List of recent Agricultural Publications in India—concluded.

Serial No.	Title.	Author.	Where published.
		Entomology—concluded.	
22	The Mosquito Blight of Tea . .	Dr. H. H. Mann, D.Sc., F.I.C., F.L.S., Scientific Officer, Indian Tea Association.	Indian Tea Association, Calcutta.
23	*Acridiidæ* A plague of Grasshoppers in the Central Provinces.	Stewart Stockman, M.R.C.V.S., Assistant Bacteriologist, Civil Veterinary Department.	Agricultural Ledger No. 3 of 1903. Government Printing, India, Calcutta. Price 3 annas.
33	*Termes taprobanes*. White ants as a pest of trees.	Department of Agriculture, Central Provinces.	Bulletin No. 6 of 1902. Department of Agriculture, Central Provinces, Nagpur, Secretariat Press, Nagpur. Price 2 annas.

G. I. C. P. O.—No. 2148 I.G. Agri.,—24-1-1906—900—H. R.

REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR THE YEARS

1905-06 and 1906-07.

REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR THE YEARS

1905-06 and 1906-07.

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1908

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8 HASTINGS STREET

TABLE OF CONTENTS.

PART I.—*Report of the Inspector-General of Agriculture in India*, by J. Mollison, M.R.A.C.

PART I.—*Report of the Inspector-General of Agriculture in India*, by J. Mollison, M.R.A.C.—*contd.*

PART II.—*Report of the Officiating Director, Agricultural Research Institute, Pusa*, by J. Walter Leather, Ph.D., F.I.C., F.C.S.

PART III.—*Report of the Imperial Agricultural Chemist*, by J. Walter Leather, Ph.D., F.I.C., F.C.S.

PART IV.—*Report of the Imperial Mycologist*, by Dr. E. J. Butler, M.B., F.L.S.

REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR THE YEARS

1905-06 and 1906-07.

PART I.

REPORT OF THE INSPECTOR-GENERAL OF AGRICULTURE.

1. *General duties.*—The duties of the Inspector-General are advisory as regards agricultural investigations which are being carried out in each Province, but they are direct as regards the work carried on at the Government of India Research Institute at Pusa. The Provincial Directors have consulted him freely, and have also readily accepted advice. They have co-operated very freely with each other. Good arrangements have been made for continuity of work in each Province and there is no special overlapping of work. Mr. F. G. Sly, I.C.S., held charge of the office of the Inspector-General of Agriculture in India until 26th February 1907, when after over two years' leave, Mr. J. Mollison, M.R.A.C., permanent incumbent of the post, again took over charge. As the work of the Imperial Department of Agriculture developed it was considered necessary to appoint an assistant to the Inspector-General. Mr. T. F. Main, B.Sc., was appointed in August 1905. His chief work has been to collect information regarding ordinary field and garden crops, agricultural implements, agricultural practices and the like. He was recently specially employed to make full enquiries regarding Coffee and Pepper cultivation in Southern India, to study the methods of keeping Farm accounts in all Provinces in order to offer suggestions to improve them and on an enquiry regarding the natural grasses and pasture plants of India. General work of this kind will be continued. One or two enquiries at a time will be taken up and fully dealt with.

2. *The staff and means for agricultural improvement in India.*—The proposals made to the Secretary of State for India for the expansion of the Agricultural Department have been generally sanctioned excepting those which refer to a third Entomologist and Crop Specialists for Tobacco, Sugarcane, Wheat, Rice and Fruit and Mycological and Entomological Experts in each Province. The appointment of a Cotton Expert has been sanctioned and is likely to be filled soon by a very experienced officer. A fibre expert has been appointed and now works under the Government of Eastern Bengal and Assam. His head-quarters and laboratories and experimental plots are at Pusa. His work in regard to the extension of jute cultivation and other fibres extends all over India, but his chief field experiments are at present arranged for at Pusa.

There are now eighteen appointments in the Imperial Department of Agriculture, *viz.*:—

1. Inspector-General of Agriculture.—J. Mollison, M.R.A.C.
2. Assistant Inspector-General of Agriculture.—T. F. Main, B.Sc.
3. Director of the Agricultural Research Institute and Principal of the Agricultural College, Pusa.—Bernard Coventry.
4. Imperial Agricultural Chemist.—J. W. Leather, Ph.D., F.I.C., F.C.S.
5. Imperial Mycologist.—E. J. Butler, M.B., F.L.S.
6. Imperial Entomologist.—H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.
7. Second Entomologist.—F. M. Howlett, B.A.
8. Imperial Bacteriologist.—C. J. Bergtheil.
9. Imperial Agriculturist.—E. Shearer, M.A., B.Sc.
10. Imperial Economic Botanist.—A. Howard, M.A., A.R.C.S.
11. Imperial Cotton Specialist.—Vacant.
12. Supernumerary Agriculturist.—A. G. Birt, B.Sc.
13. Supernumerary Agriculturist.—W. Roberts, B.Sc.
14. Supernumerary Agriculturist.—G. H. Garrad, N.D.A.
15. Supernumerary Specialist.—C. W. Mason (Entomologist).
16. Supernumerary Specialist.—H. E. Annett, B.Sc. (Chemist).
17. Supernumerary Specialist, R. J. D. Graham, M.A., B.Sc. (Botanist).
18. Supernumerary Specialist.—W. MacRae, M.A., B.Sc. (Mycologist).

The Imperial Bacteriologist has been employed by the Bengal Government in Indigo Research work. He will be able to continue this work when he takes up his permanent appointment at Pusa in April next, but there is much other work which requires his special attention at Pusa. We have found considerable difficulty in getting experienced

Agricultural Experts for particular sections. Therefore, young supernumerary officers have been appointed who are being trained at Pusa and by deputation to various Provinces. The second Entomologist and the supernumerary Mycologist have been selected, but have not yet arrived in India. The former is specializing in work which will be of value to India. The latter has gone to Germany for special studies. In each Province a great advance has been made in the organisation of its Agricultural Department. Each has a nucleus staff consisting in most cases of the Principal of the Agricultural College, a Chemist, a Botanist and one or more all-round practical Agriculturists. There are in all 38 sanctioned appointments for the Provinces as shown in the following table :—

Province.	Deputy Director of Agriculture.	Second Deputy Director of Agriculture.	Principal, Provincial College.	Botanist.	Chemist.
Madras . . .	R. W. B. C. Wood, B.A.	C. Sampson, B.Sc.	C. J. W. Shepperson, B.Sc.	C. A. Barber, M.A.	W. H. Harrison, M Sc.
Bombay . . .	F. Fletcher, M.A., B.Sc.	G. H. Henderson, N.D.A., N.D.D.	H. H. Mann, D.Sc., Principal, J. B. Knight, M.Sc., Professor of Agriculture.	G. A. Gammie, F.L.S.	H. H. Mann, D.Sc. (Chemist and Principal of College).
Bengal . . .	F. Smith, B.Sc.	(not provided)	H. H. Corbin, B.Sc.	W. R. Buttenshaw, M.A., B.Sc.	Vacant.
Eastern Bengal and Assam	Rai Bahadur B. C. Basu, M.R.A.C.	(to be filled locally in October)	(not provided)	(required in October 1907)	(1) A. A. Meggitt, B.Sc. (Agricultural Chemist). (2) R. S. Finlow, B.Sc. (Fibre Expert).
Burma . . .	A. MacKerral M.A., B.Sc.	(not provided)	M. E. Thompstone, B.Sc.	(vacant)	F. J. M. Sc.
United Provinces .	J. M. Hayman, D.V.S.	(vacant)	A. W. Fremantle, B.Sc.	H. M. Leake, M.A., F.L.S.	G. Clarke, F.I.C.
Punjab . . .	S. Milligan, M.A. B.Sc.	(not provided)	A. C. Dobbs, B.A.	(vacant)	J. H. Barnes, B.Sc., A.I.C., F.C. S.
Central Provinces .	D. Clouston, M.A., B.Sc.	(vacant)	G. Evans, B.A., B.Sc.	(vacant)	F. J. Plymen, A.C.G.I.
North-West Frontier Province.	(vacant)	(not provided)			

Note.—Postings made subsequent to June 1907 have not been included in this statement.

Eight of these officers have not yet arrived in India. The sanctioned posts will probably all be filled before the end of the financial year. The Mysore, Baroda and Kashmir States are developing their Agricultural Departments and have each done a great deal to improve Horticulture. The larger public gardens in India are doing much to improve our fruit orchards and are making other improvements. The Planters' Associations in Behar and Southern India have been active in advancing their industries. The Indian Tea Association and Indigo Planters' Association have each a staff of Agricultural Experts.

3. *Rules of Service.*—Uniform rules have been laid down for the appointment in the agricultural service. Local allowances for certain officers of the Imperial Department of Agriculture and Principals of Provincial Colleges have been sanctioned. Separate Departments of Agriculture, distinct from the Land Records Departments, have been formed in nearly all Provinces and are placed in charge of officers of the Indian Civil Service as Directors of Agriculture. The restriction limiting the total emoluments of the Directors of Agriculture to the pay of the Collectors of the highest grade as a maximum has been withdrawn. Definite orders have been issued by the Government of India regarding the authority which can be exercised by the Imperial Experts over Provincial work. This authority is purely advisory. The Imperial Experts can freely communicate direct with Provincial Experts regarding lines of work already sanctioned, and their advice is also very freely taken advantage of in executive duties.

4. *Tours.*—In 1905 Mr. Sly attended the Educational Conference held at Simla and read a paper on rural education. During the period under report the Inspector-General visited all the Provinces once or several times. The main objects of the tours were to inspect various Government Farms and to confer with the local officers regarding the work done on these Farms, and regarding the extension of experimental work of proved value into local districts and of good methods of cultivation or good varieties of crops into other parts of India. A visit was paid to Burma early in 1905 when a detailed scheme for the organisation of the Agricultural Department of the Province was framed in consultation with the Director. On this tour endeavours were made to ascertain the possibilities of cotton cultivation in the Province. These were not found to be particularly hopeful because the profitable cultivation of cotton requires much labour, and in Burma labour is both scarce and dear. In Madras the Provincial Agricultural Stations and the general agriculture of the Province were seen, and in more particular detail the sugarcane experiments at Samalkota, the Agave plantations at Hindupur and the system of rice irrigation under tanks supplemented by wells. This system can probably be adopted with advantage in many parts of Peninsular India and should be generally known. On

the same tour Mr. Tata's Silk Factory at Bangalore was inspected. Three visits were paid to the Bombay Presidency. The extensive work in the Bombay Agricultural Department was inspected and the possibilities for its extension in numerous directions discussed. The tree cotton experiments made by Mr. Tytler at Belgaum were seen, also the experiments with Egyptian cotton in Sind. The Chharodi Cattle Farm was inspected in company with the Inspector-General, Civil Veterinary Department, and the Bombay Director of Agriculture. It was decided to continue breeding operations on very definite lines and to breed from the very best cattle only. This Farm has been transferred to the Civil Veterinary Department. The Baroda State was visited, and the farms and sericulture experiments there were inspected. In the United Provinces the extensive work initiated by Mr. Moreland in wheat improvement by hybridization and selection was studied, also the general and very varied work of the Department, especially the storing and distribution of good varieties of seed. A conference was held regarding the extension of the Department. The North-West Frontier Province was visited. An area for an experimental farm was selected and general enquiries made as regards agricultural improvements in the Province. On the same tour the Lyallpur Farm and the agricultural conditions of the Chenab Colony in the Punjab were seen. In Bengal Mr. Sly advised regarding the site for the Provincial College and its Farm and also saw the experimental areas under tree cottons which are managed by Messrs. Shaw, Wallace & Co. helped by funds from the Government of India and the British Cotton Growing Association. The agricultural experiments and the general agriculture of the Central Provinces were kept well in review as the head-quarters of the Department are at Nagpur. In February 1906, Mr. Sly went to Eastern Bengal and Assam and conferred with His Honour the Lieutenant-Governor, the Director and Mr. Finlow on the organisation of the Agricultural Department and the cultivation of jute in the Province. He visited with Dr. H. H. Mann, Heeleeka, the principal experimental station of the Indian Tea Association, some tea plantations and the Sisal Hemp plantation at Daurachera.

5. *Board of Agriculture.*—The constitution of the Board of Agriculture, its duties and objects were described in the last Report of the Department. Since then, it has done most useful work in giving advice to Government in general agricultural experimental work and in other connected matters. The Board has now held three annual meetings attended respectively by 32, 35 and 48 members. The increased number of members indicates progress. The influence of these conferences greatly affects the advancement of agricultural science and practice in India. The second meeting of the Board was held at Pusa. It was attended by members from all Provinces except Burma, also by representatives from Mysore and Baroda. The subjects for general discussion

were (1) the programmes of work of the Imperial and Provincial Departments, (2) means of improving Indian wheat and tobacco, (3) the use of artificial fertilizers in India and control of the trade, (4) the provision of fodder for cattle in times of famine, (5) a syllabus for the principal branches of agricultural education. The Proceedings of the Board have been separately published. The proposals as regards the syllabus for scientific agricultural education may have to be modified before they can be accepted for general application. In fact the syllabus as framed for general agricultural education should only be taken as a guide for the agricultural course in any particular Provincial College. A sub-committee consisting of the Pusa staff and several other scientific experts proposed, in general terms, a scheme of experimental work for the Pusa Institute and the Farm. The scheme recommends that fundamental principles applicable to tropical and sub-tropical agriculture only should be dealt with at Pusa. Before we can, however, apply science to practice in the field a complete knowledge of ordinary field practices is required, and it is just as essential to study these practices at Pusa as at Provincial Research Stations. It was decided that the meeting of the Board should, in alternate years, be held at Pusa and in one or other of the Provinces. The third meeting of the Board was accordingly held at Cawnpore in February 1907. In addition to the ordinary members Sir Edward Buck, K.C.S.I., and Major Atkinson, R.E., were visitors, and made valuable contributions to the proceedings. The chief discussions referred to the programmes of work of the various Agricultural Departments, the Indian Sugar Industry, Cotton Improvement, Artificial Fertilizers and the Unification of Laboratory Methods employed by Agricultural Chemists. The question of legislation for the control of artificial fertilizers was again considered. The Board decided that such legislation though desirable is not ripe for introduction, but that trade developments should be closely watched. Sir Edward Buck introduced discussion on two very important subjects. The first was the utilization of river silt in India, the second was the employment of Agricultural Engineers in India. The discussion elicited many facts of general interest. The Board of Agriculture has grown unwieldy as regards the number of members. Its future constitution is being considered. It is proposed to reduce the number of members and to specially invite officers experienced in Agriculture.

6. *The Agricultural Research Institute, Pusa.*—The Director, Mr. B. Coventry, held charge until February 1907, when he proceeded on leave. Dr. J. W. Leather has been officiating for him. All branches of the Institute except Agricultural Bacteriology are now located at Pusa and consist of Agriculture, Chemistry, Mycology, Entomology, Bacteriology and Botany. The Imperial Bacteriologist, Mr. C. Bergtheil, is still on deputation with the Government of Bengal. The general work in

each section is described by the head of that section, and the report of each is added hereto as an appendix. Some reports being lengthy had to be summarised.

The College and Research building are nearly complete and will be opened for work by the end of April 1908. All other buildings are complete ; they include eight bungalows for European officers, quarters for six European probationers, a rest-house, hospital, veterinary dispensary, a hostel for seventy students, quarters for thirteen teachers, the farm buildings, general office, temporary chemical, biological, entomological and botanical laboratories, an insectary and a potculture house. The whole estate has been practically cleared of jungle and put in order and the roads and avenues have been greatly improved. The compounds of bungalows and other buildings are in trim order except the compound of the College building which is not yet finished. The Pusa estate, like other parts of Behar, is liable to be suddenly flooded owing to heavy continuous rain. It has, therefore, been found necessary to form embankments to exclude from the experimental areas flooding in occasional years. It is impossible to make full arrangements for the equipment of the Institute until its construction is complete ; but nucleus collections for the library and for other sections are being gathered. The museums of economic products, mycology and entomology, will be filled by specimens which have been collected or will be collected in the near future. Until the Provincial Agricultural Colleges are all in working order, we propose to teach at Pusa specially selected agricultural students who will each get a scholarship of sufficient value for support during the course of instruction. The chief object of instruction is to prepare natives of the country for practical work in scientific agriculture. Experienced highly educated natives are not now easily obtainable to supervise field experiments in a reliable way because practically trained men are not available. Eventually Pusa, by giving a post-graduate course, will, it is hoped, produce native specialists in particular lines of agricultural work such as in Agricultural Chemistry, Entomology, Mycology and Agriculture.

7. *Agriculture.*—Mr. E. Shearer, the Imperial Agriculturist, had charge of the Farm and all cultivation experiments during the period under review. The Pusa property extends over 1,300 acres, and the greater portion is intended for work-a-day methods. The clearing, levelling and reclamation of good arable land from jungle is nearly complete and preparations are being made on a small section of the property for scientific experiments which will probably benefit large areas in India. In framing the lines of experiments, the testing of varieties of crops, indigenous methods, available manures and such like, on land similar to that reserved for experimental plots, is likely to lead to useful results and this has been undertaken. In order to prepare for permanent

experiments, the uniformity of particular areas on the farm is being determined. The chief crops grown experimentally were cotton, sugarcane, jute and flax. Exceptional floods damaged the whole estate in 1905 and 1906. Precautions have been taken to prevent this damage in future. A detailed account of jute and flax cultivation is given under separate headings.

8. *Cotton.*—Imported and acclimatised American, indigenous and Egyptian varieties and perennial tree cottons were tried on the farm. After three years' experience general results indicate that many other crops are much more profitable in Behar than any description of cotton. The exotic annual cottons and even the acclimatised perennial tree cottons are liable to severe damage by boll-worm and other pests which are difficult to control.

9. *Sugarcane.*—Twenty-five varieties of sugarcane were planted in 1905. The general results are shortly dealt with in part six of this report.

