INDIAN
INDUSTRIAL COMMISSION
1916-18

APPENDICES
TO THE
REPORT

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1919

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the country, is sufficient to show that there are room and opportunity for a very substantial development of manufacturing and other industries.

2. It will be the business of the Commission, after establishing the fundamental proposition by a critical analysis of the facts, to suggest the most profitable lines of action with the object—

(*a*) of drawing out capital now lying idle;

(*b*) of building up an artisan population;

(*c*) of carrying on the scientific and technical researches required to test the known raw materials and to design and improve processes of manufacture;

(*d*) of distributing the information obtained from researches and from the results of experience in other countries; and

(*e*) of developing the machinery for—

(1) financing industrial undertakings, and

(2) marketing products.

3. As the result of the examination of Government records and preliminary discussion with various authorities, the following suggestions have been made regarding problems likely to come before the Commission. These suggestions are now being distributed among the Local Governments with a view of obtaining further suggestions during the current monsoon tour.

4. The President will be grateful for any suggestions in addition to, or in modification of, those given below, in order that, at the end of the monsoon, it will be possible to sketch out a tour programme for the Commission, and to frame a list of questions for the assistance of witnesses.

II.—Collection of preliminary information.

5. The Commission will assemble during October next, and, as soon as possible afterwards, will proceed by touring through the provinces, to collect evidence through independent witnesses, representatives of local Committees and institutions, and by personal inspection of industrial enterprises.

6. In view of the limited time at the disposal of the Commission, it would be an advantage in each of those provinces not already provided with a Director of Industries or an Advisory Board, to organise at once a representative Committee assisted, if practicable, by an officer on special duty. Steps to this end have already been taken by some of the Local Governments.

7. These representative Provincial Committees would be responsible for giving precision to questions that are now being discussed vaguely in general terms, for example, by stating them for concrete cases. The Provincial Committees would compile lists of raw materials available locally and suitable for the establishment of new industries, and also lists of raw materials that might be imported as accessory material, or even as the principal raw material with the same object. From this and other information at their disposal, they would form lists of industries already tried or new, that appear to be suitable for encouragement according to the special circumstances of each province, calling attention to enterprises that have been obviously successful or offer distinct promise of success. They might profitably make detailed and, when necessary, confidential studies of a few typical examples of recent failures, in order that the causes which have contributed to such failures may be brought to the notice of the Commission. They would also advise the Commission as to the names of suitable individual or representative witnesses.

8. It is suggested that, during the next cold weather tour, the time at the disposal of the Commission in each province might be divided as follows:—

(*a*) examination of individual witnesses, with, as convenient,

(*b*) visits to typical works or industrial centres, followed by

(*c*) a general conference between the Commission and the representative Provincial Committee.

9. The Commission will devote from a fortnight to three weeks to each of the larger provinces, and it will be an advantage to obtain from each Local Government, before the end of September, a programme indicating the most suitable centres for taking evidence and the most suitable places for visits to representative industries. It will be necessary to obtain, about the same time, a list of the individual witnesses nominated, in order that they may be supplied, about the middle of October, with a series of questions for the preparation of their preliminary written statements. It may be possible, in some cases, however, to nominate after this date additional witnesses on special subjects, but the Provincial Committees will doubtless take care that, in giving such advice, the programme in each case is not overloaded.

III.—Development of official administration.

10. Under this heading arise problems connected with the establishment or development of Imperial and Provincial Departments which are concerned, in one way or another, with

industrial enterprise. In some provinces, there are already at work Directors of Industries, assisted by technical experts and in some cases, advised by Boards of Industries, while in other provinces, proposals for a similar organisation are under consideration. It is obvious that, to effect improvements in the unorganised or cottage industries, such as hand-loom weaving, and in any industry in which local circumstances completely supersede technical considerations, the establishment of provincial departments is likely to be advantageous; but for some of the larger industries, in which purely technical matters are paramount, it may be advisable to form Imperial Departments.

11. It has been suggested that such central organisations might be formed for some of the following:—

(*a*) chemistry, including agricultural, metallurgical, tinctorial, and pharmaceutical chemistry;

(*b*) the leather and hide industries;

(*c*) glass-making;

(*d*) sugar and alcohol manufactures;

(*e*) paper-making; and

(*f*) oil-seed industries.

12. Opinions might be obtained as to whether any Imperial Departments of this description should be constituted, and, if so, for what subjects. The nature of their administration should also be considered, that is, whether their heads should be purely advisory, with inspecting powers, as in the Forest Department, or should have administrative and executive control as in the smaller and more specialised Geological Survey Department

13. It will be important also to obtain evidence as to the organisation of Provincial Industrial Departments, and the advisability of instituting Provincial Boards of Industries, or Advisory Committees, to include non-official members. Evidence as to the constitution and functions of these Boards or Committees should be obtained.

14. Finally, it will be necessary to obtain opinions regarding the relationship of a Provincial Industries Department with an Imperial Department of the kind mentioned in paragraph 11.

