27th February, 1930 . . .	9 10½	February.
3rd April, 1930.	10 0	April.
1st May, 1930	9 6	May.
5th June, 1930	8 9	June.

IV. Statistical.

Work on the statistical side includes the collection of import and export statistics for India as well as for the principal sugar consuming countries of the world, areas under sugar cane and beet in India and foreign countries, costs of production of *gur* and sugar, both white and brown, and the total and *per capita* consumption of sugar in various countries of the world. A large number of enquiries are received both from the public and Government officers asking for information on these poi nts and all available information is supplied to them.

The Bureau continued to obtain price quotations for various grades of *gur* or jaggery from the various *gur* centres in India and arranged for

their publication in " The Indian Trade Journal ". Quotations for Java white sugar at Sourabaya and for Indian factory-made sugar at Cawnpore, as also the figures of stocks of sugar at the principal ports in India which are recorded in the Bureau, were made available to the Director-General, Commercial Intelligence and Statistics, Calcutta, for publication in every weekly issue of " The Indian Trade Journal ".

The Bureau continued to furnish the Department of Commercial Intelligence and Statistics, Calcutta, with brief reviews of the sugar crop conditions in the world for incorporation in their all-India sugarcane crop forecasts published in August, October and February. For the information of those interested in the sugar trade, the Bureau continued to contribute notes to " The Indian Trade Journal " on production, imports and exports of cane and beet sugar crops of the world. A publication of the Sugar Bureau which the trade await with great interest is the Review of the Sugar Trade in India which is issued annually.

The Sugar Cable Service, which this Bureau has been conducting for the last eight years, is designed to obtain and distribute early and reliable reports of crop and market conditions in the principal sugar producing and sugar consuming countries of the world. It is still being conducted on the principle that the costs should be met by the firms or individuals obtaining the benefit of the service. The subscribers are from Bombay, Karachi, Cawnpore, Calcutta and Madras ; so the service serves an all-India purpose and pays its own way.

V. Miscellaneous.

Library. During the year under report, 236 volumes were added to the library. These were received either by purchase, exchange or free supply or by binding loose copies of the periodicals obtained in the library. Those interested in sugar manufacture and sugarcane cultivation consulted the library personally or took books on loan.

Publications. Thirty-two notes giving statistical information regarding estimates of production in and exports of sugar from Java ; imports, consumption and stocks in the United Kingdom ; consumption in and exports from and a forecast of sugar production in Mauritius ; and estimates of area under sugar beet in Europe were published in the *Indian Trade Journal.* In addition to these notes a " Review of the Sugar Trade in India during the official year 1928-29 " was published as a supplement to the *Indian Trade Journal* during the year under report.

Museum. Samples of Indian factory-made sugar were obtained in the season 1928-29 and these, as usual, replaced the old ones exhibited in the museum. Samples of white and brown Javas, British refined sugar, B. R. B., Hungarian and Yugoslavian beet sugar were also

obtained and exhibited in the museum. *Gur* samples from different provinces are also maintained.

VI. Conclusion.

The year under review saw the first few consignments of Java *gur* arrive in India at prices much under those ruling in the ports for a similar home product.

Another outstanding event of the year was the raising of the import duty on all grades of sugar by Rs. 1-8-0 per cwt. with effect from 1st March, 1930. It is too early yet to forecast with any degree of certainty what effects this extra duty will have on sugar consumption in India. Any thing that tends to increase the price must affect consumption in normal times but the rise in the price of ready sugar in India immediately after the enhancement of the duty on 1st March *was not proportional to the increase* in duty owing to absence of demand and the decline in the world's price of sugar as will be seen from the following prices per maund of ready Java whites in Calcutta :—

Date 3rd March, 1930	Date 8th March, 1930	Date 17th March 1930	Date 24th March, 1930	Date 31st March, 1930	Date 7th April, 1930
Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
8 10 6	8 11 0	9 0 3	8 13 6	9 0 0	9 2 3

as against Rs. 8-1-0 on 24th February, 1930.

Actually now the amount of duty equals the cost of Java sugar produced, bagged and shipped to India. But as sugar prices are now at their lowest level, this increase in duty has not so far caused any hardship worth mentioning to the consuming public. In fact the retail prices after the enhancement of the duty in March, 1930 are lower than those in 1929 on account of world causes and it has to be realised that duties against foreign sugar in this country can never affect world prices which must increasingly control prices at all ports. The main obstacle to the rapid expansion and prosperity of the sugar factory industry in this country is the difficulty of getting adequate supplies of good cane at reasonable prices within the area commanded by a single factory and the impossibility in consequence of making the factory take a proper interest in the production of its raw material and it is on this agricultural problem that the joint efforts of the Agricultural Departments and of the management of factories will have to be concentrated as it is here that success or disaster will be met with.

MGIPC—M—III-1-52—28-1-31—600.