Green manuring with *Sunn* hemp gave good results on newly broken up poor land. Two pasture grasses, *Chloris virgata* and *Chloris gayana* which flourish in Australia and South Africa were tried and being promising will be tried on a larger scale next year. The pasture area of the Pusa estate is now laid out. Manurial and other experiments on grass and pasture land in England have yielded very valuable and definite results. It has been arranged to start similar experiments at Pusa and to determine whether our pasture land can be improved. Mr. Shearer has framed a scheme of manuring and other experiments which is fully described in the Agricultural Journal of India, Vol. 2, Part 3. Breeding herds of local and Montgomery cattle are kept on the farm, the former with the object of distributing good bulls throughout particular districts in Bengal, the latter chiefly with the object of testing the milking quality of the breed and of supplying the Pusa establishment with milk. Montgomery cattle are probably the best milk-breed in India and apparently can be acclimatised easily in almost any other Indian district. This herd is doing very well at Pusa. The Superintendent, Civil Veterinary Department, Bengal, gives advice and takes a keen interest regarding these breeding herds. The rejection and distribution of bulls for district work is practically left in his hands. We have begun poultry breeding and bee-keeping at Pusa from stocks imported from England, but indigenous stocks will not be neglected.

10. *Agricultural Chemistry.*—Dr. J. W. Leather held charge of the section except during three months' leave when Mr. R. S. Finlow acted for him. He has now a European Assistant. Numerous analyses of soils, waters, silts, manures, feeding stuffs, oil-seeds,

sugarcanes, etc., were made and several special problems were investigated. The miscellaneous work which Dr. Leather has hitherto undertaken will decrease as the posting of Chemists to each Province is completed. He will have more time for original research and for definite large investigations. Such large investigations are now essential because the work of the department has developed. During the period under report Indian commerce has been helped by the work of the Chemical Section. The value of rain and dew in adding manurial elements to the soil is under investigation. Pusa has a well-equipped potculture house which has already given practical results regarding the manures required for particular Indian soils. Dr. Leather has described the potculture house in Memoir No. 3 of 1907, Chemical Series. He is endeavouring to popularise his potculture results by practical application in the field among Behar Indigo Planters. Meteorological records are being kept. Four drain gauges have been constructed and the chemical and other effects of the passage of water through the soil are under investigation. Dr. Leather is determining the conditions under which Cyanogenetic Glucosides are formed in certain agricultural plants, but there are yet no definite results to report.

11. *Mycology.*—The head-quarters of the Imperial Mycologist were transferred to Pusa in November 1905. Dr. Butler's practical work will be greatly facilitated by a complete reference herbarium collection of fungus diseases which affect Indian agricultural crops. The specimens are gradually being collected. His work cannot easily be applied in practice until preliminary enquiries, which take time are worked out. He is single-handed and has more agricultural crop diseases to deal with than in any country in the world. He requires a European assistant in addition to the supernumerary who has been appointed but has not yet joined. Dr. Butler was absent in Europe on leave for three months and then enlisted the co-operation of scientific workers in Paris, Berlin, and Kew. For Mycological work, the training of native assistants has been undertaken at Pusa as far as possible for every Province and will be continued. At Pusa and Poona experiments were continued to study the groundnut leaf disease. The wheat rust problem was also continued. An account of the varieties and distribution of Indian rusts has been published in the Botanical Memoir, Vol. I, No. 2, July 1906. The wilts of pigeon-pea, cotton, gram, jute, sesamum and indigo have also been under study. The knowledge so far gained indicates that the United States Cotton Wilt Fungus (*Neocosmospora vasinfecta*) which is widely distributed in India, is the probable cause. A parasite (*Sclerospora graminicola*) causes the green-ear disease of *bajra*, *jowar*, Italian millets and other cereals. A published Scientific Memoir deals with this parasite (Vol.

II, No. 1 of 1907, Botanical series). In the mycological laboratory numerous specimens of affected agricultural crops, fruit trees, and other economic plants were examined and remedies likely to prove useful were suggested. Field experiments were made at Dehra Dun and Pusa to test the value of soil inoculation recommended by the United States Department of Agriculture. They resulted in no appreciable gains. These methods probably do not generally suit the soils in India because the system of rotation usually practised includes numerous leguminous crops and the bacilli which produce the nodules on the roots of these crops and which add nitrogen in an organic form to the soil are probably numerous in every field. The study of the fungi which help to decompose the organic matter in soil has been commenced. Dr. Butler is giving special attention to the diseases of palm trees, sugarcane and mangoes. The spread of palm-tree disease from the Godavari delta threatens the extinction of palmyra, Cocoanut and betelnut palms in many parts of Madras. Dr. Butler toured through infected areas in August 1905 and March 1907. A large campaign to stamp out this disease is guided by Dr. Butler's advice, and the executive part of the work is being carried out vigorously by the Madras Agricultural Department.

A detailed account of this disease is given in the Agricultural Journal of October 1906 and a technical description of the parasite in the Scientific Memoir, Vol. I, No. 5, Botanical Series.

At Pusa investigation of the "Red Rot," "Black Rot," "Smut" and the "Red Leaf Spot," some of the chief diseases of sugarcane has been made. A simple and efficient method of checking "Red Rot," the most serious of these, has been discovered. The treatment and check of other sugarcane diseases are under investigation.

Dr. Butler visited Malda (Bengal) in 1905 to investigate the disease which is destroying the valuable mango orchards of the district. This enquiry will probably require incricate investigation. Dr. Butler is preparing a text-book regarding the fungus diseases of Indian plants for the use of Indian students.

12. *Entomology.*—Mr. Lefroy held charge of his section during the period under report. A supernumerary Entomologist joined in December 1906. Mr. Howlett as Second Entomologist will take up his appointment in December 1907. He is now specialising in England in preparation for work in India. The work of this section has progressed on very definite lines. The practical results of Mr. Lefroy's enquiries have already been of immense value to India. The entomological work in each Province is carried out by Indian assistants who have been trained at Pusa and who work more or less under the guidance of the Imperial Entomologist. They meet annually at Pusa, discuss with Mr. Lefroy the year's work and compare notes.

These meetings are extremely useful. The time of the Entomologist is largely taken up in identifying insects, reporting on them, and in satisfying enquiries. Steady progress has been made in investigating the life histories of insects injurious to agriculture. Specialists in Europe and America have helped this work. Pusa has now a large reference collection of injurious and other insects. Insecticides fatal to destructive insects but not to domesticated animals have been discovered. The insecticide experiments have reached the stage of field trials. An enquiry has been started regarding the prevalence in India of biting flies and their effects as carriers of disease. This subject is important in medical and veterinary science. The cultivation of Eri silk has been taken up to determine whether the worms can survive the dry hot weather and are likely to be acclimatised to heat in various districts. Lac was also introduced at Pusa as there is a likely field for this industry on existing trees in Behar. A severe outbreak of cotton boll-worm in the Punjab was controlled to some extent by measures described under cotton. Mr. Lefroy and Dr. Butler jointly tested the method of destroying locusts by the fungus which was reported to have been tried with success in South Africa. Healthy specimens of Bombay, North-West migratory locusts and some species of grasshopper were inoculated with pure culture of fungus in various ways. No successful results were obtained presumably because it has been found that the true natural locust parasite in South Africa is a different fungus (*Empusa grylli*) from that which has been distributed from Africa under this name (*Mucor ekiteosus*). A book on Entomology entitled "Indian Insect Pests" has been published. This book gives a summary of the facts relating to insect and insect life, origin of insect pests, their preventives and remedies and refers to the chief pests of the staple crops of India. The book has been widely appreciated in India. Mr. Lefroy is also recording general information regarding the insects of the cultivated areas. This as a text-book will be published soon to help advanced agricultural students and for general information.

13. *Botany.*—Mr. Howard took charge of the office of the Imperial Economic Botanist in 1905. At first he toured to acquaint himself with the agricultural conditions of various parts of India and the Botanical work carried on in the Provinces. A supernumerary Botanist has been added to his staff during the current year. Mr. Howard has in his charge at Pusa a large area which is partly devoted to orchards of many varieties of fruit, and partly to a botanical garden which will be chiefly planted with economic plants. The rest is really a field laboratory in which varieties of imported Indian crops are tested in small plots from which botanical descriptions and other data are obtained. The crops which have been chiefly dealt

with are wheat, barley, flax, tobacco, and fibre plants. Mr. Howard has given special attention at Pusa and in the Punjab to wheat and, I believe, has separated type specimens of all or nearly all Indian varieties from the mixed crops usually grown. This is really the first step towards the improvement of varieties. Cross-breeding and selection, and distribution of seed absolutely true to variety will follow. The general results of Mr. Howard's work with wheat will appear in a monograph which he is preparing and which will be freely illustrated with type specimens of numerous varieties. The study of various kinds of tobacco grown in India was also undertaken. Seed of tobacco was obtained from various parts of India and grown at Pusa. Much of the preliminary classification is now complete, and seed has been collected for further study this year. We have not yet got beyond the field study of varieties of tobacco, but the way has been paved for experiments in curing and also for producing fine qualities of tobacco which may command high prices for export.

14. *Cotton—Survey of indigenous varieties.*—A botanical survey of the cultivated forms of Indian cottons has been practically completed by Professor Gammie, the Bombay Economic Botanist, who has been helped by the Reporter on Economic Products to the Government of India and by experts of the Agricultural Department in each Province. The results have been published in his " Note on Indian Cottons ". The report deals with the species and varieties of cotton known in India, their distribution in particular areas, the degree to which hybridization naturally occurs, the quality of lint and other particulars. A revised illustrated classification by Professor Gammie of Indian annual cottons is now in the press and will shortly be issued as a Scientific Memoir of this Department. A provisional classification of perennial or tree cottons found in India has also been prepared by him, but it is not yet sufficiently complete for publication. The Provincial Departments of Agriculture are testing on Government farms the varieties most suited to each cotton tract.

15. *Selection of cotton seed.*—The distribution of seed from selected fields of the varieties ordinarily grown received considerable attention in the Provinces ; but this line of work is difficult because every cotton field practically contains several varieties. In India, improvement of ordinary varieties should begin by separating types and can be continued by plant-to-plant selection of seed. This work has been seriously undertaken by the Provincial Agriculturists and Botanists, and will tend slowly but with certainty towards improvement. The only other methods of improvement are (*a*) cross breeding and subsequent selection, (*b*) the introduction of exotic varieties. These methods are being fairly and fully tried. The problem of cotton improvement in India is extremely difficult. Special trade

demands require special kinds of lint. The chief and most paying demand at present is for coarse cotton to mix with wool for the manufacture of cheap warm cloth. If this demand is likely to be permanent, we ought to endeavour to increase the outturn of our so-called "inferior" cottons which are ordinarily grown with profit and without risk. The cotton farms have been extended in almost all Provinces, where it is proposed to raise on a sufficiently large scale for distribution to ryots, seed of such varieties of cotton as have been tried and found successful. A large cotton farm has been started at Surat in the Bombay Presidency for the improvement of the indigenous variety by selection of seed. Attempts to improve the indigenous *Kumpta* variety of Bombay by selection alone appeared to promise well. The various varieties of the Khandesh mixture have been isolated in order to compare the yields and quality of the produce of each. Some 30 tons of seed of the *Lalio* variety selected by the Department of Agriculture, Bombay, were distributed in the Ahmedabad District with successful results. One farm has been started in the Central Provinces for the improvement by continuous seed selection of (1) the coarse *Jari* variety and (2) of the finer *Bani* variety. Efforts have also been made to extend the area of pure crop of the *Karanganni* variety in Madras by special offers of rewards to cultivators.

16. *Cotton Hybridization.*—Experiments are in progress at several centres to improve the superior indigenous varieties by hybridization. The best results have been obtained in Bombay, Central Provinces and Madras. Practical results have been obtained by the Bombay Department of Agriculture by producing three crosses of fixed type which are superior to local cotton and which are suitable for the Surat-Broach tract which hitherto has produced the best cotton exported from India. One of these crosses can, it is believed, be grown over the whole of the Surat-Broach tract and may add immensely to the value of outturn. The other two indigenous crosses with proper treatment are expected to improve considerably. A cross between Bourbon (tree) cotton and Egyptian is also very promising; but requires experimental trial for two or three years longer. In other Provinces cross breeding results are promising, but are not yet sufficiently definite to describe.

17. *Trial of exotic cotton.*—Exotic varieties are under trial on Government farms and in cultivators' fields. Acclimatised American varieties may possibly be successfully introduced on an extensive scale in the United Provinces and in the irrigated areas of the Punjab, but they may in time deteriorate. The seed of *Dharwar-American* was distributed to planters along with seed of *Allens Hybrid* (New American), *Yennovitch* (Egyptian), *Caravonica, Broach* and *Buri.*

The trials were unsuccessful, except in the cases of *Dharwar-American* and *Brui*, both of which gave in unfavourable seasons fairly promising results in many places. The latter variety is of American Upland type. It is a fairly prolific and long-stapled cotton and may possibly be found suitable in Singbhum and Sonthal Parganas (Bengal). It gave in the Central Provinces a large outturn of very good cotton, and it will be there tested on an extensive scale. In the United Provinces the acclimatised *Dharwar-American* variety was not particularly successful. The cotton produced was equal to the best Broach, but the outturns were not uniformly good. In order to encourage the cultivation of these exotics which should be sown in the North of India with irrigation before the rains, the canal rate for this crop has been reduced. The cultivation of *American-Dharwar* cotton has increased in the Punjab, in spite of the heavy damage done by boll-worm in 1905. The area under this variety rose considerably in 1906. Experiments with Egyptian cottons indicate that they are well worth further trial in the South-Western districts of the Punjab. A farm has been started in the Province chiefly to grow exotic cottons under irrigation. Egyptian cotton in Sind occupied over 5,000 acres in 1906. The cultivation will probably extend largely, but boll-worm has done much damage. This damage can probably be controlled. The extension of this cultivation is restricted by inferior tillage which will improve as labourers are attracted to these new Canal Colonies, where labour is at present scarce and very dear. In Madras, American, Egyptian and *Caravonica*, varieties were tried, but there were no useful results. In Eastern Bengal and Assam, Spence tree cotton, *Caravonica*, *Dharwar-American*, *King's Improved* and *Buri* have done well on an Upland private estate. *Caravonica* cotton may succeed as a field crop in Assam. The Burma experiments with tree cottons were fairly successful and should be persevered with. The general experimental results indicate that exotic varieties of cotton producing fine lint may be extensively introduced into the Indo-Gangetic plain and particularly into the new Canal Colonies of the Punjab and Sind, provided we can overcome the traditions of the people and the ravages of boll-worm. The latter are more virulent on exotics than on indigenous varieties.

18. *Tree Cottons.*— Experiments with tree cottons are in progress in various Provinces. The results are generally unfavourable. All known varieties previously grown in India have been collected and have been cultivated under various conditions of soil and climate. The numerous varieties, grown on the Poona farm in 1904, were classified by Professor Gammie. The experiments undertaken by a syndicate with Messrs. Shaw, Wallace & Co. as Managers are still in their experimental stage, but this stage has so far been unsuccessful.

I have nothing, therefore, very definite to report regarding perennial cottons, but I am strongly convinced that they will never enter into regular cultivation in India. The British Cotton Growing Association and the Government of India, however, each contributed Rs. 10,000 towards the losses incurred by floods and otherwise on these syndicate plantations. The firm of Messrs. Shaw, Wallace & Co., has transferred their operations to some extent to Mourbhanj, where it is proposed to plant out about 500 acres chiefly with a particular variety of clustered-seed perennial cotton. The best sample of lint of this cotton was valued at 9*d.* per pound. The syndicate have now got about 294 acres under cultivation in different places.

Mr. Tytler, who was assisted by Government in starting a tree cotton plantation at Belgaum had no particular success in his experimental trials (without irrigation). His experiments suffered from the bad season of 1905-06. He has since formed a syndicate for the cultivation of tree cottons on an extensive scale with irrigation at Belgaum. Experiments by Provincial Departments of Agriculture with tree cottons have given conflicting results. *Caravonica* cotton gave promising results in Assam. Experiments have recently been started under irrigation by Mr. Spence at Deesa (Bombay) with a tree cotton which yields superior lint. These trials are in their experimental stage as the trees are yet young. The greatest risk in growing tree cottons is that they are very susceptible to insect pests which once established are difficult to get rid of because the trees are perennial.

19. *Extension of Cotton cultivation.*—The possibility of extending cotton cultivation in India has received a good deal of attention. The area under cotton has considerably increased in recent years chiefly owing to higher prices. The extension of railway systems and particularly of branch lines has materially helped this increase. The British Cotton Growing Association have made a large grant of £10,000 to be spread over four years for the improvement of the quality of Indian cottons and for the introduction and extension of the finer varieties of cotton in India. This grant has been used chiefly in providing seed of good varieties, in safe-guarding cultivators against loss in experimental trials and in obtaining through dealers an adequate price for superior cotton grown by individual land-owners. A sum of Rs. 28,500 was paid as subsidy in 1906-07. Out of this Rs. 10,000 were paid to the Indian Long-stapled Cotton Growing Syndicate to compensate against loss by floods. From the remaining sum of Rs. 18,500, the Provincial Departments of Agriculture spent Rs. 4,025 only during 1906-07. Rs. 10,000 are allotted for expenditure during 1907-08. The Provincial Directors of Agriculture have been consulted regarding the utilization of the grant in future years. Our Agricultural experts in every Province are almost unanimously of opinion that the agricultural

prosperity of India will be benefited less by improving the quality of Indian cottons than by improving the outturn, cultivation and trade practices of the ordinary indigenous varieties. Cotton experiments are likely to greatly expand. A Cotton Expert will be very shortly appointed. He will tour through the Provinces, co-ordinate the cotton experimental work and give in each Province, advice based upon his wider experience gained throughout India.