15. Evidence might also be obtained on the following points:—

(*a*) the suitability of the present system of collecting and distributing statistics and commercial intelligence, by the Director of Statistics and the Director-General of Commercial Intelligence, respectively;

(*b*) the advantages of establishing or assisting special journals for the chief industries and also general industrial and trade journals;

(*c*) any recognisable advantages which have followed the issue of special monographs and other Government publications such as those of the Forest and Geological Departments;

(*d*) the formation of commercial museums, and of sales agencies or of commercial emporia, in the principal towns of India and possibly abroad, for the display and the sale of the products of unorganised cottage industries;

(*e*) the institution of periodical industrial exhibitions;

(*f*) the appointment of trade representatives in other provinces, and, for the whole of India, in Great Britain, the Colonies and foreign countries;

(*g*) the possibility of establishing some system of Government certificates regarding the quality of products, accompanied by the institution of testing laboratories;

(*h*) the regulations of trade marks and the working of the patent laws; and

(*i*) the suitability of the present law for the acquisition of land on behalf of industrial companies.

IV.—Government aid to industries.

16. Evidence might suitably be collected regarding the experience so far obtained of financial and technical assistance rendered to industrial enterprises, and opinions might be obtained as to the most suitable form in which Government aid can be given to existing or to new industries.

17. The following methods have been suggested, and some have been tried, at different times:—

(*a*) loans and money grants-in-aid;

(*b*) supply of machinery and plant by Government on the hire-purchase system;

(*c*) guaranteed dividends for a limited period, with or without subsequent refund to Government of the expenditure incurred in paying dividends at the guaranteed rate;

(*d*) guaranteed Government purchase of products for limited periods;

(*e*) concessions of land;

(*f*) special railway transport facilities and rates;

(*g*) bounties and subsidies;

(*h*) pioneering industries and handing them over to private companies;

(*i*) loan of services of Government-employed experts.

18. With regard to any of these forms of direct Government assistance, it will be important to obtain opinions as to whether, and to what extent, they should be accompanied by Government control, as for instance, by the appointment of Government Directors for the period during which the direct assistance lasts. The information collected by officers placed on special duty will assist the Provincial Committees and the Commission in considering the extent to which Government aids to new enterprises will compete with those already existing and with established external trades.

V.—Technical and scientific work.

19. (*a*) What can be done to improve the labourers' efficiency and skill, generally or in particular industries? What advantages have followed from the establishment of industrial schools? What experience has been gained in training apprentices in factories or workshops?

(*b*) What steps are desirable for the improvement of supervisors of all grades and of skilled managers? Should assistance be given to these, or to technical experts of private firms, or to Government officials, to study conditions and methods in other countries? It is important to obtain some idea as to the benefits that have been gained by the deputation of officers abroad for special enquiries, or on ordinary study leave.

(*c*) What noticeable benefits have local industries received from researches conducted by Government Departments?

(*d*) What experience has been gained from demonstration factories? It would be interesting to obtain opinions as to where, and what kind of, factories should be instituted in each province.

(*e*) Problems have been referred at times to the Scientific and Technical Department of the Imperial Institute; it is important to obtain from those who have utilised the Institute opinions as to the relative merits of conducting researches in India and in England.

(*f*) It is understood that the activities of the new Advisory Council for Research in the United Kingdom may extend to India and Colonies; it will be useful to have opinions from scientific and technical men as to ways in which this opportunity may be utilised.

(*g*) It is important to obtain opinions as to the most suitable way of developing technological research institutions, such as the Indian Institute of Science. Should these be general in their interests or be confined to limited groups of related subjects, and should they be imperial in their interests, or be maintained as provincial institutions?

(*h*) Whether the time has come when measures should be adopted to prevent the unnecessary overlapping of research activities by Technical Departments, special Technological Institutes, and University Colleges?

VI.—Miscellaneous Questions.

20. Evidence might be obtained regarding the following questions:—

(*a*) Facilities for the development of hydro-electric power and the positions of apparently suitable power sites in the various Provinces.

(*b*) The effect of railway freight rates on local industries. Are there any practicable changes that can be made with apparent advantage, or are there any railway extensions that are necessary to develope possible new industries, or to extend existing industries? What waterways can be improved with advantage?

(*c*) Have any local difficulties been noticed in the working of the new mining and prospecting rules issued in September 1913? Are there any minerals that are essential for industries of imperial importance that ought to be developed at public expense, for example, minerals of direct importance for the manufacture of munitions of war, or substances which are ordinarily obtained in commerce only from one country?

(*d*) Can the forest policy be modified so as to permit of reducing the cost of assembling raw forest products, as for example, by the concentration of special kinds of trees in limited areas, and by improved forest transport facilities?

(*e*) In view of the report of Sir Edward Maclagan's Committee, it is important to obtain opinions as to what extent, and in connection with what industries, co-operative societies can be encouraged.

(*f*) In connection with the points already noticed in paragraph 15, regarding the collection and distribution of information under Government agency, could the principal Government departments which use imported articles assist Indian industries by publishing lists of these articles, or by exhibiting the articles in commercial museums?

(*g*) The possibility of formulating a scheme for financing, by existing or new banking agencies, the marketing of indigenous products.

APPENDIX A—3.

INSTRUCTIONS TO PERSONS INVITED TO GIVE EVIDENCE BEFORE THE COMMISSION.

IT IS NOT INTENDED THAT INDIVIDUALS OR BODIES INVITED TO GIVE EVIDENCE SHOULD ATTEMPT TO ANSWER ALL THE QUESTIONS.