20. *Tea.*—The Indian Tea Association in its scientific and practical investigations was assisted by a subsidy of Rs. 15,000 from the Imperial Government and with Rs. 13,500 jointly from the Governments of Bengal and Eastern Bengal and Assam. This Department was strengthened by the appointment of an Entomologist (Mr. C. B. Antram), whose head-quarters are at Cachar. He has been provided with a laboratory and insectary. A survey of the tea soils of North-East India has been completed. Experiments have been made to determine the flavour of tea by quantitative analysis. The results have been published as a pamphlet on "Factors determining the quality of Tea." The general characters of many kinds of tea have been studied. The use of green manures and of bones in various forms has been tested in a general way. The different systems of cultivation are under systematic observation. Experiments regarding pruning and plucking promised to give useful results and will be continued till definite issues are obtained. Fungal parasites have been dealt with in a practical way. The causes, the means of infection and of prevention of the disease known as "Blister Blight" of tea plants were ascertained; the results have been published as Bulletin No. 3 of 1906 (Blister Blight of Tea Plant). A Bulletin on the "Mosquito Blight" (Indian Tea Association, Scientific Series, 1905, No. 1), has been published. Other investigations indicate methods of eradicating various insect pests including the "Bark eating Borer," the "Looper," the "Sandwich" and the "Red Slug Caterpillars" and of preventing damage done by "green fly" and the "white ant."

21. *Indigo.*—Scientific investigations were continued and controlled by Mr. C. J. Bergtheil whose services were lent to the Bengal Government for the purpose. The work done is described in appendix A of this report. The improvement of indigo manufacture has received a good deal of attention from specialists and others for many years. Little has yet however been done to improve the plant by selection. The Behar Planters' Association have recently appointed an Economic Botanist. He will have great scope for useful work in systematic field selection and in watching the results of cross fertilization. The superiority of the Java variety under very varying conditions of soil and climate is now generally recognised. There is very little doubt that its cultivation could, with advantage, be greatly extended in India

Mr. Bergtheil in his report of the Indigo Research Station, Sirsiah, 1906-07, however, states that the Sumatrana plant can be grown in Behar on certain classes of soil which are unsuitable for the Java variety. The ordinary field crops grown from Sumatrana or Java seed produce plants of great variety of type. The first step towards real improvement is to isolate type specimens and subsequently determine the economic value of each. As the economic value of a pure type depends upon leaf percentage and indigotin content, it is clear that the field work of an Economic Botanist should be in close touch with chemical laboratory investigations. The importance of an enquiry of this sort and the value of ultimate results to the indigo growers cannot be questioned. Mr. Bergtheil states that a preliminary step has been taken by growing and examining sub-varieties which were identified in 1903. The work of the Economic Botanist will help Indigo Planters when type plants of superior merit are grown and when sufficient seed is available for demonstration areas. The Behar Indigo Planters' Association have established seed farms in Behar. A seed farm has also been opened at Dasna in the United Provinces. The first crop of Java seed was bought by planters at a very high price. Recently at Cawnpore, important tests were carried out to determine the relative dyeing values of synthetic and natural indigo. The results were in favour of the natural product, as regards depth of colour and in other ways. It is conjectured that the impurities in natural indigo have something to do with these results.

22. *Jute.*—Though the area under jute very considerably increased during the two years under review, the demand for the fibre exceeded the supply. Prices remained high. The increasing demand shows the necessity of extending its cultivation outside Bengal. Madras, Burma and parts of Assam appear to offer very favourable physical and climatic conditions for its cultivation. The extension of jute cultivation is being investigated, and preliminary results have been published in Bulletin No. 3 of 1906. Trials with jute were made at the Samalkota Experimental Station (Madras), Ganeshkhind Gardens (Bombay) and at Nagpur and Raipur (Central Provinces). The results at the first two stations were fairly promising. Indigo Planters in Behar took up the cultivation, and their example was successfully followed by their tenants. Extensive tracts in the Assam Valley were for the first time brought under jute and yielded very fine crops. The cultivation is rapidly extending in the plains of Assam, but the lack of labour prevents extensive development. On the Lyallpur Farm (Punjab), jute was also successfully grown this season, but in the Chenab or other Canal Colonies of this Province, scarcity of labour will make extensive cultivation impossible. It has been suggested that the extension of jute cultivation may reduce food supplies for men and cattle in the congested districts

in Bengal and perhaps elsewhere. The experiments on Burdwan and Cuttack Farms clearly indicate that a crop of jute and a good crop of winter paddy can be got from the same field in one year provided the land is sufficiently manured and properly dealt with. Great developments in the jute trade are likely to occur in Burma when the Agricultural Department of that Province gets into full working order which will happen shortly. The crop will also extend largely in Eastern Bengal and Assam and probably in the delta areas of Madras. The scientific enquiries which have been made are described fully in the Agricultural Journal of India, Volume II, Part 2. With the co-operation of Mr. Finlow, forty-four so-called varieties of jute were grown at Pusa with the object of determining their characteristics and to gain knowledge regarding the differences in quality of fibre produced in different districts. Definite results have not yet been arrived at, and the experiments will be continued. A very practical aspect of the jute enquiry relates to improvement of varieties, manuring and cultivation. This is being fully dealt with. In particular, type specimens of each of the numerous races have been separated, and we are now able to supply pure seed of such races as are considered by our Botanists to be distinct. Mr. Finlow and Messrs. Cross and Bevan of London are collaborating in a bacteriological investigation regarding the alleged deterioration of Indian jute, but at present there is no evidence that the plant or its fibre have in any way deteriorated. Deterioration in the fibre is unquestionably due to malpractices in the trade after the crops are grown and retted. The Governments of Bengal and the Eastern Bengal and Assam have declined to undertake legislation to prevent fraudulent adulteration of jute.

23. *Flax.*—The possibility of cultivating flax in India as a paying fibre crop was recently revived by Sir Lewis Hay and the Dundee Chamber of Commerce. The Board of Scientific Advice published a Report on experiments with flax. The subject was referred to in an article issued in Volume I, Part III, of the Agricultural Journal of India. The Dooriah Indigo Factory in Behar, in which Sir Lewis Hay has an interest, carried out experiments which gave promising results. In 1906-07, a quantity of Russian (Riga) seed was distributed through the Department of Agriculture, Bengal. At Pusa and Bankipore, the results were promising, elsewhere they were not. At Bankipore the outturn of green plant was $2\frac{1}{4}$ tons per acre. The Pusa experiments indicated that fibre as well as seed might be profitably obtained in India by introducing the best kinds of Russian, Belgian and Irish seed. At Pusa we have arranged for fibre-extracting machinery suitable for flax. The Government of Bengal made a special grant to the Behar Indigo Planters' Association in 1906-07, to help them to procure the services of an expert from Europe and to instruct them in the methods of steeping, retting,

scutching and placing the fibre on the market. He has been appointed and has arrived. He is engaged in supervising experiments at Dooriah and in giving general advice. (*Vide* appendix B)

24. *Other Fibres.*—The cultivation of Sunn-hemp (*Crotolaria juncea*) and *Hibiscus canabinus* largely increased during the period under report. Formerly they were produced chiefly for use in India, but they are now exported to some extent as substitutes for jute. An investigation regarding possible jute substitutes has been undertaken by Mr. Finlow.

25. *Tobacco.*—Tobacco is a specially important crop in Bengal, Madras and in parts of the Bombay Presidency. Experiments at Pusa and in the Provinces have been undertaken in testing indigenous and exotic varieties, in hybridization and in methods of cultivation. These experiments will gradually lead up to the testing of methods of fermentation and curing. Fairly complete arrangements for these lines of work have been made at Pusa, but I do not anticipate any very special advance in our work until a Tobacco Expert is appointed, as no one in the Department has a specific knowledge of the work which should be done. Some foreign varieties have given good results in growth and apparently also in texture of leaf. Some experiments were conducted by Messrs. Spencer & Co. of Dindigul (Madras) to determine whether Indian grown tobacco could produce a good wrapper leaf when properly cured. The results were not indefinite. The Peninsular Tobacco Company, Limited, have started manufactories at Monghyr and Karachi and are producing cigarettes which, I believe, are superior to those previously produced in India. The fungoid and insect pests of tobacco are under investigation by Dr. Butler and Mr. Lefroy, and a certain amount of advice has been given to Planters.

26. *Wheat.*—The improvement of Indian wheat was fully discussed at the second meeting of the Board of Agriculture. The Provincial experts described the experiments which were being carried out in their respective areas. This information was epitomised by Mr. Howard. Dr. Butler and Mr. Lefroy prepared notes on the fungus and insect enemies of the crop. The Board of Agriculture considered in detail the suggestions and made proposals. The improvement of the Indian wheat trade requires numerous investigations specially as regards facilities for transport and also notably in regard to the separation of varieties, their improvement by selection of seed and by cross-breeding, the provision to cultivators of pure seed of varieties which can be grown without risk and which are suitable for export. The best means of storage in India requires investigation, also the milling and baking qualities of particular varieties. In the Canal Colonies of the Punjab, wheat has been grown year after year on the same land, and this system will certainly become unprofitable in time, even on the highly fertile soil of

these Colonies. The Muzaffarnagar wheat which has been distributed in large quantities from the Cawnpore Farm seed-stores for many years, continues to increase in popularity. In Bengal, this variety has given encouraging results. Pure samples of wheat which are suitable for export are being distributed by Provincial Departments of Agriculture. Rust resistance experiments are in progress on several Government Farms and are everywhere of very great importance. An account of the Indian wheat rusts has been published by Dr. Butler and Mr. J. M. Hayman as a Botanical Memoir, Volume I, No. II of 1906.

27. *Groundnut.*—The most important centres of groundnut cultivation in India are Madras and Bombay. During recent years there has been a marked decline, particularly in the Bombay Presidency in groundnut cultivation and a consequent falling off in the export trade. The causes of the decrease in Bombay cannot be definitely stated but are partially due to a fungoid disease locally known as *Ticca* and also to recent seasons of deficient rainfall. The Imperial Mycologist has shown that this disease which is due both to infected seed and infected soil can be combated by spraying. The chief damage is done late in the monsoon, and therefore early ripening varieties are to some extent exempt. Many foreign varieties have been introduced, and some of these practically escape damage by disease on account of their short period of growth. The most successful introductions in this respect have been Spanish and Japanese groundnuts. The indigenous varieties, however, command a higher price than any one of the Foreign varieties, for reasons which at present are difficult to understand. In Madras, the disease has been so disastrous that a special Government farm has been recently started at Palur in South Arcot for groundnut. There has been a keen demand for sound seed from many parts of the Presidency. Elsewhere also Provincial Departments of Agriculture have distributed sound seed. The groundnut area is rapidly extending in Burma and is likely to expand in the Central Provinces and Bengal and in the irrigated areas of Sind.

28. *Artificial Fertilizers.*—This subject is beginning to attract the general attention of agriculturists in India. It was considered by the Boards of Agriculture and Scientific Advice, and it has been recommended that various Agricultural Departments should undertake experiments to test such manures of this class as are available. A series of experiments are in progress on cotton with various artificial manures, and similar experiments will be extended to wheat, sugarcane and other valuable crops. The Board of Scientific Advice recommended that special attention should be given to the trial of sulphate of ammonia in sugarcane cultivation. This fertilizer is very largely used for sugarcane in Java and Mauritius, both of which countries are importing into India an increasing amount of sugar. When the Tata Iron and Steel manufactur-

ing project is in operation, the output of Ammonia Sulphate will greatly increase and be cheaply available for use in this country. The new artificial manures of Basic Nitrate, Calcium Nitrate and Calcium Cyanamide are under trial and will be tested on several Government Farms, although their prime cost in India for experimental trial is much beyond their worth in practical agriculture. Messrs. Phirozsha B. Petit & Co., Bombay, have, however, proposed to establish a factory in Kashmir for the manufacture of Nitrate of Calcium. At the instance of the Madras Agricultural Department, the Inspector-General of Agriculture referred to the Board of Agriculture at its second meeting, the question whether it was advisable for the Agricultural Departments to undertake the inspection and control of commercial fertilizers in India. Suggestions for legislation on the lines of those adopted in the United States and other foreign countries were also considered. After very careful consideration it was decided that the time was not ripe for the introduction into India of legislation on commercial fertilizers, but the Board considered it desirable to keep special watch over the developments of the trade.

29. *Irrigation.*—This subject, in relation to the improvement of agriculture, was fully discussed by the Board of Agriculture at its first meeting in January 1905 (Items Nos. 23—27 of the Proceedings). In pursuance of the recommendations of the Indian Irrigation Commission, hydraulic experiments in the irrigation of crops have been undertaken in most of the Provinces. In Bengal, the Agricultural Department started hydraulic experiments at Burdwan, Dumraon and elsewhere. These experiments, for the present, have been stopped owing to difficulties connected with reliable supervision. Mr. N. N. Banerji was placed on special duty to enquire into the possibility of extending well-irrigation in Behar and in Chhota-Nagpur. The results of his enquiry have been published as a separate report. The United Provinces have continued the investigations regarding general well irrigation and percolation wells. Well boring experiments are now a permanent feature in the work of the Department of Agriculture of this Province. Government provides the tools and supervision. The land-owners provide labour. Well sinking is also encouraged by giving advances. It is established that perforated cylinders provide the best casing for percolation wells. The Agricultural Department is also making experiments to solve the problem of sinking wells in the rocky parts of the Province and to protect the tracts of deep water level by tube wells worked by a central plant. In the Punjab, hydraulic experiments for irrigating wheat were conducted with the object of (1) determining the least number of waterings required and (2) the quantity of water required in each watering. These experiments will have to be continued for a number of years before definite results can be expected. The local Department of Agri-

culture is considering the question of employing an expert staff to report and prepare maps showing the possibilities of irrigation in each district, to improve the water supply of existing wells, to make trial borings and to generally aid the small proprietors to improve the irrigation of their fields. Hydraulic experiments for irrigating crops have been in progress for some time in Bombay. An oil engine and a pump is at work at the Nadiad Farm in Guzarat. The wells in this tract are deep, and their supplies of water are not easily exhausted. The cost of irrigation by oil-engine and pump is about half the cost by bullock power. The Department has arranged to maintain in each division a small staff of well borers. Boring trials will indicate where wells can be sunk with advantage. It is proposed to place an officer of the Public Works Department on special duty to enquire into the extension of irrigation from rivers by means of oil engines and pumps and to advise and assist land-owners in the erection and management of such machinery. Experiments in boring wells on the Japanese system were carried out in 1905 in the Bhavnagar State, Kathiawar. In all, five borings were made. The Japanese expert well sinker had his implements made locally. The depth reached in one case was 110 feet. The boring implements stuck at a certain depth before water was found and the boring had to be abandoned in each trial. The failure is partly attributed to the difficulty of making the Japanese expert and the labourers understand each other. The total cost of these experiments amounted to Rs. 5,500. Probably better and cheaper results would have been obtained by ordinary boring appliances. Madras has made very useful experiments on an extensive scale in pumping water with oil engines and centrifugal pumps under the supervision of Mr. A. Chatterton, Director of Industrial and Technical Enquiries. His report for 1905-06 fully describes his results. It embodies information in regard to (1) the actual cost of raising water under different conditions ; (2) the amount of irrigation water required under varying conditions as regards crop, soil and rainfall ; (3) the advantage of employing small oil engines and pumps for the irrigation of intensive cultivation such as that of garden crops on small areas ; (4) the quantity of water available for lift irrigation throughout the year from various sources of supply ; (5) the distribution of underground water in various parts of the Presidency and practical means of making larger use of it than at present ; (6) the efficiency of different oil engines and centrifugal pumps, the practical methods and the precautions to be taken in using them ; (7) the general arrangement of installations. In various parts of India *intensive* cultivation is practised and sugarcane, tobacco, ginger, turmeric, and many other crops are grown with extraordinary success. For this *intensive* cultivation, expensive well irrigation by bullocks and ordinary leather bags is very commonly used. This irrigation costs not less than Rs. 100 per acre per annum. The experiments of the last three

years have conclusively proved that there is great economy in using oil engines and pumps if there is a sufficient water supply in the wells. Oil engines can be worked fairly satisfactorily by native drivers on wages of Rs. 10 to 15 per month. In the Central Provinces a series of irrigation experiments with wheat and rice are being conducted on the Government Farms with the object of discovering the duty of water in various classes of soil, the maximum intervals between waterings and the like. In 1906, these Provinces were helped by a grant of Rs. 3,500 from the Imperial Department for experiments with oil engines and pumps. The Burma Agricultural Department is arranging to carry on experiments at Mandalay with irrigated paddy and also with a number of crops grown in the dry zone.

30. *Sericulture.*—Experiments in sericulture are in progress in several Provinces. The Bengal Silk Committee, with the support of annual subsidies from the Governments of Bengal and Eastern Bengal and Assam, continued to do useful work. Several model-rearing houses have now been constructed by the Committee. Microscopes and disinfectants were distributed to rearers. The necessity for these is gradually being appreciated by rearers particularly in Birbhum. The principal firms interested in the silk industry made a representation to the Government of Bengal showing a marked decline in the industry. A small Committee was appointed to make inquiries, and certain remedial measures were suggested. The late Mr. N. G. Mukerji, known as a Silk Expert, was deputed to Kashmir and Bangalore to report on methods of rearing, reeling, etc. He returned with the belief that the Bengal system of reeling could not be much improved and that inferiority in quality of silk was due to inferior cocoons. He was also deputed to the Baroda State, where Mulberry silk experiments have recently been started. After enquiry in the Central Provinces he also made recommendations for the improvement of the Tussar silk industry in that province. Sericultural experiments in the rearing of Univoltine silk in Eastern Bengal and Assam have, for the last three years, been giving successful results. In Hoshiarpore (Punjab) there has been a small but successful experiment. The raw silk produced in Kashmir in 1905 yielded a very high profit of £28,139 or 58½ per cent. on invested capital. The profits of 1906 are expected to exceed those of the previous year. The Kashmir industry gives employment to nearly 70,000 persons. A great success has already been achieved in establishing the silk industry at Mustang in the Kalat State (Baluchistan). The silk produced is equal in quality to Kashmir silk. Experiments in rearing Eri silk were started by the Imperial Entomologist at Pusa. Between April and November, five broods aggregating 150,000 worms were fed on the leaves of castor plants. The silk produced was valued in Calcutta at Rs. 80 per maund.