The Commission will naturally attach importance to the practical experience and special knowledge which witnesses have acquired of the matters regarding which they offer opinions.

1. The questions in the accompanying lists have been framed so as to cover, as far as practicable, the whole scope of the enquiry to be made by the Indian Industrial Commission.

2. Each witness will also be examined orally by the Commission. At the oral examination, he will probably be examined on his written evidence in order to make clear doubtful points, and otherwise to enable the Commission to estimate its value.

3. A Chamber of Commerce or similar body invited, as a Chamber or body, to give evidence, may either submit one set of answers to the questions, which it desires to answer, and select not more than three representatives to support its views in oral examination; or it may nominate two or three individuals to give each his own views, in writing and afterwards orally. These individuals may be selected either as representing different interests or as having knowledge and experience of different subjects, or as representing different views on one or more subjects.

Individuals who are members of Chambers of Commerce or similar bodies may give evidence, at their own request or by invitation, independently of these arrangements. The evidence of these witnesses will be taken as representing their individual views only.

4. In answering the printed list of questions, *witnesses need not restrict themselves to a series of answers to the questions* on which they desire to give evidence. The questions are intended merely as a guide to show witnesses the matters on which the Commission desires to gather information and opinions. *The Commission prefers that witnesses should submit their views in a connected statement for each subject,* and include in each such statement their answers to the various questions.

5. Witnesses who desire that any portions of their evidence should be treated as confidential are requested clearly to mark such portions. Oral evidence will also be treated as confidential when witnesses so desire. They will be given the opportunity of revising the proofs of their oral evidence.

QUESTIONS FOR THE ASSISTANCE OF WITNESSES.

I.—FINANCIAL AID TO INDUSTRIAL ENTERPRISES.

Capital.

1. Please state if you have had any experience of the raising of capital for industrial enterprises?

If so, what difficulties have you found in doing so?

What suggestions have you to make for removing these difficulties?

2. What are the sources from which capital for industrial enterprises is principally drawn?

2 (*a*). Can you suggest any new sources from which capital may be drawn?

3. Do you know of any kinds of industrial enterprises where more concerns have been started than can be maintained in full-time employment?

If so, please describe the general conditions.

Government assistance.

4. What is your knowledge or experience of financial aid by Government to industrial enterprises?

5. What are your opinions on the following methods of giving Government aid to existing or new industries:—

(1) money grants-in-aid;

(2) bounties and subsidies;

(3) guaranteed dividends for a limited period, with or without subsequent refund to Government of the expenditure incurred in paying dividends at the guaranteed rate;

(4) loans, with or without interest;

(5) supply of machinery and plant on the hire-purchase system;

(6) provision of part of share capital of companies on the same basis as public subscriptions of capital;

(7) guaranteed or preferential Government purchase of products for limited periods; and

(8) exemption for a limited period of the profits of new undertakings from income-tax; and exemption from any tax on an industry, or on any article used in an industry.

6. In which methods of Government assistance should there be Government control or supervision?

What should be the form of such control or supervision? (*E.g.*, Government audit or appointment of Government directors with defined powers for the period during which direct assistance lasts.)

7. What is your experience or opinion of Government pioneer factories? Pioneer factories.

[NOTE.—By pioneer factories are meant those established primarily to ascertain whether a new industry is commercially practicable?

By demonstration factories (see questions 19 and 20) are meant those established primarily for giving demonstrations of, and instruction in, improved methods for industries which have been proved to be commercially practicable.]

8. In what ways and to what extent should Government pioneer industries?

At what stage should pioneer factories be either closed or handed over to private capitalists or companies?

What limits and restrictions, if any, should be imposed on the conversion of successful pioneering experiments into permanent Government enterprises?

9. In your experience what industries are hampered by the conditions under which they are financed as going concerns? Financing agencies.

Please describe the method of financing and its effect on the industry in each case.

10. In what ways is it possible to give more assistance to industrial undertakings by existing or new banking agencies?

10 (*a*). Do you think there is need of a banking law?

[See also question 39.]

11. Do you know of any industries which have been developed or assisted by the formation of co-operative societies? Co-operative societies.

What were the exact means adopted and what were the results obtained?

12. In your experience what are the industries for which co-operative societies should be encouraged.

What should be the organisation and special objects of these societies?

12 (*a*). What suggestions have you to make for industrial development by means of Trade Guilds, such as exist in other countries?

How far should the State encourage the promotion of such Guilds?

13. What principles should be followed in order to prevent Government aid competing with existing or discouraging fresh, private enterprises Limits of Government assistance.

14 Should there be any limitations on Government aid to a new enterprise if it competes with an established external trade?

II.—TECHNICAL AID TO INDUSTRIES.

15. What is your personal knowledge or experience of technical and scientific aid provided by Government to industrial enterprise? Technical aid in general

16. What is your personal knowledge or experience of noticeable benefits received by local industries from researches conducted by Government departments?

17 On what conditions should the loan of Government experts be made to private firms or companies?

18. Under what restrictions and conditions would you allow publication of the results of researches made by a Government-paid expert while attached to a private business?

19. Can you suggest any industry for which Government demonstration factories should be adopted and on what lines? (See note below question 7.) Demonstration factories

20. Should any demonstration factories be instituted in your province?

21. What has been your experience of the aid afforded by the Scientific and Technical Department of the Imperial Institute? Research abroad.