31. *Agricultural Education.*—The scheme sanctioned by the Secretary of State for higher agricultural education provides for seven Provincial Agricultural Colleges. In each of the larger Provinces except Eastern Bengal and Assam a site has been selected, land for experiments acquired and considerable progress made in construction of buildings. In most Provinces, the Colleges will be in working order within the next two years. The Madras College will be established at Coimbatore and the Bombay College near Poona. The Agricultural Schools at Nagpur (Central Provinces) and Cawnpore (United Provinces) will be each raised to the status of an Agricultural College. The needs of the Punjab and the North-Western Frontier Province will be met by a new Agricultural College at Lyallpur. The Agricultural Branch of the Sibpur (Calcutta) Engineering College will be closed as soon as the new Agricultural College at Bhagalpur is ready. The Burma Agricultural College is being built at Mandalay. The provision of Provincial Agricultural Colleges has modified the original aim of the Pusa Agricultural College. It will provide a post graduate course extending over two years to qualify graduates of Provincial Colleges as Experts in specialized branches of Agricultural Research. Pending the completion of the provincial Colleges selected students have been sent to Cambridge and America to complete their higher training in Agriculture. Four Bombay students are specializing in Sciences connected with Agriculture at Cambridge. Similarly the Government of Bengal have sent six students to America to graduate in Agriculture and specialize in particular lines of Agricultural work. Twenty-two probationers from various Provinces were under training at Pusa. Some were found unfit and rejected. Thirteen completed their training and were qualified for Provincial service. Three were trained in general agriculture, two in Agricultural Chemistry, two in Mycology and six in Entomology. Two probationers are still under training in Agriculture and Mycology. Besides these, six men were trained for field work in Entomology and one in Entomological drawing. The most pressing requirements of Provincial Departments are thus met; but the real development of agricultural improvement hinges on the completion of the Provincial Agricultural Colleges and the Pusa Institute. When these are ready, arrangements will be made to give full agricultural training, and the necessity of sending students to foreign countries will cease. Questions relating to educational qualifications necessary for admission, scholarships, the curriculum of studies and the degree to be conferred on passed students have practically been settled.

32. *Distribution of seeds and implements.*—This branch of work engaged much attention during the past two years. The demand for pure and selected seed has increased, and a number of seed depôts have been started by the Provincial Departments of Agriculture. The distribution has not, however, been successful in all directions particularly in regard

to indigenous varieties of cotton. For distribution in the Central Provinces cotton seed was obtained from particularly selected fields of good crop, but this selection was really no selection at all, because every field in the Central Provinces grows a very mixed crop of cotton. We have to begin much more humbly, go slow and be quite sure that we are really distributing seed which is true to a particular type. This principle is the beginning of seed selection, and the sooner this is fully recognised in every Province in India, the better for the country. In some of the other Provinces, the cotton seed distributed was truer to kind. Besides cotton, seed of other crops such as wheat, ground-nut, jowar, jute, tobacco, indigo, mustard, etc., was distributed to Government Farms or private persons, the object being to introduce new and superior varieties. Mention may be made of the successful results obtained at the Dumraon Farm by the introduction in 1902 of Jubbulpore and Raipur mustard. These varieties have been found superior to the local variety not only in the quantity of yield but also in the quality of oil. The Provincial Agricultural Departments have mostly established seed farms on a sufficiently large scale to grow seed of such varieties of crops as have been tried and found successful. We have had numerous indents from foreign countries for seeds and plants, and we get an adequate return in kind. We have sent abroad, in small parcels, a total of nearly four tons of seed during the last two years.

The interchange between Provinces of superior indigenous implements was as satisfactory as in the previous years. The agricultural exhibitions and shows which are becoming important features of the Provincial activities have greatly helped this work. There has been a marked increase in the demand for iron ploughs in some of the Provinces; winnowers and fodder cutters are gaining favour among cultivators. The Poona sugar boiling apparatus and the plant used in Mr. Hadi's process of sugar making have become widely known to cultivators, and the demand for these is steadily increasing. The merits of new implements are fully tested on Government Farms, and demonstrations are made to show the advantages of those which suit local conditions. Owing to scarcity of labour in the Canal Colonies of the Punjab, bullock-power reapers and steam threshers are coming into use, because, the enormous irrigated wheat crop of these Colonies must be handled expeditiously.

33. *Publications.*—At the suggestion of the Board of Agriculture of 1905 (Item 43 of the Proceedings) the Annual Reports of the Experimental Farms and the Departments of Agriculture have been improved. These reports will be issued hereafter in uniform size and at uniform dates. The work of each experimental station will be described in the form of a continuous record which will include any positive action taken to make the station and its teachings known to agriculturists generally. Accounts of experiments which have yielded very definite

results in experimental plots and demonstration areas will be published in Bulletin form. These Bulletins will be translated in simple vernacular for the information of native cultivators.

The Imperial Department of Agriculture now issues two important publications (1) the Agricultural Journal of India—a quarterly Journal, intended for the use of educated Indian Agriculturists and general readers interested in agriculture, and (2) the Scientific Memoirs of the Department of Agriculture, which are papers of a scientific or technical nature and are published occasionally. These publications are widely distributed in India and to learned societies and interested individuals in all countries. The free distribution is more extensive than the sale list. An adequate return is, however, obtained in free copies of publications which are indispensable to the Department. Moreover, advertisement is essential for new publications. The Journal and Scientific Memoirs are liberally supported by contributed articles from the Imperial and Provincial Experts of the Department and also from other Government officials and private individuals. Articles on original work in India can be published quicker in the Memoirs than in any home journal. This is a matter of importance to scientific men working for the Indian Agricultural Departments and is fully appreciated. A good many Bulletins have been published during the year by the various Agricultural Departments. They deal with definite results of agricultural experiments. All the agricultural publications issued in India during the past two years are given in the list of publications (Appendix C).

34. *Expenditure.*—The expenditure incurred in the Imperial Department of Agriculture (apart from expenditure on buildings constructed by the Public Works Department) has been as follows :—

Section of Department.	1906-07.	1905-06.
	Rs.	Rs.
Inspector-General of Agriculture in India . . .	90,235	1,03,360
Director, Pusa	1,06,300	60,665
Chemical Section	28,268	28,694
Mycological Section	25,382	24,055
Entomological Section	28,588	32,056
Bacteriological Section	2,500	900
Agricultural Section	99,248	63,692
Botanical Section	19,743	21,503
TOTAL .	4,00,264	3,34,925

The figures for 1905-06 include Rs. 99,572 for the initial expenditure under the following heads :—

	Rs.
Construction of Departmental Buildings and Machinery	50,747
Equipment of the Pusa Library	18,825
Laying out roads	15,000
Irrigation	15,000
TOTAL	99,572

Deducting this amount from Rs. 4,00,264 we get a net recurring expenditure of Rs. 3,00,692 for 1905-06. The expenditure of 1906-07 is larger than that of 1905-06. The increase in 1906-07 is due to the expansion of the Department. In addition to the ordinary budget provision, the Inspector-General of Agriculture in India receives an annual grant for expenditure upon special investigations, improvements and the like, which he may desire to introduce. The principal objects to which this grant has been devoted in the past two years are as follows :—

Particulars.		Amount.
1. Grants-in-aid of long stapled cotton experiments by Messrs. Shaw, Wallace & Co.		Rs. 40,000
2. Grants-in-aid of the Department of Agriculture, Bombay		12,000
(1) For Mr. Tytler's cotton experiment at Belgaum	5,000*	
(2) For Sugarcane Power Crusher for Manjri Farm	5,000	
(3) For sugarcane experiments in Sind and for demonstration of improved Poona method of *gul* making at the Ahmedabad Exhibition	1,200	
(4) Contribution to the Nadiad Farm	800	
3. Grants-in-aid of the Department of Agriculture, Bengal, for distribution of seed of the *Aus* variety of Central Provinces paddy in the Chota Nagpur District		350
4. Grants-in-aid of the Department of Agriculture, Central Provinces, for expenditure upon experiments with an oil engine and a pump in the Central Provinces		8,200
5. Paid to the Secretary to the Chief Commissioner, Coorg, for agricultural improvements in Coorg and for experiments with Caravonica cotton		3,000
6. Grants to the Indian Tea Association		30,000
7. Purchase of seeds, implements and other requirements for agricultural experiments		2,680†
8. Extension of Botanical Garden at Pusa		4,000
TOTAL		1,00,230

* Recovered from Mr. Tytler owing to his having formed a syndicate.

†The main heads of expenditure under this item are (1) Supply of jute seed to the Colonial Office, London, for trial in West Africa ; (2) Purchase of Arlington ploughs for trial in India; (3) Supply of Indian cotton gins to the Crown Agents for Colonies, Whitehall Gardens, London, for transmission to Lagos ; (4) Purchase of sugar boiling pans, for trial in the Central Provinces ; (5) Purchase of Hodgkinson's cotton hand-gins for trial ; (6) cost of date palm off-sets and tree cotton seeds ; (7) Sugarcane cuttings supplied to Samalkota Experimental Station.

35. *Provincial Departments of Agriculture.*—It is unnecessary to give details of work done in each Province because each Department publishes its own report. I may, however, give the following information.

36. *Bombay.*—The Department has five European Experts, a large staff of well-trained Indian assistants, an Agricultural College and

twelve experimental stations. The College is at present the only one that teaches up to a degree standard in Agriculture. It is at present located in a hired bungalow. The classes for the three years' course are large. The permanent building for teaching and research work is being built. One hundred and forty-three acres of land have been acquired for the College Farm. An Industrial and Agricultural Exhibition was held at Surat in 1906. The Department sent 722 exhibits. The Department holds annually an Agricultural Conference chiefly to obtain the views of practical business men regarding agricultural improvements. The Conference was held in Bombay in 1905, in Surat in 1906 and will be held at Ahmedabad in November 1907. Similar conferences if held regularly in other Provinces would also be of great value.

37. *Madras.*—The Expert European staff of the Department now consists of the Principal of the College, an Agricultural Chemist, Economic Botanist and two Deputy Directors of Agriculture. Mr. Chatterton, Director of Industrial and Technical Inquiries, helps the work of the Agricultural Department in many ways. His long experience in India is invaluable. There are now ten experimental stations in Madras which are devoted to general agricultural problems, also to particular enquiries regarding sugarcane, pepper, jute, groundnut, agaves, rice and cotton. Groundnut has received prominent attention, and there is a high demand for sound seed. The need is felt for practical Indian subordinates who can properly supervise field work. The new Agricultural College and the head-quarters of most of the expert staff will be at Coimbatore. Agricultural Shows and Associations are a marked feature in the useful work of the Department.

38. *United Provinces.*—The Director, Mr. W. H. Moreland, C.I.E., after a visit to Australia began the first work in wheat improvement by cross-breeding in India. This work continues to be a very important enquiry in his Department. His expert staff of European specialists is being gradually recruited, and the old Cawnpore School of Agriculture is advancing to the status of a college. Four agricultural stations are now at work, and the Province has been mapped out into four divisions, to each of which an all-round agricultural expert will be appointed. The methods adopted for storing and distributing good seed of particular crops could, with great advantage, be carried out in other Provinces. The method devised by the Assistant Director, Khan Bahadur H. M. Hadi, M.R.A.C., for refining sugar, has attracted much attention. Boring experiments for well water have been very successful. A superior method for constructing percolation wells has been devised.

39. *Bengal.*—The work of the Department of Agriculture was separated from that of Land Records towards the end of the year 1905-06. The expert staff sanctioned for this Province consists of Deputy Director of

Agriculture, Principal of the College, Economic Botanist and Agricultural Chemist. The last two places are still vacant. Indian assistants trained at Pusa have been appointed for such Entomological and Mycological work as can be done by them under the guidance of the Pusa staff. There are six agricultural stations at Dumraon, Burdwan, Sripur, Cuttack, Bankipore and Sabour near Bhagalpore. The first three stations are maintained at the cost of the Dumraon, Burdwan and Hathwa Rajs, respectively. The Bankipore (210 acres) and Sabour (340 acres) Agricultural Stations are being organised. A farm of 200 acres will be opened at Chinsura on the East Indian Railway line for the deltaic alluvium. The Department has opened a seed, implement and manure store which is increasing in usefulness. It is proposed to open such stores at each Agricultural Station. A Committee, with the Director as President, was appointed to enquire into the present decline of silk industry and to suggest remedial measures. The improvement of jute as regards agricultural and trade aspects has received much attention by the Department. The cultivation of imported varieties of flax is likely to lead to a new profitable fibre industry. The value of the *Rhea* industry which was boomed in Bengal some years ago, may now be discounted. The Bengal Government has continued to make an annual grant of Rs. 50,000 to the Behar Indigo Planters' Association for research work in indigo. The services of Mr. Bergtheil have been placed at the disposal of the Association. A very short summary of the research work done by him and his assistants at Sirsiah is given in Appendix A. The details of work done cannot be conveniently described here, but I consider that Mr. Bergtheil should continue his present investigations when he takes up his permanent appointment at Pusa and also as far as possible guide by advice the scientific work of the Behar Planters' Association. Pending the completion of the Provincial and Pusa Colleges, the Department has sent six passed students of the Sibpur College to America for higher agricultural training. The report of the progress of these students is satisfactory.

40. *Punjab.*—A separate Department of Agriculture has been formed in the Punjab as in other Provinces. The expert staff at present consists of the Principal of the Agricultural College and Research Institute, the Deputy Director of Agriculture and the Agricultural Chemist. An Economic Botanist will join shortly. The extraordinary fertility of the new Canal Colonies and the enterprise of the cultivators offer exceptional chances for agricultural improvement. The Punjab agricultural experts have thus unusual opportunities of improving the agriculture of the Province. The scarcity and dearness of labour in the Punjab will probably require the introduction of labour-saving machinery for the wheat crop. There are very large exports of wheat from the Punjab, and prompt harvesting and disposal of the crop is very important,

I suggest that it is extremely important that railway and other facilities for export should be improved.

41. *Central Provinces.*—The Department of Agriculture is now separated from that of Land Records and Settlements. Two Deputy Directors of Agriculture, an Agricultural Chemist, a Principal of the College and an Economic Botanist have been sanctioned. There are four experimental farms at Nagpur, Raipur, Hoshangabad and Akola. The Nagpur Farm deals chiefly with cotton, wheat and rotation experiments and the Raipur Farm with rice. The Hoshangabad Farm is specially intended for wheat experiments and the Akola Farm for experiments with cotton. The Department has particularly demonstrated in the districts the advantages of drilling particular crops and of using particular implements, specially winnowers, chaffcutters, iron-ploughs and sugar-making appliances. A good deal of useful work has been done in the sanitary disposal of sewage on cultivated fields on the Meagher System. The method of applying sulphate of copper to juar (*Sorghum vulgare*) seed to prevent smut has been extensively demonstrated. The distribution of selected seed was extended. The Nagpur Agricultural School has been raised to a College with a three years' course. The Agricultural Gazette which is published in vernacular has maintained its circulation. Several Agricultural Associations have been formed.

42. *Eastern Bengal and Assam.*—The expert staff of the Department consists of the Assistant Director and the Fibre Expert. The posts of Economic Botanist, Agricultural Chemist and the second Deputy Director of Agriculture have been sanctioned, but are not yet filled. The College and Laboratories are under construction at Dacca, and land has been acquired for a College Farm. The experimental stations are at Rangpur, Rajshahi, Jorhat, Upper Shillong and Wahjain, and land for a tobacco station at Burihat is being acquired. Important jute experiments are in progress. Bengali cultivators, to demonstrate the proper method of cultivation and of extracting the fibre, have been employed. The Rajshahi Sericultural School has been taken over by Government and remodelled on a popular basis.

43. *Burma.*—The Agricultural Department has now been fairly organised. The Land Records and Agricultural Departments have been separated. The expert staff consists of an all-round Agriculturist, as Principal of the College, Deputy Director of Agriculture, Agricultural Chemist and Botanist. Arrangements have been made to start three agricultural stations—one at Mandalay as College Farm, one at Hmawbi chiefly for the study of paddy and a third in the dry zone of Burma.

44. *Expansion of the Department.*—The general expansion of the Agricultural Departments in India outlined in the last report has progressed. The experimental stations and demonstration plots in each Province have increased in number. I have already referred to the strength-

ened staff of European Specialists. I am hopeful that the Indian staff will be improved by better rates of pay and prospects. The work of the Department will be much extended by the Provincial Agricultural Colleges, Agricultural Associations, Agricultural Shows and the establishment of cattle-breeding farms. Efforts are being made to provide improved seed, good manures and better implements. In the Provinces, the Departments of Agriculture have been separated from the Departments of Land Records in order to enable the Directors to devote undivided attention to the improvement of agriculture. There is, in fact, a general advance which need not be further particularised, but which is an advance for progress.

J. MOLLISON, M.R.A.C.,
Inspector-General of
Agriculture in India.

SIMLA, E.,
The 17th October 1907.

REPORT OF THE OFFICIATING DIRECTOR OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA

1. *Charge of Office.*—Mr. B. Coventry held charge of the office of Director until February 20th, 1907, when he proceeded on leave and I was appointed to act for him in addition to my own duties.

2. *General work of the Institute.*—The Institute consists of six sections, namely, Agriculture, Chemistry, Botany, Entomology, Mycology and Bacteriology. The agricultural, entomological and botanical sections have been located at Pusa during the whole two years; the chemical and mycological sections were transferred from Dehra Dun in 1905; whilst the bacteriological section remains to be opened. Excepting Agriculture, the sections which are already at Pusa are accommodated in temporary buildings pending the completion of the new laboratories. The nature of the work is fully explained by myself and my colleagues in the following sectional reports.

The extensive laboratories which have been under construction for three years will be ready for occupation by the end of April 1908.

3. *Buildings.*—Quarters for the European and native establishments, students' hostel, rest house, hospital and veterinary dispensary have been completed. The Farm buildings, Farm Office, Botanical and Entomological minor laboratories, Insectary, Fumigating House, and Potculture House were constructed departmentally.

4. *Roads, etc.*—The estate is liable to inundation from two sides and during the monsoon of 1905 and 1906 a large area of land was under water on this account. Three protective embankments became necessary, two of which have been completed and the third will be so shortly.

The roads of the estate have been made. The avenues have been thinned or new trees planted where necessary and generally improvements introduced. In some cases areas of jungle have been cleared for cultivation and pasture land.