What are its advantages and disadvantages?

22. In addition to arrangements made for research in India, is it advantageous to have provision for research for special subjects in the United Kingdom?

If so, for what special purposes is it advantageous to conduct researches in England rather than in India?

23. In what ways can the Advisory Council for Research in the United Kingdom give assistance to Indian industries?

24. Can you suggest for this country any system, similar to that of the Advisory Council for Research in the United Kingdom, for referring research problems to Colleges and other appropriate institutions in India? (See questions 75 and 76.)

Surveys for industrial purposes.

25. Does the existing knowledge of the available resources of the country—agricultural, forest, mineral, etc.—require to be supplemented by further surveys?

26. How should such a survey be organised?

What should be its precise objects?

27. How should its results be made most useful to industries?

27 (*a*). What is your experience or opinion of the value of Consulting Engineers appointed by Government to aid industrial enterprise by technical advice and by the supply of plans and estimates?

(*b*) Should such Consulting Engineers be allowed to undertake the purchase of machinery and plant for private firms or individuals? If so, under what conditions?

[See questions 63 *et seq.*]

III.—Assistance in marketing products.

Commercial museums

28. What is your experience or opinion of commercial museums, *e.g.*, that in Calcutta?

29. If you think commercial museums should be developed and increased in number what suggestions have you to make regarding their situation, arrangement and working.

Sales agencies

30. What is your experience or opinion of sales agencies or commercial emporia for the sale as well as the display of the products of minor and unorganised cottage industries.

How should they be developed?

Exhibitions.

30 (*a*). Would travelling exhibitions of such industries be of advantage?

31. What is your opinion or experience of the value of industrial exhibitions?

32. Should Government take measures to hold or to encourage such exhibitions?

If so, what should be the Government policy?

33. What should be the nature of such exhibitions?

Should they be popular in character, or should they aim merely at bringing sellers and buyers into contact?

Trade representatives.

34. Should trade representatives be appointed to represent the whole of India, in Great Britain, the Colonies and foreign countries?

What should be the qualifications of these trade representatives?

How should their duties be defined?

35. In addition to these trade representatives would it be suitable in some cases also to have temporary Commissions for special enquiries?

36. Should provinces in India itself have trade representatives in other provinces?

How should such representation be arranged for?

Government patronage.

37. Should the principal Government departments which use imported articles publish lists of these articles, or exhibit them in commercial museums?

38. With reference to the encouragement of Indian industries, have you any criticisms to offer regarding the working of the present rules relating to the purchase of stores by Government departments?

Have you any changes to propose in the rules themselves.

Banking facilities

39. In what way is it possible to assist in marketing indigenous products by more banking facilities, either through existing agencies (such as the Presidency, Exchange, Joint Stock and Co-operative Credit Banks) or through new agencies (such as Industrial and Hypothec Banks)? (See also question 10.)

IV.—Other forms of Government aid to industries.

Supply of raw materials

40. What conditions should control the supply of Government-owned raw materials (*e.g.*, forest products) on favourable terms?

Land policy

41. Is there any check at present imposed on industrial development in your province by the land policy of Government?

If so, what remedies do you suggest?

(Note.—The expression "land policy" is intended to cover laws and regulations relating to settlements, the Government assessment, rents, tenant rights, permission to use land for industrial purposes, and generally all matters connected with the ownership and use of land.)

42. On what principles should Government give concessions of land for the establishment of new, or the development of existing industries?

43 What criticisms have you to make regarding the working of the present law for the acquisition of land on behalf of industrial companies?

What modifications of the law do you recommend?

43(*a*). In what ways and on what terms can Government assist in the provision of subterranean or surplus surface water for industrial purposes.

V.—Training of Labour and Supervision.

44(*a*). Do you think that the lack of primary education hinders industrial development? General.

(*b*) What has been done in any industry of which you have had experience to improve the labourers' efficiency and skill?

45. What steps do you consider should be adopted to improve the labourers' efficiency and skill—

(*a*) generally, and

(*b*) in any industry of which you have had experience?

46. What special knowledge or experience have you of the training of apprentices in factories and workshops? Apprenticeship system and industrial and other schools.

47. What advantages have you observed to follow from the establishment of industrial schools?

48. On what lines should these two systems of training (*i.e.*, apprenticeship system and industrial schools) be developed and co-ordinated?

49. What has been your experience of day schools for short-time employees, or of night schools?

How should these be developed?

50. Should industrial and technical schools and commercial colleges be under the control of the Department of Education or of a Department of Industries?

What measures should be adopted in order that these two departments should work in unison in controlling industrial schools?

51. What measures are necessary for the training and improvement of supervisors of all grades and of skilled managers? Training of supervising and technical staff.

52 What assistance should be given to supervisors, managers and technical experts of private firms to study conditions and methods in other countries? (See question 77.)

53. In what circumstances and under what conditions should industries assisted by Government be required to train technical experts?

54. Is there a want of uniformity in the standard of examinations for mechanical engineers held in the various provinces where engineers in charge of prime-movers are required in certain cases to be certificated? Mechanical engineers.

If so, should measures be adopted to make such tests uniform so that the Local Governments and Administrations may reciprocate by recognising each other's certificates?

55. If the law in your province does not require any qualifications in an engineer in charge of a prime-mover, have you any criticisms or suggestions to make?

VI.—General Official Administration and Organisation.

56. What provincial organisation exists in your province for the development of industries?

What criticism have you to make regarding its constitution and functions?

57. What organisations do you recommend for the future development of industries in your province?

Should there be a Board of Industries?

If so, what should be the functions of such a Board?

Should it be merely advisory or should it have executive powers with budgetted funds?

58. If you recommend an Advisory Board, how should it be constituted?

59. If you recommend a Board with powers, what should be its constitution and how should its powers be defined?

60. Should there be a Director of Industries?

What should be his functions?

Should he be a business man, or a non-expert official, or a technical specialist?

What other qualifications should he possess?

61. If you recommend both the formation of a Board of Industries and the appointment of a Director of Industries, what should be the relations between the Board of Industries, the Director of Industries and the Provincial Government or Administration?

62. What form of machinery do you propose in order to correlate the separate activities of the various provinces as regards industries?

Is it practicable to form an Imperial department under a single head?

If so, what should be the functions of such a department?

Cottage industries.

62(*a*). Should there be special measures taken or special sections of a Department of Industries organised for the assistance of cottage industries?

62(*b*). Please explain in detail what should be the Government policy as regards cottage industries and how it should be carried into effect? In this connection, see especially questions 11, 30, 64 and 72.

62(*c*). What cottage industries do you recommend should be encouraged in this way?

VII.—Organisation of Technical and Scientific Departments of Government.

General.

63. Are there in your province any technical and scientific departments which are capable of giving assistance to industries?

If so, what criticisms have you to make regarding their organisation?

What changes do you recommend?

Imperial department.

64. In order to aid industrial development do you recommend the formation of any new Imperial Scientific and Technical Departments?

If so, for what subjects or natural groups of subjects?

65. How should such an Imperial department be constituted and recruited?

66. What should be the powers of the head of the department?

If he has executive control of the department, what should be his relationship to the Imperial Government?

67 What should be the relationship of an expert, whose services are loaned by the Imperial department to a Local Government, with the Local Government and the latter's Department of Industries?

Provincial departments

68. For what subjects should Local Governments engage their own experts or organise their own technical and scientific departments?

69. Under what direct control should these experts and departments be placed?

70 On what terms should these experts be employed?

Technological institutions.

71. What is the most suitable way of developing technological research institutions, such as the Indian Institute of Science?

71(*a*). Should there be a Technological Institute for each province, and should such Institutes be allowed to develop as independent units, or should they be fitted into a general development scheme for the whole of India, with a central Research Institute?

72 As regards investigation and research should each Institute be general in its activities and interests, or should each deal with limited group of related subjects?

73. Should there be any Government control?

If so, should this control be imperial or should it be purely provincial or local?

Co-ordination of research.

74. Is it desirable that measures should be taken to co-ordinate and prevent unnecessary overlapping of the research activities in Government Technical and Scientific Departments, special Technological Institutes and University Colleges?

If so, what are your suggestions?

75. What noticeable results have followed from the institution of the Indian Science Congress?

76. Can you suggest any ways in which the Congress might become more useful in assisting industrial development? (See question 24.)

Study of foreign methods.

77. What encouragement should be given to Government technical and scientific experts to study conditions and methods in other countries? (See question 52.)

Reference libraries.

78. What difficulties have you experienced in consulting technical and scientific works of reference?

79. Have you any suggestions to make regarding the establishment of libraries of such works?

Colleges of Commerce.

80. Do you think that the establishment of a College of Commerce is necessary in your province?

If so, on what lines should it be organised?

81. In what ways do you expect such a college to assist industrial development?

81(*a*). In what ways can Municipalities and Local Boards assist in promoting industrial and commercial development?

VIII.—Government organisation for the collection and distribution of commercial intelligence.

Statistics.

82. Have you any criticisms to offer on the present system of collecting and distributing statistics by the Director of Statistics?

What changes do you suggest?

83. Have you any criticism to offer on the present system of collecting and distributing commercial intelligence by the Director-General of Commercial Intelligence? Commercial intelligence.

What modifications do you suggest?

84. What advantages have you found in the issue of the "Indian Trade Journal"? Industrial and trade journals.

85. Should Government establish or assist industrial or trade journals, either for general or special industries, which would be of real use to persons actively engaged in industries?

86. What proposals do you make for the dissemination of information of this kind through the various vernaculars?

87 What advantages have you known to follow the issue of special monographs on industrial subjects or publications like those of the Forest and Geological Departments? Other publications.

What measures do you advise in order to increase the usefulness of these publications?

88. Are there any other directions in which Government could collect and publish information of a kind likely to assist industries and trades?

IX.—Other forms of Government action and organisation.

89 Are there any products for which a system of Government certificates of quality should be established? Certificates of quality.

For what products should such certificates be compulsory, and for what products voluntary?

90. What should be the organisation for testing each class of products and granting certificates?

91. Are there any classes of materials for manufacture or of manufactured articles for the adulteration of which penalties should be imposed Prevention of adulteration.

92. For each such class of goods what organisation do you suggest for purposes of inspection and prosecution of offenders?

93. Have you any other suggestions to make in regard to the prevention of misdescription of goods generally? Misdescription.