Most of the compounds of the completed buildings have been laid out, but that of the large laboratories cannot be dealt with until the building is completed.

5. *Medical.*—A Military Assistant Surgeon was appointed in September 1906 but reverted almost immediately to military duty. He was succeeded by Mr. J. R. Foy in November 1906. The average number of cases in hospital has been 2·66 per day since the hospital was opened and the average number of out-door patients has been 13·11. In the

opinion of the European staff at Pusa the present medical arrangements are unsatisfactory.

6. *Training.*—Some students have undergone periods of training in special subjects. The courses of instruction will be much amplified when the Institute laboratories are complete.

7. *Library.*—The Library of the Institute consists of about 4,000 volumes, many of which are very valuable. It has been arranged to lend books to officers of the provincial departments under certain conditions. The catalogue is about to be issued.

8. *Publications.*—The publications of the Institute comprise (1) The Agricultural Journal of India, published quarterly, (2) Scientific Memoirs of the Department of Agriculture in India, (3) Bulletins which deal with matter in process of investigation, (4) Leaflets in English or the vernacular are issued at intervals.

The Inspector-General of Agriculture in India is the Editor and is assisted by advice from the staff. The grant is Rs. 25,000 per annum.

The preparation of these publications takes up much time. The Artist's work is supervised by Mr. Lefroy and the Photography is in my charge. These duties are by no means nominal and absorb much time. An Assistant Editor is urgently required.

9. *Accounts.*—The whole of the accounts pass through the Director's office. The total current cost of the Institute may be summarised as follows :—

	1905-06.	1906-07.
	Rs.	Rs.
Pay and travelling allowances	1,16,500	1,31,900
Publications	15,000	25,000
Farm expenditure and Scientific apparatus buildings, sanitation, etc., and contingencies . . .	1,78,500	74,700
TOTAL .	3,10,000	2,31,600

J. WALTER LEATHER,
Officiating Director, Agricultural Research Institute, Pusa.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST FOR THE YEARS 1905-06 AND 1906-07.

1. *Charge of Office.*—I held charge of this branch of the Institute until April 11th, 1906, when I proceeded on privilege leave until July

2nd and Mr. R. S. Finlow officiated for me ; I again held charge throughout the following 12 months.

2. *Laboratory.*—The laboratory was transferred from Dehra Dun to Pusa in November 1905 where it has been accommodated in a temporary building pending the completion of the permanent laboratory.

3. *General analytical work.*—In past years a large part of the energies of the establishment have been absorbed by the examination of specimens sent by provincial departments. With the appointment of provincial chemists a material change has been effected in the character of the work undertaken, and investigations of a more special nature have been taken up.

The following statement shows the number of samples analysed in each of the two years :—

	1905-06.	1906-07.
Soils	244	255
River water and silt	..	82
Waters	65	65
Manures	229	124
Feeding stuffs and oil-seeds	63	51
Sugars and surgarcane	46	132
Plants examined for glucoside	..	40
Rubbers	9	..
Gum	1	..
TOTAL	657	749

4. *Potculture House.*—A very well-equipped house for experiment on plants and soils by potculture methods has been erected at Pusa and a description of it published as Memoir No. 3 of the Chemical Series. The nature of the work carried on here is explained in paragraphs dealing with plant food in soils and cyanogenetic glucosides.

5. *Available plant food in soils.*—For several years a good deal of attention has been given to a study of available plant food in soils. The earlier work consisted in comparative tests of the validity of Dyer's method for the estimation of a soil's requirements in phosphates or potash and the principal results obtained have been published as Memoir No. 4, Chemical Series. As a practical adjunct to this work, a series of field experiments on the value of superphosphate in Behar, where the soil seems to be generally, within certain geological limits, deficient in available phosphate, has been commenced.

The investigation on available plant food in soils has more recently been directed to a more exact knowledge of the precise state in which

these compounds exist, in the hope that more accurate methods of soil examination may be evolved.

6. *Pusa soils.*—In 1906 samples of the surface and sub-soils of all the fields within the arable area at Pusa were taken ; they were subsequently analysed and, in addition, specimens of each were stored for possible future examination.

7. *Meteorology.*—The usual meteorological records are maintained and the Institute is a reporting station of the meteorological department.

8. *Rain and Dew.*—A record of the amount of Nitrogen compounds in rain and dew was maintained last year at Pusa to provide a confirmation of that which was obtained by the examination of rain water and dew at Cawnpore and Dehra Dun (Memoir No. 1, Chemical Series) and the newer data agree with these in demonstrating the smallness of the total amount of these compounds in the annual rain and dew.

9. *Drain gauges.*—During the hot weather of 1906 four gauges were constructed at this Institute for observing the nature of percolation during wet weather. They are similar to those at Rothamsted in England and at Cawnpore and each consists of a block of earth 1—1000 acre in area which has been isolated in the undisturbed state. In two, the earth is three feet deep, and in the other two it is 6 feet deep. Rain water falling on them may either soak into the soil, or if the fall is very heavy it may also overflow. Arrangements are made for measuring the amount of water which percolates, the velocity of percolation, the chemical characteristics of the drainage water, and for measuring any water which overflows at 2″, 3″ or 4″ above the ground level, as may be desired. The construction was carried out by Mr. M. H. Arnott, Superintending Engineer, Public Works Department, to whom we are much indebted for the care and interest that he devoted to this work. We shall thus have two records in India regarding the nature and quantity of percolation. Of those at Pusa it is proposed to keep one six-foot and one three-foot gauge entirely bare fallow, and on the other two vegetation, either grass or other plants, throughout the year, in order to determine the difference between the amount of drainage in the two cases.

10. *Loss of water from soil.*—Information as to the rate at which water is lost from soil during periods of dry weather and the amount of movement through the soil naturally forms the counterpart to a knowledge of drainage conditions, and records have been kept, in the first instance in bare fallow land, for this purpose. The first year's results have been considered of sufficient interest to merit publication and will appear shortly.

It will be evident that information regarding the movement of water through the soil during wet and dry weather respectively in India, important as it is when considered alone, is enhanced by the fact that it at the same time assists the formation of an opinion as to possible movements of plant food through the soil.

11. *Saltpetre.*—A reference was made in my last report to the saltpetre industry. Experiments were made to ascertain the manner in which the salts are removed from the nitre-earth during the percolating process so universally employed, and these demonstrated that the nitrates and chlorides pass out first, the major part of the sulphate remaining, in the ordinary course of the work, in the soil; and that the effect of the ashes which are so commonly added is to convert some of the nitrates of soda and lime into the potash salt. It was also ascertained that the common belief in the formation of nitrate in the refinery earths has no foundation in fact.

12. *Sugarcane.*—An assistant of this laboratory was again deputed during 1906 to analyse sugarcane in the Balaghat district.

The composition of the juice of the varieties of sugarcane at Pusa has been ascertained each year, and latterly this has been done periodically during the whole ripening period in order to ascertain what changes occur at this time.

13. *Cyanogenetic glucosides.*—Various plants, jowar, linseed, have been grown under varying conditions in order to try to determine the conditions under which their peculiar cyanogenetic glucosides are formed in large amount. It has been found that this is not a feature of the variety, for instances of the same variety forming much glucoside, or none at all respectively, have been met with. It is hoped that by carefully controlling the conditions of growth, the cause of formation may be isolated, and the work has met with a certain measure of success.

14. *Establishment.*—Mr. H. E. Annett, Supernumerary Chemist, arrived in May 1907. Mr. W. Roberts, Supernumerary Agriculturist, has been detailed to this section for experimental work on Behar soils. Four of the Indian assistants, who have served for some years in this section, are doing good work. Four of the provincial chemists spent some months at Pusa in order to acquaint themselves with the general work which is in progress.

In December 1905 three probationers, one each from Bengal, Madras, and the Central Provinces, were sent to this Institute for a period of training in the chemical section. Of these one resigned: the other two

remained until March 1907 and then returned to appointments in their respective provinces. The sanctioned scale of pay is insufficient to secure the best men, and only attracts probationers possessed of very limited qualifications. Much more than this is required if any particular progress is to be made in Agricultural Chemistry in India.

J. WALTER LEATHER,
Imperial Agricultural Chemist

PUSA.

PART IV.

REPORT OF THE IMPERIAL MYCOLOGIST.

1. I held charge of my section during the period under review, with the exception of three months from the 9th of August 1906, when I took privilege leave and Mr. S. K. Basu, Senior Assistant, took charge.

My laboratory was transferred from Dehra Dun to Pusa, in November 1905. It now occupies a temporary building. Considerable difficulties have been caused by damp and dust. Though these will be largely obviated when the main building is ready for occupation, still the experience of the past two seasons has shown that certain classes of work will always be carried on at a disadvantage in the warm, moist climate of Pusa.

My section will have two distinct functions to fulfil. One, common to all similar sections of Agricultural Departments everywhere, is the investigation of plant diseases and the study of fungi concerned in them, or otherwise agriculturally important. The other, usually separated or, indeed, in the older departments often unnecessary, is the accumulation of a representative collection of fungi for consultation. A large general fungus herbarium is not usually considered a necessary part of the equipment of an agricultural mycologist's laboratory. Such a collection is generally available elsewhere and in cases of difficulty the services of competent systematists near at hand can be obtained for the identification of species. As a matter of fact, however, in Europe at least and in a measure in the United States, cases of difficulty rarely arise. The fungus flora of these areas is well known and the identity of the species parasitic on particular plants can be determined with considerable ease. In India circumstances are different. It is probably the least known, excepting China, of any large area in the civilised world as regards the fungus flora. Almost the only important group of parasitic fungi which has been studied in India is the "rusts". Hence, though many of the commoner crop diseases of Northern India are known and have been studied in Europe, cases constantly occur of diseases which have not been previously investigated. In order to deal with these it is necessary to have the means of identifying the parasites concerned. The co-operation of other workers is not always available, and though I have to acknowledge generous assistance from outside India it is essential that the Mycological section at Pusa should eventually reach a position in which it will be able to deal with work of this nature. Further, one of the important duties at Pusa will be to assist

other Mycologists in India in determining their species and forthis purpose good consulting collections are necessary.

Much time has been given to organising the sectional library and collections for ready reference to meet this demand. Card indices of the collections both parasites and host plants, and of all fungi hitherto described from India, have been prepared.

When on leave in Europe, I visited Kew, Paris and Berlin to secure assistance in naming and describing my collections of Indian fungi. I was fortunate enough to obtain the co-operation of Messrs. H. and P. Sydow of Berlin, and technical descriptions of Indian fungi will appear from time to time in their Journal, the " Annales Mycologici ", one of the chief organs of systematic Mycology.

During the period under review, I collected specimens in Central Bengal, Behar, Godaveri, Belgaum, Bassein, Kumaon and Lyallpur. A very useful collection was made by Mr. S. N. Mitra, 3rd Assistant, in parts of the Bombay Presidency. Munshi Inayat Khan collected in Bundelkhand and Kumaon. Specimens have been presented by Mr. I. H. Burkill, Mr. J. M. Hayman, Mr. C. A. Barber, Professor Gammie, Mr. Sundararaman, Mr. R. S. Hole, Mr. R. S. Troup, in India and by Dr. Walter Busse, Berlin, Mr. E. W. Holway, University of Minnesota, Mr. C. G. Lloyd of Cincinnati, Professor Jakob Eriksson, Stockholm, and Herr H. Sydow, Berlin, to all of whom I am much indebted.

The main lines of research work which it is proposed to follow at Pusa, were submitted to the Committee of the Board of Agriculture appointed to advise on the scientific work of the Institute at the second meeting of the Board held in January 1906, and were approved of.

2. *Investigations of Plant Diseases.*—Palm diseases. A serious disease of cultivated palms has broken out within the past few years in the Godaveri Delta. It is spreading slowly in a continuous area. Palmyra palms are chiefly attacked, but coconut and probably betelnut palms are also destroyed. In many villages over eighty per cent. of the palms have been killed. I visited the diseased area in August 1905 and March 1907. Proposals were made for an organised campaign to endeavour to stamp it out before the very valuable coconut forests further south were infected. A sum of Rs. 5,000 was sanctioned by the Madras Government, in 1906, for experimental measures for its control in a small area. This was increased by Rs. 26,000 in 1907, for the treatment of the whole area affected. The present operations are under the control of an Assistant Collector with a supervising staff from the Madras Department of Agriculture and two assistants from Pusa. The working parties are composed of palm climbers (toddy drawers) under several Revenue Inspectors. The cause of the disease is a fungus which chiefly attacks the leaf sheaths, and spreads gradually through

successive sheaths until the central bud is reached and the tree is killed. An account of it was given in the Agricultural Journal for October 1906, and a technical description of the parasite in the Memoirs, Volume I, No. 5, February 1907.

3. *Sugarcane diseases.*—The chief sugarcane diseases studied were red rot, smut, black rot and red leaf spot. Experiments with the former extending over two seasons show that the chief mode of conveyance is by the use of cuttings already containing the fungus. As this view is not in accord with the ideas prevailing in other countries where the disease has been a cause of loss, it required very full testing. The result has been to leave no doubt as to its substantial correctness in the more severe forms of the disease. Two distinct types of disease, however, occur and have been the cause of the misconception. In the milder first type air-borne spores gain access to the standing cane, being assisted by anything which tends to weaken the latter, such as the attacks of borers or leaf-hoppers. Individual canes become diseased, but the whole stool is not as a rule affected. The use of such infected canes as cuttings for seed leads to the second and (in Northern India) much the more severe type. The living fungus is planted out inside the cuttings and the resulting stool is attacked from below and eventually killed. The first form was active in the Pusa crop in the season of 1906-07, following on an epidemic of leaf-hopper. By carefully excluding all canes with recognisable symptoms of infection in selecting seed cane, the more serious type of disease can be, as a rule, eliminated. The practical conclusions to be drawn are that while it is impossible to avoid completely the first type of disease, it may probably be much diminished by checking pests and is not in any case likely to lead to very severe loss. Most of the loss caused by this disease is due to the use of infected seed and this loss can be avoided by discarding such seed in planting, without great difficulty. "Ratooning" varieties subject to the disease (as most of the thick canes) is liable to result in loss, which may be entire or almost entire if the ratooned crop had any large proportion of diseased canes the previous year. Further experiments are in progress to determine how far the fungus can exist in a cane without causing discoloration, whether soil infection ever occurs, the co-existence of other fungi in red rot, its connection with borers and some other points. Experiments with smut have been commenced this season. Black rot is primarily a disease of cuttings and is not at present a serious disease, though a near ally, the "pine apple" disease, is a cause of much loss in other countries. The latter was detected in newly imported cane and the consignment was destroyed. Accounts of these and other diseases of cane were published in the Memoirs, Volume I, No. 3, July 1906, and in a paper on the selection of sugarcane cuttings in the Agricultural Journal in April 1907.

4. *Cereal rusts.*—Experiments have been carried on in conjunction with Mr.J.M. Hayman, Deputy Director of Agriculture, United Provinces at Cawnpore in growing wheat in rust proof cases to test the validity of the "hereditary" theory of the disease. About 180 plants have been thus grown and two pustules of rust occurred in two cases this year. On the whole the evidence is against this being a frequent occurrence and it is possible that accidental contamination took place. A preliminary enquiry into the degree of resistance and susceptibility to rust was carried out at Lyallpur and Pusa, but it has been considered advisable to postpone taking this up in detail until pure races of Indian varieties have been separated. An account of the experiments and of the varieties, distribution, etc., of Indian rusts was published in conjunction with Mr. J. M. Hayman in the Memoirs, Volume I, No. 2, July 1906.

5. *Ground-nut leaf disease.*—Failure to establish this disease at Pusa has led to the abandonment of local experiments in its treatment. At Poona, steeping and spraying experiments are in progress, without as yet, any definite results.

6. *Wilt diseases.*—An area was reserved on the Poona Farm for an attempt to produce a resistant strain of pigeon pea by selection. Last year's results were promising. A similar experiment commenced at Pusa was destroyed by floods. Biological work with wilt-producing fungi absorbed much time but the conditions of infection are not yet determined. Wilts of cotton, gram, Bimlipatam-jute (Hibiscus cannabinus), sesamum and indigo have also been under study and it is probable that the majority of these diseases are caused by the United States cotton-wilt fungus (Neocosmospora vasinfecta) which was discovered to be widely distributed in India this year. A paper describing the pigeon pea wilt was published in the Journal in January 1906.

7. *Green-ear disease of cereals.*—Bajra, jowar, Italian millet and Euchlæna luxurians are all attacked in India by a parasite, Sclerospora graminicola, previously known on Italian millet and wild grasses only. An account of its life history and effects was published in the Memoirs, Volume II, No. 1, March 1907. This should enable practical methods of treatment to be employed in localities where it causes loss.

8. *Mango diseases.*—I visited Malda in August 1905, at the request of the Bengal Agricultural Department, to enquire into a disease which was reported to be damaging the valuable mango orchards of the district. The cause was found to be an alga already known as the cause of "red rust" of tea, one of the worst blights of this crop. The features of the disease correspond closely with those observed on tea and, like the latter, serious loss appears to be confined to certain districts, though the alga is widely distributed all over India. The conditions determining viru-

lence are not clearly known but they are evidently local, and prolonged investigation on the spot would be necessary before any suggestion for treatment could be made. This is not possible at present. Other minor diseases of the mango have also been studied.

9. *Other diseases.*—A large number of other diseases of plants, including most of the cultivated crops of the plains and several fruit and economic plants, were examined. A proportion of these are specimens sent in by Superintendents of Farms and other persons interested in agriculture, and reports are issued giving such recommendations for prevention or remedy as are likely to prove most useful. Others are collected by the establishment. Information regarding these is steadily accumulated, cultures obtained, the life histories studied and inoculations tried as opportunity permits. When necessary, a personal visit is made to the locality reporting the disease, or an assistant is deputed for local investigation. It will be years before we have anything like a comprehensive knowledge of Indian plant parasites and every occasion is utilised towards this end. This may be taken as the routine work of the Laboratory at present. It is essential to acquire information regarding the characters, distribution and effects of the diseases of important crops in India as rapidly as possible. A few only can be selected for further investigation at any one time. Such are, at present, the cereal rusts, sugarcane diseases, wilts of Leguminosæ, and Malvaceæ, and palm diseases. In some cases simple preventive or remedial measures suggest themselves at once, and detailed study can be left over. A commencement has been made in expanding work through the medium of trained native assistants in the Provincial Departments. These men will be able to inculcate simple measures of improved sanitation, the selection of disease-free seed, the destruction of infective matter and the like; they will also assist largely in the crop disease survey. Larger measures of dealing with severe outbreaks of disease must be, as far as can be judged at present, left to Government agency. Government can also take an active part in checking imports of disease and in providing disease-free seed through seed farms. Further progress in the general control of plant diseases depends on the education of the cultivators.

10. *Soil inoculation for legumes.*—Field experiments with cultures of the bacilli obtained from pigeon pea, grown and applied after the methods recommended by the United States Department of Agriculture were carried out at Dehra Dun and Pusa. The Dehra Dun experiments, which alone were satisfactory, showed that no appreciable gain resulted from the application. The probable explanation is that bacilli, capable of forming nodules on this commonly grown pulse, must have been present in the field even though the crop itself had not recently been grown there.

11. *Fungus diseases of injurious insects.*—A joint investigation of the possibilities of this method of destroying locusts was carried out with the Imperial Entomologist. The locust fungus is a parasite which is capable of causing epidemic disease in certain locusts. Healthy specimens of the Bombay and North-West Migratory locusts and some species of grasshoppers were inoculated with pure cultures of the fungus, in various ways. Everything was done to increase the chances of infection. The results showed that for the species tested, the method is not likely to be of the slightest use. A Bulletin (No. 5 of 1907) giving details of the experiments and results is now printed. A supposed parasite of the green coffee bug was imported by the United Planters' Association of Southern India and forwarded to Pusa for cultivation. Repeated attempts were made to obtain a strong growth, but it failed to thrive and reports from South India indicate that no cases of infection occurred even with the freshly imported material, so that nothing is to be expected from this method of fighting the pest. These results are in harmony with the general experience of other countries, where the claims of those who advocate this line of work have not as a rule borne full enquiry.

12. *Soil fungi.*—A commencement has been made in the study of the soil fungi which assist in the decomposition of organic matter and help to render it available for plant food. The necessary preliminary to this is a knowledge of the species which are most constantly present in a given soil. This work has been in the hands of Mr. S. K. Basu, M.A., 1st Assistant, who has isolated and determined a number of the commoner soil forms at Pusa.

13. *Systematic Mycology.*—A monograph of the genus Pythium, an imperfectly known group of lower fungi to which the "damping off" and palm rot parasites belong, was published in the Memoirs, Volume I, No. 5, February 1907. To this was added a description of its parasites and some allied fungi. The first part of a systematic account of the fungi in the Herbarium at Pusa, entitled "Fungi Indiæ Orientalis", was published in conjunction with Messrs. H. and P. Sydow in the Annales Mycologici for October 1906. A second part is in preparation. Part of the collections of fungi, chiefly the larger woody forms, was sent to Kew, and descriptions of the new species published by Mr. G. Massee in the Kew Bulletin.

14. *Text-book.*—Some progress has been made in the preparation of a text-book of Indian diseases of plants. It is hoped to complete this during the coming year. Nothing of the sort is available for students of tropical and sub-tropical plant diseases.

15. *Training.*—The training of probationary assistants for the Central Provinces and Bengal was completed in April 1907. A pro-

bationer for the United Provinces has been under training since the 4th March 1907.

16. *Establishment.*—The staff has been strengthened by the recent appointment in England of Mr. W. McRae, M.A., B.Sc., as Supernumerary Mycologist. This officer has not yet, however, joined in India. Mr. J. H. Mitter, B.Sc., was appointed 2nd Assistant in July 1906. Babu R. R. Sen was appointed 3rd fieldman in August 1905, and N. C. S. Gupta, 4th fieldman, in December 1905, but transferred on deputation to the office of the Director, Pusa, in June 1906. All have worked satisfactorily, particularly Mr. S. K. Basu, Senior Assistant, Munshi Inayat Khan, 1st fieldman, and Babu Rameshwar Dayal, Clerk.

E. J. BUTLER,
Imperial Mycologist.

PUSA.
The 18th August 1907.

PART V.

REPORT OF THE IMPERIAL ENTOMOLOGIST.

1. *Training.*—Entomological Assistants were given a full course of training for the Agricultural Departments of Bombay, Bengal, United Provinces, Madras and Assam. A short course of training was given to the Entomological Lecturer, Poona Agricultural College, to a Farm Overseer undergoing a general Agricultural training for Bengal, and to six Agricultural Assistants who had completed their agricultural course at the Cawnpore Agricultural College for the Punjab Agricultural Department.

2. *Establishment.*—The Supernumerary Entomologist, Mr. C. W. Mason, arrived in December 1906. In anticipation of the appointment of the Second Entomologist, the staff allotted to this officer was appointed. The post of First Assistant to the Imperial Entomologist was held by C. S. Misra who is directly engaged in training the probationers sent to Pusa. The second Assistant, C. C. Ghosh, has had charge of the insectary. One Assistant, T. V. R. Aiyar, was transferred to Madras as Entomological Assistant. P. G. Patel has been specially employed to work at biting flies. The other assistants are now being trained. The artist staff appointed for the Institute and for the Journal worked under my guidance.

3. *Buildings.*—The insectary was occupied in July 1905; the insecticide godown has been used as a laboratory since June 1906 and a large part of the staff still work in the old barn. Lack of light and of working accommodation have caused great difficulties in carrying out Laboratory work. The full work of my section can only be entered into when the permanent Laboratory is complete.

4. *Provincial work.*—Trained Assistants are now employed in each Province and, in most cases, the Imperial Entomologist suggests and guides the year's programme of work. Progress has been made in the general study of injurious insects. In the Punjab, the severe outbreak of boll-worm required special measures which are reported to have given good results. The three principal measures were:—

(1) Removal and burning of the old plants in January.

(2) The cultivation of *bhinda* (Hibiscus esculentus) as a trap crop.

(3) The reintroduction of the parasite of the boll-worm.

The first did good generally, but the second was a general failure except in such localities as depended on well irrigation and where

the people understood how to grow the plant. The third measure was an apparent success. Damage estimated in 1905 at two to three crores of rupees was very greatly reduced in 1906 by these measures and in 1907 the crop is reported to be normal, the parasite being abundant generally. In Sind, the loss in 1906 was as bad as in 1907, but the parasite was reintroduced in April-May 1907 from Pusa and is now re-established there. The Bombay Entomological Assistant has given special attention to the outbreak of Potato Moth, an imported pest. In the Central Provinces, good progress has been made in investigating the general pests and a good course of practical entomology is being framed for the college. In Madras and Bengal good progress has also been made in general investigation regarding injurious insects.

The Provincial Entomological Assistants meet at Pusa in January of each year to discuss the year's programme, see the progress made at Pusa and compare notes. Real progress regarding Entomological enquiries is being made in the various Provinces and useful information about the injurious crop pests can without difficulty be diffused.

5. *Correspondence.*—Reports of injury to crops with specimens of the insects are received from the District officials and when possible a report is sent back at once. These district reports show when insects are doing injury and would be extremely valuable if more frequently sent; damage by insects is constantly reported in the weekly crop reports, but no report with specimens is sent to Pusa. I receive numerous enquiries from Farm Superintendents, Superintendents of the State Gardens, and from other official sources; from commercial firms, planters, zemindars and other private individuals. These enquiries cover a wide range and I have to devote much attention to answering them. A considerable part of my work is devoted to acquire the information necessary to answer such enquiries.

6. *Research.*—Progress has been steadily made in the investigation of the life histories and habits of injurious insects. A detailed study has been made or is being made of the most important insects, but for numerous destructive insects a full enquiry must wait until we have more time. For each injurious insect all observations are recorded and will in time be worked up. Every stage of the insect's life is recorded pictorially by an artist and the "plate" to illustrate each insect is brought to completion. When particular insects begin to do damage to crops, methods of treatment are experimented with. In co-operation with Mr. R. S. Finlow, a special investigation into insecticides was made, in the hope of finding a substance poisonous to insects but not poisonous to cattle, which could be applied profitably in the field. This investigation has reached the stage of field trials. Other subjects under enquiry, as time allows, are the

influence of climatic phenomena on insects, the utilisation of beneficial insects and the value of trap crops in Indian Agriculture. In collaboration with the Imperial Mycologist an enquiry was made into locust fungus and its value.

The cultivation of "Eri" silk was taken up to determine whether the worms will survive the dry hot weather or can be acclimatised to it. Lac was also introduced under cultfvation, as there is a large field for lac culture on existing trees in Behar.

7. *Insect survey.*—In addition to work of a purely economic nature, provision has to be made for teaching, both in the shape of a collection of the common insects of India and of facts concerning them. The general collection of insects at Pusa has accordingly been made as large as possible. The insects collected are, when necessary, sent to specialists in Europe or America for identification and are then classified. Large collections have been sent to England for the use of authors of prospective volumes of the Fauna of India; I have received the greatest help from the Editor of the Fauna, Colonel Bingham, and our collection owes much to the generous help of Mr. H. E. Andrewes, in sending named specimens of beetles.

It has also been necessary to gather together all the recorded information about insects as the basis of teaching and to supplement this by observation and research. This has been done and the text of a volume on the insects of the cultivated areas of India has been prepared. This will serve as a basis for teaching or, if published, will be an advanced student's text-book and a manual for all workers in Entomology in India. No such work exists at present and its preparation has taken much time. Mr. F. M. Howlett, who will take up the work of the Second Imperial Entomologist in November has collaborated. He has been working at Indian Diptera in England.

8. *Summary.*—The chief work of the past two years has been a continuation of the preliminary work commenced in 1903, the chief object being the study of the injurious insects of this country with a view to recommend measures to check them or at least to give reliable information about them. The publication of this information is important to the agricultural classes. Practical instruction in entomology can be more effectively carried out when the Provincial Agricultural Colleges and the permanent Laboratories at Pusa are opened.

9. *Publications.*—"Indian Insect Pests" is the most important item and its publication and wide circulation in India has already produced marked effects. The publication of the Journal and Memoirs has given me heavy work. I have had to supervise the preparation of illustrations for all sections of the Institute including the reproduction of the plates and illustrations of the Journal and Memoirs. I have acquired technical knowledge of printing processes, under some

difficulties. The publishers have introduced the "Three Colour Process," and other improvements and illustration work in India is being vastly improved. Although the work of Messrs. Thacker, Spink & Co. is excellent, we have great need for an Assistant Editor skilled in printing processes and who can bring the work of illustrating to the highest possible level without increased cost. I consider that an Assistant Editor for our publications is urgently required.

H. MAXWELL-LEFROY,
Imperial Entomologist.

PUSA ;
The 12th August 1907.

PART VI.

SUMMARY OF THE REPORT OF THE IMPERIAL AGRICULTURIST.

1. *Staff.*—Mr. E. Shearer was in charge of the section for the whole period. Mr. R. W. B. C. Wood joined as supernumerary in October 1905. In May 1906, he was appointed Deputy Director of Agriculture in Madras. Mr. A. G. Birt and Mr. W. Roberts joined each as a supernumerary in October 1906, and Mr. G. Garrad, in December 1906. Mr. Garrad was deputed to Bombay in May 1907 and Mr. Roberts to the Imperial Agricultural Chemist, each for special agricultural work which will probably give them some experience necessary for Provincial appointments.

2. *Historical.*—The Pusa estate of over 1,300 acres was largely occupied by jungle when first taken in charge by the Agricultural Department and the work of clearing the good land for arable cultivation has been extensive and costly. The work is not complete and apart from agriculture the amenities of the estate in this section still require considerable improvement.

3. *Training.*—Two probationers from Bengal completed two years' training in April 1906, and were respectively appointed overseers on the Bankipur and Sabour Farms. A probationer from the Central Provinces completed eighteen months' training in March 1907, and was appointed overseer on the Akola Farm. A probationer from Bengal was, after six months' training, appointed in December 1906, Travelling Inspector of Agriculture in the Orissa Division of Bengal. Another from Eastern Bengal and Assam continues under training.

4. *Cropping.*—The crops on particular selected fields were grown with the intention to determine how far the fields are uniform in character so that they may be eventually devoted to permanent experiments. The produce from each acre of these fields has been weighed separately. Information regarding the suitability of particular areas for particular experiments is required and a decision on this point will be come to shortly. So far, the indications are that, while large areas are not uniform, considerable blocks will be suitable for accurate experimental work.

5. *Cotton.*—Extensive trials began in 1904 and included the following:—

(*a*) Selected indigenous (annual and tree varieties).
(*b*) Newly imported American.
(*c*) Acclimatised American.
(*d*) Egyptian.

The general results have been unsatisfactory. It has been therefore decided that other crops are more profitable in Behar. In consultation with the Inspector-General of Agriculture, it has been further decided that these experiments should be abandoned. The varieties of tree cotton have given particularly unsatisfactory results at Pusa.

6. *Sugarcane.*—Twenty-five varieties were tested as regards methods of cultivation, manuring, irrigation, susceptibility to disease, outturn, etc. Damage was done particularly to thick soft varieties by white ants, borers, leaf hoppers, jackals and pigs. Fungus diseases caused considerable damage. Dr. Butler deals with the last-named troubles and Mr. Lefroy with insect attacks.

7. *Jute.*—Forty-four varieties of jute were grown in 1906, forty-two of *C. capsularis* and two of *C. olitorius*. The results are described in a general way by the Fibre Expert.

8. *Flax.*—Experiments with this crop have been carried on since 1904 for seed and fibre but chiefly for the production of fibre. The various varieties imported from Russia, Belgium and Ireland grew very well. An estimate of their value for fibre does not belong to my Department.

9. *Mangel wurzels.*—Mangel wurzels, as well as turnips, are grown to a limited extent in Northern India. The former was grown at Pusa in the rabi season of 1906 on well manured irrigated land and yielded just under 20 tons per acre. This crop will probably supply in part very suitable food for our cattle and sheep in the hot weather.

10. *Green manuring.*—The advantage of green manuring with San-hemp was tested and, in newly broken land, proved very profitable.

11. *Trial of new pasture grasses.*—The seeds of *Chloris virgata* (known in South Africa as "Rhodes grass") and *Chloris gayana* were received from New South Wales. They grew well and will be tried again on a larger scale.

12. *Breeding herds.*—Montgomery cattle continued to do well. The best of them give eight to nine sers* of milk a day when in full profit but this yield is less than in their own country. These cattle have remained healthy.

A herd of local cattle was started with the object of distributing bulls to improve Bengal cattle and the management is practically supervised by the Bengal Civil Veterinary Department. This breed is kept at Pusa to supply Provincial requirements but under present circumstances could possibly be more correctly controlled on a farm managed by officers of the Bengal Government.

13. *Establishment.*—The staff have worked well especially the two Farm Overseers, Mr. Gulabbhai Desai and Mr. Mohammed Ikram-uddin, and Mr. Judah Hyam, the Veterinary Overseer, who is in charge of the breeding herds.

* Ser = 2 lbs.

PART VII.

SUMMARY OF THE REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

1. Mr. A. Howard took up appointment in India in May 1905. During the first three months he saw a good deal of the work carried on by the Agricultural Departments in various Provinces. The area under his charge at Pusa contains a fruit orchard and also a Botanical Garden which is in part devoted to such crops as he is studying. The area is securely fenced and laid out conveniently with paths and in plots. The Botanical Garden of Economic plants is only now being laid out as funds were not available until this year. The want of a laboratory and apparatus greatly impeded his work at Pusa during the first year. Convenient buildings have since been erected. One building is provided with north light and is quite suitable for laboratory work.

Extensive orchards have been planted and these comprise plots of peaches, figs, mangoes, litchis, guavas, loquats, plums and citrus fruits. The experimental scheme refers to pruning, cultivation, irrigation, manuring, planting and the influence of stocks on the scion. The whole is commanded by irrigation from the river and drainage has been arranged for. An account of this work has been published as Bulletin No. 4 of the Agricultural Research Institute, Pusa. The fruit trees are yet all young. They have, however, grown well and all are likely to succeed as they were selected as suitable for the soil and climate of Pusa. Some trees have already fruited. The fruit from the peach trees was notably perfect.

2. *Wheat investigation.*—In 1905, Mr. Howard collected many samples of seed in the wheat-growing districts. These samples mostly contained mixed seed. The different varieties had to be sorted out and their botanical characters and agricultural values studied. He has obtained a representative collection of Indian wheats through the Agricultural Departments, the Reporter on Economic Products, the Superintendent, Botanical Survey of India, and from other sources. He has undertaken a detailed study of the Punjab wheats at the request of the Punjab Director of Agriculture. A preliminary classification was made in 1906. By extensive field studies a classification of all wheats grown in the various Provinces has been nearly finished. He started cross-breeding wheat experiments in the Punjab and at Pusa. On account of favourable climatic conditions the former are

likely to be the most productive. The cross-breeding wheat experiments in the United Provinces and in Bombay have been conducted by local officers for a number of years. Mr. Howard is preparing a book of reference regarding Indian wheats. The work has been more laborious than he expected. He hopes to finish it soon.

3. *Tobacco.*—The study of the numerous varieties grown in India has been commenced. Exotic varieties likely to grow well in India have been collected. A classification of various types is a necessary preliminary to work on improvement. This classification has been undertaken.

4. *Barleys.*—A survey of the barleys grown in India is being made with the aim of improving this crop by cross-breeding and selection of seed. Many varieties were grown at Pusa in 1906-07.

5. *Ganja* (*Cannabis sativa*).—The attention of the Imperial Economic Botanist has been drawn to the need of a biological study of the *ganja* plant, but at present he is fully employed on other and more important work and a general enquiry must wait. He has, however, started minor enquiries regarding this crop at Pusa.

6. *Library Catalogue.*—A complete revision of the Library catalogue was found necessary and was undertaken in 1907.

7. *Tours.*—Mr. Howard toured extensively to become acquainted with the agricultural conditions of various parts of India, to see the general agricultural and experimental work which is being carried out in the Provinces, and to gain special information regarding his work on wheat.