94. What is your opinion on the present state of Indian law relating to marks and descriptions of proprietary and other articles of trade. Trade marks and trade names.

95. Have you any criticisms or suggestions to make regarding the existing law and regulations relating to patents? Patent laws.

96. Is it desirable and practicable in the interests of trade, to introduce a system of registration or disclosure of partnerships? Registration of partnerships.

97. To what extent does the lack of transport facilities by road, rail or water hinder industrial development in your province? Roads, railways and waterways.

Have you any specific recommendations to make?

98. Have you any criticisms to offer regarding railway freights, the classification of goods, the apportionment of risk, and the regulation of rates?

What are your proposals?

99. Are there any railway extensions necessary in your province to develope new or to extend existing industries?

100. Similarly, are there any waterways which should be constructed, extended or improved?

101. Are you aware whether the external trade or internal industries of the country are handicapped by any difficulties or disadvantages as regards shipping freights? Shipping freights.

Can you suggest any remedies?

102. What has been done in your province towards ascertaining the possibilities of developing hydro-electric power? Hydro-electric power surveys.

Should further investigation be made in this matter?

102 (*a*). Have you any criticisms to make regarding the effect of the Electricity Act on industrial enterprise?

103 What difficulties have been experienced in the working of the Mining and Prospecting Rules (1913)? Mining and Prospecting Rules.

104. Are there any minerals that are essential for industries of Imperial importance that ought to be developed at public expense? (*Eg*, minerals of direct importance for the manufacture of munitions of war, or minerals ordinarily obtained in commerce from one country only.)

105. From the point of view of industrial enterprise, have you any criticisms to make regarding the policy and working of the Forest Department? Forest Department.

What suggestions do you make?

106. What measures are practicable to reduce the cost of assembling raw forest products?

107. To what extent is it practicable to concentrate special kinds of trees in limited areas?

108. What noticeable deficiencies in forest transport are known to you?

What suggestions do you make for their removal?

Jail competition. 109. Have you any complaints to make regarding competition by jail industries?

X.—General.

110. What suggestions have you to make for the development of any industry in which you have been actively concerned or interested?

111. Does your experience suggest to you any new industry for which India seems peculiarly suited on account of its resources in raw materials, labour and market?

112. What supplies of raw materials are known to you of which the use in industry or trade is retarded by preventible causes?

What are these causes, and how should they be removed?

112 (*a*). Have you any suggestions to make regarding the utilization of waste from raw materials?

112 (*b*). Have you any suggestions to make regarding Government aid in the improvement of raw material, such as, cotton, silk, sugarcane, etc.?

112 (*c*). What industries in the country are dependent on the importation of raw materials and partly manufactured articles from abroad?

113. Do you know of any supplies of raw materials for which there is a good case for investigation with a view to their development?

APPENDIX—A-1.

ITINERARY OF THE PRESIDENT'S MONSOON TOUR 1916.

1916—

June 30th	. . .	Departed Simla.
July 2nd to 13th	. .	Halted Calcutta.
„ 14th to 16th	. . „	Ranchi.
„ 17th to 19th	. . „	Sakchi.
„ 20th and 21st	. . „	Calcutta.
„ 22nd to 24th	. . „	Kulti with a visit to Asansol.
„ 25th and 26th	. . „	Calcutta.
„ 28th to August 4th	. „	Madras with visits to Nellikuppam and Cuddalore.
August 5th and 6th	. . „	Coimbatore.
„ 7th and 8th	. . „	Ootacamund.
„ 9th to 15th	. „	Bangalore with a visit to Oorgaum.
„ 17th to 24th	. „	Bombay.
„ 25th to September 3rd	„	Nagpur.
September 4th to 8th	. „	Jubbulpore with a visit to Katni.
„ 9th	. . . „	Maihar.
„ 10th	. . . „	Allahabad.
„ 11th to 15th	. „	Naini Tal.
„ 16th and 17th	. „	Dehra Dun.
„ 18th to 20th	. „	Cawnpore.
„ 21st	. . .	Returned Simla.

ITINERARY FOR THE YEAR 1916-17 (FIRST TOUR OF COMMISSION).

1916—

October 27th	Assembled at Delhi	Mr. Low was absent October 27th—November 16th.
„ 27th to November 1st.	Halted Delhi.	
November 2nd	„ Dehra Dun.	
„ 3rd	„ Bareilly.	
„ 4th and 5th	„ Lucknow	Pandit Malaviya was absent November 5th—7th
„ 6th to 12th	„ Cawnpore	Pandit Malaviya was absent November 12th—17th. Sir D. Tata was absent November 10th—30th.
„ 13th	„ Agra.	Sir F. Currimbhoy was absent November 13th—26th.
„ 14th	„ Firozabad.	
„ 15th	„ Benares.	
„ 16th to 20th	„ Bankipore.	
„ 21st to 26th	„ Muzaffarpur with a visit to Pusa.	
„ 27th to December 13th.	„ Calcutta.	
December 14th to 20th	„ Nagpur with a visit to Katni.	Sir F. Currimbhoy was absent December 17th—24th. Pandit Malaviya was absent December 17th—24th. Sir F. Stewart was absent December 14th—23rd. Sir D. Tata was absent December 17th—24th.
„ 21st to 23rd	„ Jubbulpore.	
„ 24th to January 5th, 1917.	„ Calcutta.	