8. *Staff.*—Mr. R. J. D. Graham, M.A., B.Sc., has been appointed Supernumerary Economic Botanist, and arrived in May 1907. Mr. Howard has found difficulty in obtaining a sufficient staff, because neither pay nor prospects are at present attractive.

APPENDIX A.

A SHORT ACCOUNT OF RECENT WORK IN BEHAR IN INDIGO RESEARCH.

In continuation of the far more extensive work of the previous years experiments in manufacture have been carried out at Pusa and at the Bengal Research Station (Sirseah), but chiefly at the latter place.

The Java and Sumatrana varieties yielded the largest outturns of dye by steeping in water at a temperature of 104° F. for 7 hours. These results require confirmation. Extra expense is incurred by using water at a high temperature but water which is too low in temperature is frequently employed with loss on cold and wet days at the beginning and at the end of the manufacturing season. The value of the plant at various stages of growth has been investigated and the study of the fermentation process has been further extended. It is recommended that the conditions of time and temperature mentioned above should be rigidly adhered to. There are inevitable losses of indigotin in the seet water and also in boiling, straining and pressing; but it is believed that an increase of outturn can be usually obtained between the oxidizing process and the finished product. This is under investigation. Attention has been directed to drying indigo in the form of powder as indigo cakes have to be reduced to powder for dyeing purposes. The agricultural and laboratory tests have clearly proved the superiority of the Java plant over the old Sumatrana variety. The difficulties connected with the poor germination of Java seed have been overcome. Treatment with sulphuric acid is effective. The idea was suggested by Dr. Butler and the treatment is successful because the outer tough coat of the seed is weakened and germination in the ordinary moisture of Indian soils is thereby facilitated. The Java plant is a perennial. It should be sown in October-November and cut back in the spring in order to multiply branches and increase leaf growth. There are divided opinions regarding the effect of pruning in subsequent years and the question requires further investigation. As regards manurial experiments no very definite results can yet be reported. The inoculation of Indian soils with a culture of the appropriate nodule bacteria has produced no advantageous results in Behar, presumably because the soils of this district are already sufficiently stocked with such bacteria. Considerable advance has been made in supplying good seed of both Java and Sumatrana varieties to Indigo Planters from established seed farms.

The Behar Indigo Planters' Association have appointed a Botanist and further advancement in indigo research in India will greatly depend upon his work. Nothing has yet been done to separate the best types of plants of any particular variety. The indigo industry is by no means yet dead in India and may yet become again very prosperous by seed selection on rational lines and by other agricultural improvements which are quite feasible. Much less attention has been given to the agricultural improvement of the crop than to chemical and other enquiries regarding the best means of extracting the dye.

Samples of known indigotin content sent to various analysts for examination showed considerable discrepancy in their results. A uniform method of trade analysis for indicating the true indigotin content of the samples dealt with has, therefore, been attained and its use by the leading analysts of Calcutta and England secured. The relative dyeing values of synthetic and natural indigo have been tested by Mr. Bergtheil and very interesting results were obtained. Further trials are probably necessary, but as far as the tests at Cawnpore go natural indigo gave a better depth of colour than synthetic indigo and was pronounced a better dye for ordinary Indian cloths. Mr. Bergtheil is, at present, on leave in England. When he returns from leave his research work regarding indigo will be continued at Pusa where complete arrangements have been made for manufacture and research. We may thus help European Planters in Behar, but we are still more likely to help the backward methods of manufacture in the United Provinces and Madras where cultivation has recently extended.

APPENDIX B.

A SHORT ACCOUNT OF EXPERIMENTS WITH JUTE AND OTHER FIBRES.

Jute.

For several years the jute trade has been in a critical condition but it has been generally profitable to Indian cultivators and dealers. There has been a large expansion in its cultivation. The demand for the fibre increased so rapidly that supplies began to run short during 1905, with the result that prices had doubled. In 1906 and 1907 the areas under this crop expanded considerably with the result that in 1907 prices have fallen steadily and in time will probably become more normal.

Jute Extension.—Mr. Finlow, the Fibre Expert, has published a full report (Agricultural Research Institute Bulletin No. 3 of 1906) which deals with the possibilities of extending jute cultivation in various Provinces. This report has been supplemented by the report of Mr. F. Smith, published in the Agricultural Journal of India, Vol. II, Part 2, April 1907, which refers particularly to the results of the experiment in Bengal. Outside Bengal, Madras appears to offer more favourable opportunities for jute cultivation than any other part of India. The climate of the Malabar Coast is distinctly similar to that of Bengal, although the hilly nature of some parts indicates unsuitability at first sight. Trials with jute have been conducted in the Godavari delta, at the Samalkota Experimental Station, since 1905, by Mr. Barber, the Madras Government Botanist. The results of the experiments in 1905 were not successful, but in 1906, owing to better experience regarding the necessary agricultural conditions, they were much more satisfactory. These experiments have been continued at the Samalkota Farm in 1907 and seed has been distributed to a number of cultivators in the district, who have received advice from the Agricultural Department regarding the proper method of cultivation. In 1907, jute experiments are also being carried out in other parts of Madras, notably at Tanjore in the Godavari delta on the Malabar Coast. In Bombay, trials were carried out in 1906 at the Ganeshkhind Gardens, Poona, by Professor Gammie on manured land but without irrigation. A yield of over 7½ maunds of fibre per acre was obtained, the value in Calcutta being Rs. 10-4-0 per maund. A larger area has been put down this year. Experiments at the Poona and Manjri Farms—at the latter with irrigation—are also being continued. Conditions in the rice districts of Bombay are not so favourable as in Madras owing to the want of early rains. The Central Provinces commenced trials with jute in 1905 at Nagpur and at Raipur, which were continued in 1906 ; the results were not satisfactory, chiefly because there are usually no premonsoon showers and the seed cannot, therefore, be sown early enough under favourable circumstances. This season (1907), however, sowings were made at Raipur on manured land in April with well irrigation and the results are reported to be much more promising. Well irrigation early in the season is very expensive and it is extremely doubtful whether it will pay even with a valuable crop like jute in the Chhattisgarh district where rice is practically the only crop at present. Behar and the Assam Valley, where jute had not hitherto been cultivated to any large extent, will probably produce very fine crops as experience is gained by cultivators. In 1904, Behar Indigo Planters began to get interested in jute and their tenants are now growing the crop to a considerable extent. In this tract, about 8,500 acres are under cultivation in the Mozafferpore and Champaran Districts this season (1907). Jute cultivation will probably extend largely into the plains of Assam because physical and climatic conditions are suitable. During the months of March, April and May of the present year, Mr. Finlow made a prolonged tour through the districts north and south of the Brahmaputra, including Cachar. The land near the river on both banks of Brahmaputra is in some places subject to deep inundation in the rainy season, but in others the banks are

practically, if not entirely, above flood level. Away from the river, there are large areas of rich land, much of it virgin and covered with dense reed jungle which, when brought under cultivation, may yield large crops of jute. The cultivation of jute is extending rapidly in the western end of Assam Valley where the acreage is estimated at 60,000 acres this year (1907) as against 33,700 acres in 1906. Many tea planters are interested, but the lack of labour will prevent rapid development. Forty-four varieties of jute were grown at Pusa in 1906, with two objects —(*a*) to commence plant to plant selection of seed, (*b*) to study the botanical characteristics of the different races and their agricultural values. Our observations tend to show that the Bengal jutes can be generally classified into (*a*) green stemmed races, (*b*) red stemmed races, (*c*) early maturing races, and (*d*) late maturing races. Different districts do produce fibre of different qualities and we are enquiring into the reasons. A full report on the experiments made at the Burdwan and Cuttack Farms has been published by Mr. F. Smith in Agricultural Journal, Vol. II, Part 2, April 1907.

Seed Distribution.—The Bengal Agricultural Department in 1906 distributed about 300 maunds of seed of jute from crops grown specially for the purpose. The Eastern Bengal Department of Agriculture also distributed 75 maunds of seed grown at the Rajshahi Farm, a considerable proportion of the latter was distributed in small quantities free of charge to intending cultivators chiefly in Assam. Part of the seed was also used for experimental purposes in other parts of India.

Jute substitutes.—The question of utilizing the various fibre plants which are possible substitutes for jute is assuming increasing importance. Both San-hemp (*Crotalaria juncea*) and *Hibiscus cannabinus* are grown throughout India chiefly for home use but to a considerable extent for export. Madras had nearly 70,000 acres of *Hibiscus cannabinus* in 1906 (the acreage for 1905 was probably less than 45,000) grown for export, or for gunny bags made in the mills at Bimlipatam. Seventy thousand acres of San-hemp were grown in the plateau districts of the Central Provinces in 1905. The crop is also fairly important in Madras, the Punjab, Bombay and Bengal.

While these and other fibres have not all the peculiar properties of jute, they are superior to it in some respects and can be used for purposes for which jute is not suitable.

Other jute investigations.—Mr. Finlow has made arrangements with Messrs. Cross and Bevan of London, the well-known authorities on cellulose, to collaborate with them in certain scientific investigations regarding fibres. The first of these investigations is an attempt to find out the cause of the alleged deterioration which has occurred in jute during recent years. It is hoped that the Calcutta Baled Jute Association will co-operate in the enquiry which will, in the first instance, be chiefly bacteriological.

Diseases.—During the present season the crops of jute over a large part of Bengal have been attacked by insects ; but serious damage has not been done except in a few instances. The Imperial Entomologist is dealing with these pests.

Fraudulent watering of jute is a common practice among small dealers and leads to much damage to baled jute during transport to Europe. Repressive legislation which was regarded as essential by a considerable section of the commercial community was declined by the Governments of Bengal and Eastern Bengal and Assam on various grounds.

Scientific work.—A temporary laboratory has been equipped at Pusa and work has been carried on during the last three months. At present the investigations are devoted chiefly to a chemical and microscopical examination of numbers of samples of fibre with the object of establishing data to assist the selection experiments in the field. Other problems will be taken up as opportunity offers.

Flax.

Experiments in cultivating flax in India as a fibre crop began as early as 1840 but no definite results were obtained. Experiments have again recently been started chiefly by Sir Lewis Hay, Bart., who, together with his manager Mr. Cameron, has

commenced operations on a large scale at Dooriah, Behar. The results of these experiments were considered by the Government of Bengal to justify assistance and an expert flax cultivator, M. Vandekerkhove, from Belgium, was appointed in February 1907. He will have to gain experience of Indian conditions of cultivation before he can give reliable advice on all points regarding the prospects of the crop. He states, however, that the weight of the rippled straw at present obtained in India is only about half of the yield obtained in Europe. He considers that this return would not be sufficiently remunerative to induce cultivators to take up flax ; but he is quite sanguine that better results can be obtained by increasing the yield of straw per acre and by more expert manipulation in the extraction of the fibre. The retting process should be carried out in the fair season not in the rains. The hot weather is too dry for the breaking and scutching processes. Six varieties of imported flax were grown at Pusa during the rabi season of 1906-07 ; both for fibre and for seed. The yields of straw rippled (threshed), unrippled and seed were fairly satisfactory. Unfortunately, part of the machinery obtained from Europe for extracting the fibre arrived in broken condition so that it is impossible to give yields of fibre at present. The best plots gave about 25 maunds of rippled straw per acre. The European yield is from 40 to 50 maunds per acre. The cultivation expenses in Europe are higher than in India and acclimatization of seed may tend to increase the yield in India. The experiments will be continued until definite issues are obtained and a note will be published regarding results as soon as full experience on the prospects of the crop has been gained. In considering the value of a flax crop account must be taken of the seed, as the straw need not be cut for fibre until the seed is approaching ripeness. The average yield of seed from each of four plots at Pusa was worth about Rs. 17 per acre.

Mr. Finlow hopes in time to show, as regards Bengal and Eastern Bengal and Assam, (*a*) the best varieties of fibre plants to grow, (*b*) the best methods of cultivation, (*c*) the best means to produce the best fibre for the market, (*d*) the best means of getting full value for good fibre, and (*e*) the best way of growing seed on a large scale for distribution. He also hopes to be able to show to which areas jute cultivation can be profitably extended, where jute substitutes can be profitably grown and in which parts other profitable fibre plants can be introduced.

APPENDIX C

List of Agricultural Publications in India during 1905-06 *and* 1906-07.

No	Title.	Author.	Where published.
		General Agriculture.	
1	Annual Report of the Imperial Department of Agriculture for the year 1904-1905. Price 12 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
2	Proceedings of the Board of Agriculture in India, 1906. Price 12 annas.	Ditto ditto .	Ditto.
3	Proceedings of the Board of Agriculture in India, 1907. Price Re. 1-2.	Ditto ditto .	Ditto.
4	Annual Report of the Board of Scientific Advice for the year 1904-05. Price Re. 1.	Secretary, Board of Scientific Advice, Calcutta .	Government Central Press, Calcutta.
5	Annual Report of the Board of Scientific Advice for the year 1905-06. Price Re. 1-2.	Ditto ditto .	Ditto.
6	Agricultural Statistics of British India, 1904-05. Price Rs. 3.	Director General of Statistics . . .	Government Printing, India, Calcutta.
7	Agricultural Statistics of Native States, 1904-05. Price Rs. 3.		
8	Area and yield of certain crops in India, 1905-06. Price 5 annas.	Department of Commerce and Industry . .	Ditto.
9	Agricultural Journal of India, Vol. I, Parts 1-4. Price Rs. 6.	Agricultural Research Institute, Pusa . .	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
10	Agricultural Journal of India. Vol. II. Parts I to IV. Price Rs. 6.	Agricultural Research Institute, Pusa . .	Messrs. Thacker, Spink & Co., Calcutta.
11	The Extension of Jute Cultivation in India. Bulletin No. 3, 1906, of the Agricultural Research Institute, Pusa. Price 12 annas.	R. S. Finlow, B.Sc., F.C.S., Fibre Expert to the Government of Eastern Bengal and Assam.	Government Printing, India, Calcutta.
12	Note on the Oudh Seed Depôts . .	W. H. Moreland, C.I.E., I.C.S., Director of Agriculture, United Provinces of Agra and Oudh.	Ditto.
13	Report on the Control and Utilization of Rivers and Drainage for the fertilization of Land and mitigation of Malaria.	Sir Edward Buck, K.C.S.I., LL.D. . . .	Government of India, Revenue and Agricultural Department.
14	Sorghum Vulgare, Pers. (Andropogon Sorghum, Brot). The great millet or Juar in India. Agriculture Ledger No. 6 of 1905. Price 6 annas.	Sir George Watt, Kt., C.I.E.	Government Printing, India, Calcutta.
15	Phœnix Daetylifera Linn. (The Date Palm). Part I. Notes on Date Palm cultivation in countries other than India. Agriculture Ledger No. 1 of 1906. Price 3 annas.	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Ditto.
16	Psophocarpus Tetragonolobus (Goa Bean) Goa Beans in India. Agriculture Ledger No. 4 of 1906. Price 3 annas.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Ditto.

17	Report of the Agricultural Department, Bengal, for the period of 15 months from 1st April 1905 to 30th June 1906. Price 8 annas.	Department of Agriculture	The Bengal Secretariat Book Depôt, Calcutta.
18	Report on the Administration of the Department of Agriculture of the United Provinces of Agra and Oudh for the year ending 30th June 1906. Price 8 annas.	Ditto	United Provinces Government Press, Allahabad.
19	Report on the operations of the Department of Land Records and Agriculture, Punjab, for the year ending 30th September 1905. Price 5 annas.	Ditto	Civil and Military Gazette Press, Lahore.
20	Report on the operations of the Department of Agriculture, Punjab, for the year ending 30th June 1906. Price 4 annas.	Ditto	Ditto.
21	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1905-06.	Ditto	Government Central Press, Bombay.
22	Report on the working of the Department of Agriculture of the Central Provinces, during the year ending 31st March 1906. Price Re. 1.	Ditto	Secretariat Press, Nagpur.
23	Report on the operations of the Department of Agriculture, Madras Presidency, for the official year 1905-06. Price 6 annas.	Ditto	Government Press, Madras.
24	Burma Land Records Administration Report for the year ending 30th June 1906. Price Re. 1.	Ditto	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
25	Report of the Agricultural Branch of the Department of Land Records and Agriculture, Eastern Bengal and Assam, for the year 1905-06.	Department of Agriculture	Eastern Bengal and Assam Secretariat Press, Shillong.
26	Annual Report of the Burdwan Experiment Station for the year 1905-06. Price 4 annas.	Ditto	The Bengal Secretariat Book Depôt, Calcutta.
27	Annual Report of the Dumraon Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
28	Annual Report of the Sripur Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
29	Annual Report of the Cuttack Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
30	Report on the Cawnpore Agricultural Station in the United Provinces for the year ending 30th June 1906. Price Re. 1.	Ditto	United Provinces Government Press, Allahabad.
31	Report on the Agricultural Station, Orai, Jalaun, of the United Provinces of Agra and Oudh, for the year ending 30th June 1906. Price 8 annas.	Ditto	Ditto ditto.
32	Annual Report of the Government Experiment Farm, Lyallpur (Punjab), for the Kharif and Rabi Seasons, 1904-05. Price 5 annas.	Ditto	Civil and Military Gazette Press, Lahore.

33	Annual Report of the Government Experiment Farm, Lyallpur (Punjab), for the Kharif and Rabi Seasons, 1905-06.	Ditto	Ditto	Ditto.
34	Annual Report of the Agricultural and Botanical Stations in the Bombay Presidency for the year 1905-06. Price Re. 1-2.	Ditto	Government Central Press, Bombay.	
35	Report on the Agricultural Stations in the Central Provinces for the year ending 30th June 1906.	Ditto	Secretariat Press, Nagpur.	
36	Annual Report on the Agricultural Stations in Eastern Bengal and Assam for the year ending 30th June 1906.	Ditto	Eastern Bengal and Assam Secretariat Press, Shillong.	
37	Annual Report of the Tropical Plantation at Wahjain for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
38	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
39	Annual Report of the Rangpur Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
40	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto
41	Annual Report of the Shillong Fruit Gardens for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
42	Scientific Report of the Attur Agricultural Station for the official year 1905-06.	Ditto	Government Press, Madras.	