1917—

January 6th	„ Kulti	Sir F. Stewart was absent January 6th—8th.
„ 7th and 8th	„ Sakchi.	
„ 9th to 19th	„ Calcutta	Sir D. Tata was absent January 19th—28th.
„ 21st to 31st	„ Madras	Sir T. Holland was absent January 29th—February 14th.
February 1st to 3rd	„ Calicut	Dr. Hopkinson was absent February 1st—3rd.
„ 4th to 8th	„ Coimbatore	Pandit Malaviya was absent February 4th—14th.
„ 9th to 14th	„ Bangalore.	
„ 17th to 20th	„ Delhi.	

Subsequently went into recess.

ITINERARY FOR THE YEAR 1917-18 (SECOND TOUR OF COMMISSION).

1917—			
November 7th . .	. Assembled at Bombay.		
„ 7th to December 4th.	Halted Bombay .		Sir T. Holland was absent December 2nd—24th. Mr. Chatterton was absent November 28th—December 24th. Pandit Malaviya was absent November 7th—December 10th. Sir R. Mookerjee was absent December 1st—9th.
December 6th to 15th .	„ Lahore.		
„ 16th and 17th .	„ Lyallpur with a visit to Gojra.		
„ 18th and 19th .	„ Rasul .		Pandit Malaviya was absent December 18th—22nd.
„ 20th to 22nd .	„ Amritsar with a visit to Dhariwal.		
„ 24th to January 3rd, 1918.	„ Calcutta .		Sir T. Holland, Sir F. Currimbhoy and Sir D. Tata were absent January 3rd.
1918—			
January 4th to 8th . .	„ Gauhati .		Sir T. Holland, Sir F. Currimbhoy, and Pandit Malaviya did not take part in Assam or Burma tours. Sir D. Tata did not take part in Assam tour.
„ 9th and 10th .	„ Shillong.		
„ 12th to 18th .	„ Calcutta.		
„ 21st „ 26th .	„ Rangoon.		
„ 28th and 29th .	„ Namtu with a visit to the Bawdwin Mine.		Sir D. Tata was absent January 28th—29th.
„ 31st to February 1st	„ Mandalay.		
February 2nd . . .	„ Nyaungu.		
„ 3rd . . .	„ Singu.		
„ 4th . . .	„ Yenangyaung.		
„ 5th . .	„ Allanmyo.		
„ 6th . . .	„ Prome.		
„ 7th and 8th .	„ Rangoon.		
„ 12th to April 6th .	„ Calcutta .		After February 14th the Commission went into recess. The Members met March 18th—29th to consider the draft report, with the exception of Sir T. Holland who was unable to be present. Mr. Chatterton was absent March 24th—29th and Pandit Malaviya March 18th—21st.
April 8th . .	. Arrived Simla		

LIST OF INSPECTIONS (1916-17 TOUR).

Date of inspection.	*Name of place visited or inspected.*
October 1916—	
26th	Delhi Biscuit Factory.
28th	The Art Industries of Delhi.
November 1916—	
2nd	Forest Research Institute, Dehra Dun. Thymol Factory of the Dixon Chemical Company, Dehra Dun.
3rd	Match Factory, Bareilly. Furniture Workshops, Bareilly. Government Carpentry School, Bareilly.
4th	Upper India Paper Mills, Lucknow. School of Arts and Crafts, Lucknow. Mechanical Engineering School, Lucknow.
7th	Cawnpore Woollen Mills.
8th	Brushware, Limited, Cawnpore. Elgin Mills, Cawnpore.
9th	Messrs. Cooper Allen and Company, Limited, Cawnpore.
10th	Government Harness Factory, Cawnpore.
11th	Village Settlements, Cawnpore.
12th	Cawnpore Sugar Works, Limited.
13th	John's Flour Mills, Agra.
14th	Glass Works at Firozabad.
15th	Government Weaving School, Benares.
16th	Bihar School of Engineering, Bankipoer.
22nd	Japaha Sugar Company, Muzaffarpur.
23rd	Agricultural Research Institute, Pusa.
24th	Bose's Cutlery Factory, Muzaffarpur. Bengal Preserving Company, Muzaffarpur.
25th	Saltpetre Refinery, Muzaffarpur.
29th	Titaghur Paper Mills. Titaghur Jute Mills.
30th	Calcutta Pottery Works.
December 1916—	
2nd	Sibpur Civil Engineering College.
4th	Calcutta Port.