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
43	Scientific Report of the Hagari Agricultural Station for the official year 1905-06.	Department of Agriculture	Government Press, Madras.
44	Scientific Report of the Bellary Agricultural Station for the official year 1905-06.	Ditto	Ditto.
45	Scientific Report of the Palur Agricultural Station for the official year 1905-06.	Ditto	Ditto.
46	Scientific Report of the Koilpatti Agricultural Station for the official year 1905-06.	Ditto	Ditto.
47	Report of the Indigo Research Station, Sirsiah, for the year 1905-06.	C. J. Bergtheil, Imperial Bacteriologist . .	Behar Planters' Association, Mozufferpore.
48	Report of the Indigo Research Station, Sirsiah, for the year 1906-07.	Ditto ditto . .	Ditto.
49	Ficus Elastica. Its natural growth and Artificial propagation. Forest Bulletin No. 4.	E. M. Coventry, Deputy Conservator of Forests .	Government Printing, India, Calcutta
50	The cultivation of Ficus Elastica. Price Re. 1-6-0.	Claud Bald	Messrs. Thacker, Spink & Co.
51	The Objects and Plan of the Heelcaka Experimental Station.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association ; and C. M. Hutchinson, Assistant Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
52	Green Manuring in Tea Culture in India .	Ditto ditto.	Ditto.

53	Factors determining the Quality of Tea .	Ditto ditto .	Ditto.
54	Experiments in Heavy Pruning . .	Ditto ditto .	Ditto.
55	Report on the Heeleaka Experiments .	Ditto ditto .	Ditto.
56	Report on Sugar Mill at Benipur Factory .	Percy Jones	Behar Planters' Association, Mozufferpore.
57	A note on the results obtained with Java Indigo.	C. J. Bergtheil, Imperial Bacteriologist . .	Ditto.
58	A note on Testing the germinating capacity of Seeds.	Ditto	Ditto.
59	A note on Harvesting Java Indigo Seed .	Ditto	Ditto.
60	A note on the Treatment of Java Indigo Seed with Sulphuric Acid to promote germination.	Ditto	Ditto.
61	A note on Pruning Java Indigo . .	Ditto	Ditto.
62	Jute in rotation with Paddy in the same year. Leaflet No. 1 of 1907.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
63	Groundnut. Leaflet No. 2 of 1907 . .	Ditto ditto . .	Ditto.
64	Winter Rice. Leaflet No. 3 of 1907 .	Ditto ditto . .	Ditto.
65	Potatoes at Burdwan. Leaflet No. 4 of 1907	Ditto ditto .	Ditto.
66	Potatoes in rotation with Jute. Leaflet No. 5 of 1907.	Ditto ditto .	Ditto.
67	Variety Experiment on Mustard at Dumraon Agricultural Station. Leaflet No. 6 of 1907.	Ditto ditto . .	Ditto.
68	Suggestions on the improvement of Silk reeling in Bengal. Price Re. 1-8-0.	N. G. Mukerji, M.A., M.R.A.C., F.H.A.S., Assistant Director of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07.—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
69	A Report on Sericulture in Baroda . .	N. G. Mukerji, M.A., M.R.A.C., F.H.A.S., Assistant Director of Agriculture, Bengal.	Government Press, Baroda.
70	A Report on Kashmir Silk Industry . .	Raojibhai B. Patel, M.R.A.C., M.R.A.S., Director of Agriculture and Industries, Baroda.	Ditto.
71	Monograph on the Cattle and Buffaloes of Burma.	Major G. H. Evans, F.L.S., I.C.V.D. . .	Government Printing, India, Calcutta.
72	Notes on indigenous breeds of Cattle in the Punjab.	Major H. T. Pease, I.C.V.D.	Ditto.
73	Manual of Irrigation Wells. Bulletin No. 22 of 1907. Department of Agriculture, United Provinces. Price 12 annas.	E. A. Molony, I.C.S.	United Provinces Government Press, Allahabad.
74	Conditions determining the area sown with crop in the United Provinces, Part I. Bulletin No. 23 of 1907. Department of Agriculture, United Provinces. Price 2 annas.	W. H. Moreland, C.I.E., I.C.S., Director, Department of Land Records and Agriculture, United Provinces.	Ditto ditto.
75	Note on Sugarcane. Bulletin No. 25 of 1905. Department of Agriculture, Bombay.	J. B. Knight, M.Sc., Professor of Agriculture, Bombay.	Government Central, Press, Bombay.
76	Cattle in the Bombay Presidency. Bulletin No. 26 of 1905. Department of Agriculture, Bombay. Price Rs. 8-4.	Major F. Joslen, Superintendent, Civil Veterinary Department, Bombay.	Ditto.
77	Date Palm. Bulletin No. 28 of 1906. Department of Agriculture, Bombay.	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay.	Ditto.

78	The Bombay Cottons. Bulletin No. 29 of 1906. Department of Agriculture, Bombay. Price 10 annas.	Ditto ditto	Ditto.
79	The Statistical Atlas of the Bombay Presidency. Price 14 annas.	Department of Agriculture, Bombay . .	Ditto.
80	The Elements of Agriculture of the Bombay Presidency. Price Re. 1-4.	P. R. Mehta, M.R.A.C.	Government Central Book Depôt, Bombay.
81	Cultivation of Bersim or Egyptian Clover (intended for cultivation in Sind only).	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay.	Department of Agriculture, Bombay.
82	Instructions for the sowing and after cultivation of Egyptian cotton (without ridging).	Ditto ditto . .	Ditto.
83	First Book of Agriculture. Price 12 annas.	C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras.	MacMillan & Co., Ld., London.
84	Lift Irrigation. Price Rs. 2 . . .	Alfred Chatterton, Professor of Engineering, Madras.	G. A. Nateson & Co., Madras.
85	Report on Experiments in pumping with Oil Engines and Centrifugal Pumps in 1905-06.	Alfred Chatterton, Director of Industrial and Technical Enquiries in Madras.	Government Press, Madras.
86	Progress Report on the work of the Samalkota Farm during 1903-04, Bulletin No. 51.	Department of Agriculture, Madras . .	Ditto.
87	The Agathi Plant. Its growth in connection with the cultivation of the Betel vine which is trained thereon. Bulletin No. 52 of 1905. Madras Department of Agriculture. Price 9 pies.		

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
88	The cultivation and curing of Tobacco as followed near Dindigul, Madura District. Bulletin No. 53 of 1905. Madras Department of Agriculture. Price 3 annas.	Department of Agriculture, Madras . . .	Government Press, Madras.
89	Note on Irrigation by pumping from a well at Melrosapuram. Bulletin No. 54 of 1905. Madras Department of Agriculture. Price 3 annas.	Alfred Chatterton, Professor of Engineering, Madras .	Ditto.
90	The Great Millet or Sorghum in Madras. Bulletin No. 55 of 1906. Madras Department of Agriculture. Price 3 annas.	C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras, and C. K. Subba Rao, B.A., Sub-Assistant Director of Agriculture, Madras.	Ditto.
91	The Sunflower. Price 1 anna 6 pies . .	Department of Agriculture, Madras . . .	Ditto.
92	Some suggestions for Madras Ryots. Bulletin No. 3 of 1906. Price 2 annas 9 pies.	The Central Agricultural Committee, Madras .	Ditto.
93	The use of Prickly Pear as fodder. Bulletin No. 4 of 1906. Price 3 pies.	Ditto ditto . .	Ditto.
94	Squash. Bulletin No. 15 of 1906. Department of Agriculture, Eastern Bengal and Assam.	Department of Agriculture, Eastern Bengal and Assam.	Secretariat Press, Shillong.
95	Proceedings of the Agri-Horticultural Society of Madras (Quarterly, 1906).	Ditto ditto . .	Higginbotham & Co., Madras.

96	Journal of the Agri-Horticultural Society of Western India (Quarterly, 1906).	Honorary Secretaries, Poona	Scottish Mission Industries Company, Ld., Poona.
97	Experiments with Aman Paddy. Bulletin No. 1 of 1907.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Bengal Secretariat Press.
98	List of the Principal Economic Plants grown in Bengal. Price 7 annas.	Department of Agriculture, Bengal . . .	Bengal Secretariat Book Depôt.
99	Manual of Arboriculture . . .	Ditto	Bengal Secretariat Press.
100	Report on the Sugarcane Industry of Bengal.	Ditto	Ditto.
101	Report on the possibility of extending well irrigation in Behar and Chota Nagpur. Price 12 annas.	N. N. Banerjea, B.A., M.R.A.C., F.H.A.S., M.R., A. S.I., Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt.
102	Note on the Production of Coffee in India in the year 1906. Price 4 annas.	Office of the Director General of Commercial Intelligence.	Superintendent, Government Printing, India, Calcutta.
103	Production of Tea in India, 1906. Price 8 annas.	Ditto ditto .	Ditto ditto.
104	Note on the cotton failure on account of boll-worm in the Central and South-West Punjab in 1905 and on the results of the measures taken to prevent a recurrence in 1906. Bulletin No. 1 of 1907. Price 2 annas.	W. Renouf, C S., Director of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
105	Jute. Leaflet No. 1 of 1906 . . .	Department of Agriculture, Bengal . . .	Bengal Secretariat Press, Calcutta.
106	Note on Agricultural Experiments suitable for the Bhagalpur Division. Leaflet No. 2 of 1906.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
107	Suggestions on the Cultivation of Cotton. Leaflet No. 3 of 1906.	N. G. Mukerji, M.A., M.R.A.C., Assistant Director of Agriculture, Bengal.	Ditto.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—concld.	
108	A Short Note on Jute for Cultivators. Leaflet No. 4 of 1906.	Department of Agriculture, Bengal . .	Bengal Secretariat Press, Calcutta.
109	Short Note on Cotton for the use of Cultivators. Leaflet No. 6 of 1906.	Ditto	Ditto.
110	Simple instructions for the destruction of Insects attacking Jute. Leaflet No. 7 of 1906.	Ditto	Ditto.
111	Instructions in regard to Cotton Picking. Leaflet No. 8 of 1906.	Ditto	Ditto.
112	Short Note on Potato Cultivation for cultivators. Leaflet No. 9 of 1906.	Ditto	Ditto.
113	Teaching of Experiment work at the Burdwan Station. Leaflet No. 10 of 1906.	Ditto	Ditto.
114	A simple method of destroying the Red Cotton Bug which is now found in large quantities on the Cotton near Jamtara. Leaflet No. 11 of 1906.	Ditto	Ditto.
115	Jute Experiment, Cuttack, 1906 . .	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Ditto.
116	Jute Experiment, Burdwan, 1906. Leaflet No. 12 of 1906.	Ditto ditto . .	Ditto.

Agricultural Chemistry.

1	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1904-05.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
2	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1905-06.	Ditto ditto . .	Ditto ditto.
3	Phaseolus Lunatus (Lima or Duffin Bean). A Report on the Chemical examination of Beans. Agricultural Ledger No. 2 of 1905. Price 2 annas.	Wyndham R. Dunstan, F.R.S., Director of Imperial Institute, London.	Government Printing, India, Calcutta.
4	Saltpetre. A Report on the Manufacture of Indian saltpetre. Agricultural Ledger No. 3 of 1906. Price 6 annas.	D. Hooper, F.I.C., F.C.S., Superintendent, Industrial Section, Indian Museum, Calcutta.	Ditto.
5	The Fermentation of Tea, Part I . .	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
6	The rate of Hydrolysis in the Septic Tank .	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Paper read at the 6th International Conference of applied Chemistry, Rome, 1906.
7	The Agricultural Research Institute, Pusa .	Ditto ditto . .	Ditto ditto.
8	The supply of nitrate to the surface soil from the underground water. Price 5*s*.	Ditto ditto . .	The Journal of Agricultural Science, Cambridge. Vol. I, Part 4.
9	Some preliminary notes on the physical properties of the soil of the Ganges Valley, more especially in their relation to soil moisture.	H. M. Leake, M.A., F.L.S., Economic Botanist to the Government of the United Provinces of Agra and Oudh.	Ditto ditto.
10	The fermentation of the Indigo Plant .	C. J. Bergtheil, Imperial Bacteriologist . .	Transactions of the Chemical Society, 1904 Vol. 85.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		Agricultural Chemistry—contd.	
11	The Determination of the Indigotin in Commercial Indigo yielding plant.	C. J. Bergtheil, Imperial Bacteriologist . .	Journal of Society of Chemical Industry. Vol. XXV, page 729.
12	The Composition of Indian Rain and Dew. Price Re. 1.	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
13	The Composition of Oil Seeds. Price Re. 1	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
14	The Potculture House at the Agricultural Research Institute, Pusa, Part I. Price Rs. 3.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. 1. No. 3. Messrs. Thacker, Spink & Co., Calcutta.
15	Experiments on the availability of Phosphates and Potash in soils, Part I. Price Re. 1-8.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
		Botany.	
1	Bearing of Mendelism on the susceptibility of wheat to rust. Price 5*s*.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Journal of Agricultural Science, Cambridge, Vol. I, Part III.
2	The Blister Blight of Tea . . .	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
3	Agave and Furcræa, spp Agricultural Ledger No. 7 of 1906. Price Re. 1-8.	J. R. Drummond and D. Prain . . .	Office of the Superintendent, Government Printing, India, Calcutta.

4	The varieties of cultivated pepper. Bulletin No. 56, Vol. III of 1906. Madras Department of Agriculture. Price 3 annas.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Government Press, Madras.
5	Some results of acclimatization work at Saharanpur Botanical Gardens. Bulletin No. 21 of 1906. Department of Agriculture, United Provinces. Price 2 annas.	W. Gollan, Superintendent of Gardens, Saharanpur.	Government Press, Allahabad.
6	First Report on the Fruit Experiments at Pusa. Bulletin No. 4 of the Agricultural Research Institute, Pusa. Price 6 annas.	Albert Howard, M.A. (Cantab.), A.R.C.S. (Lond.), F.C.S., F.L.S., Imperial Economic Botanist.	Government Printing, India, Calcutta.
7	The Haustorium of Santalum Album I. Early stages, up to Penetration. Price Re. 1.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
8	Indian Wheat Rusts. Price Rs. 3 . .	E. J. Butler, M.B., F.L.S., Imperial Mycologist, and J. M. Hayman, Deputy Director of Agriculture, United Provinces.	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
9	Fungus Diseases of Sugarcane in Bengal. Price Rs. 3.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. I, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
10	Gossypium Obtusifolium, Roxburgh. Price Re. 1.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
11	An account of the Genus Pythium and some Chytridiaceæ. Price Rs. 4-8.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. I, No. 5. Messrs. Thacker, Spink & Co., Calcutta.
12	Cephaleuros Virescens, Kunze: The Red Rust of Tea. Price Rs. 4.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association, and C. M. Hutchinson, Assistant Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 6. Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		Botany—contd.	
13	Some Diseases of Cereals caused by Sclerospora Graminicola. Price Re. 1-8-0.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. II, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
14	Studies in Root Parasitism. The Haustorium of Santalum Album. Part 2.—The structure of the mature Haustorium and the inter-relations between Host and Parasite. Price Rs. 3.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1, Part II. Messrs. Thacker, Spink & Co., Calcutta.
15	Notes on Agave and Furcræa in India. Bulletin No. 8. Agricultural Series No. 7. Price Re. 1.	J. R. Drummond and D. Prain	Bengal Secretariat Book Depôt, Calcutta.
16	Report on trials of the South African Locust Fungus in India. Bulletin No. 5 of 1907. Agricultural Research Institute, Pusa. Price 2 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, and H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing, India, Calcutta.
		Entomology.	
1	An outbreak of Cotton Pests in the Punjab, 1905. Bulletin No. 2 of the Agricultural Research Institute, Pusa.	H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
2	The Indian Insect Pests. Price Re. 1-8 .	Ditto ditto . .	Ditto.
3	The Bombay Locust. Price Rs. 2-8 .	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.

	The more important Insects injurious to Indian Agriculture. Price Rs. 3.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
5	The Indian Surface Caterpillars of the Genus Agrotis. Price Re. 1-8.	Ditto ditto and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Memoirs of the Department of Agriculture in India, Vol. I, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
6	Individual and seasonal varieties in Helopeltis Theivora, Waterhouse, with description of a new species of Helopelties. Price Re. 1-8.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
7	The Coccidæ attacking the Tea Plant in India and Ceylon. Price Re. 1.	E. E. Green, F.E.S., Government Entomologist, Ceylon, and Harold H. Mann, D. Sc., Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 5. Messrs. Thacker, Spink & Co., Calcutta.
8	Rice Grasshopper. Bulletin No. 27 of 1906. Bombay Department of Agriculture.	J. B. Knight, M.Sc., Professor of Agriculture, Bombay, Poona, and R. M. Dixon, B.A., Entomological Assistant, Bombay.	Government Central Press, Bombay.
9	Red Slug Caterpillar (a serious Pest of the Tea Plant).	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
10	The Mosquito Blight of Tea, Part III . .	Ditto ditto .	Ditto.
11	Notes on Entomology. Bulletin No. 1 of Mysore Department of Agriculture.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
12	Destruction of Fleas by Insecticides. Leaflet. Agricultural Research Institute, Pusa.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing Press, Calcutta.
13	Useful Insects. (Leaflet.) Agricultural Research Institute, Pusa.	Ditto ditto .	Ditto.
14	Household Insects. (Leaflet.) Agricultural Research Institute, Pusa.	Ditto ditto .	Ditto.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—concld.

No.	Title.	Author.	Where published.
		Entomology—contd.	
15	Direction for sending Insect specimens. (Leaflet.) Agricultural Research Institute, Pusa.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial, Entomologist.	Government Printing Press, Calcutta.
		Bacteriology.	
1	A note on the Inoculation of the soil for leguminous crop. Bulletin No. 1.	C. J. Bergtheil, Imperial Bacteriologist .	Indigo Research Station, Sirsiah, Mozufferpore.

G. I. C. P. O.—No. 21 I. G. Agri.— 9-4-08—1,500.—J. E. J.