LIST OF INSPECTIONS (1916-17 TOUR)—*contd.*

Date of inspection.	*Name of place visited or inspected.*
December 1916—concld.	
5th	Pen and Pencil Factory of Messrs. F. N. Gooptu and Company, Calcutta.
6th	Messrs. Jessop and Company's Iron Works, Howrah.
12th	Bengal National Tannery, Calcutta.
15th	School of Handicrafts, Nagpur.
20th	Cement Works, Katni.
21st	Pottery Works of Messrs. Burn and Company, Jubbulpore.
22nd	Gun Carriage Factory, Jubbulpore.
January 1917—	
6th	Bengal Iron and Steel Company's Works, Kulti. Kumardhubi Engineering Works, Limited (Bird and Company). Kumardhubi Fireclay and Silica Works, Barakar
7th and 8th . . .	Tata Iron and Steel Company, Sakchi.
12th	Workshops of Messrs. Burn and Company, Howrah.
13th . . .	Messrs. D. Waldie and Company and the Bengal Distilleries, Limited, Konnagar. Government Central Weaving Institute, Serampore.
15th	Ordnance Factories, Cossipore and Ishapur.
23rd	Buckingham and Carnatic Mills, Madras.
25th	Chrome Leather Company's Tannery, Pallavaram
26th	Indian Aluminium Company, Madras.
27th	Harbour Works, Madras.
February 1917—	
1st . .	Henke's Tile Works, Feroke, Malabar. Government Fish Canning Station, Beypore.
3rd . .	Cocoanut Oil Mill, Calicut. Coir Weaving Shed, Calicut. Basel Mission Weaving Establishment, Calicut New Malabar Timber Yards, Calicut. Government Soap Factory, Calicut.
5th . .	Agricultural College, Coimbatore.
8th	Singanallur Jaggery Factory (near Coimbatore).
11th . . .	Sandalwood Oil Factory, Bangalore.
12th	Kolar Gold Fields.
13th . . .	Indian Institute of Science, Bangalore. Steam Jaggery Boiling Plant, Agaram.

LIST OF INSPECTIONS (1917-18 TOUR).

Date of inspection.	*Name of place visited or inspected.*
November 1917—	
14th	Bombay Harbour.
17th	Great Indian Peninsula Railway Carriage and Wagon Workshops, Matunga.
19th	J. J. School of Art, Bombay.
20th	Victoria Jubilee Technical Institute, Bombay.
21st	Bombay Medical Stores Depôt.
22nd	Inspection of Chawls, Bombay
24th	Tata Hydro-electric Works.
27th	Royal Indian Marine Dockyard, Bombay.
28th	Sydenham College of Commerce, Bombay. Bombay Swadeshi Stores.
29th	Queen Mary Technical School for disabled Indian Soldiers, Bombay.
December 1917—	
9th	Government Rosin and Turpentine Factory, Jallo
11th	North-Western Railway Workshops, Lahore. Railway Technical Institute, Lahore Hindu Technical School, Lahore.
14th	Government Central Weavery, Lahore.
15th	Mayo School of Art, Lahore. Central Jail and Borstal Jail, Lahore
16th	Cotton Market, Gojra.
17th	Agricultural College, Lyallpur. Wheat Elevator, Lyallpur.
18th	Salt Mines, Khewra.
19th	Engineering College, Rasul. Head Works of Lower Jhelum Canal. Upper Jhelum Canal.
20th	Hydro-electric Works and Pumping Scheme, Amritsar
21st	Criminal Tribes Settlement, Dhariwal New Egerton Woollen Mills, Dhariwal. Borstal Jail, Dhariwal.
22nd	Ghulam Sadiq's Carpet Factory, Amritsar. Municipal Technical School, Amritsar.

LIST OF INSPECTIONS (1917-18 TOUR)—*concld.*

Date of inspection.	*Name of place visited or inspected.*
January 1918—	
6th	Silk-Weaving Village of Sualkuchi.
10th	Experimental Fruit Station, Shillong.
22nd	Arts Exhibition, Rangoon.
23rd	Teak Yards and Saw Mills of the Bombay-Burma Trading Company, Limited, Rangoon.
24th	Messrs. Steel Brothers' Rice Mill at Pazundaung.
25th	Burma Oil Company's Refineries at Syriam.
28th	Namtu Smelters.
29th	Bawdwin Mine.
31st	Irrawaddy Match Company, Mandalay.
February 1918—	
1st	Saunders' Weaving Institute, Amarapura.
2nd	Lacquer Workers at Nyaungu.
3rd	Oil fields, Singu.
4th	Oil fields at Yenangyaung—Drilling and Pumping station.
5th	Jamal's Cotton and Produce Company, Limited, Allanmyo.
6th	Hand-loom Weaving at Shwedaung.
7th	Government School of Engineering and Technical High School, Insein.
28th	Calcutta Technical Evening School.
March 1918—	
11th	East Indian Railway Locomotive Workshops, Jamalpur.

APPENDIX B.

DRAFT NOTE ON THE INDUSTRIAL ASPECT OF COTTON GROWING IN INDIA.

The first point for consideration is the possible increase of the outturn of Indian cotton. The figures below, which are taken from Professor Todd's book "The World's Cotton Crops" (pages 395, 410), will show the world position. **The world position.**

(Figures in 000's of 500 lbs bales.)

* Year.	1907-08.	1908-09	1909-10.	1910-11.	1911-12.	1912-13.	1913-14.
Production .	18,640	22,271	20,536	22,829	26,186	26,044	27,703
Consumption .	21.053	22,387	22,318	24,605	26,126	26,863	27,000

According to these estimates, the supply was as a rule in considerable deficit, but it is, at any rate, clear that there has thus been an actual shortage of cotton, which will tend to become more acute as the standard of comfort rises in the less civilised countries of the world. It seems a generally accepted view that much more cotton cloth could be sold, if greater supplies of cotton were available. In case of shortage, it is evident that Great Britain will be the chief sufferer. Her mills consumed 4,300,000 bales, of which 3,700,000 (500 lbs.) came from America, 400,000 from Egypt (720 lbs.), 50,000 from India (400 lbs.), and 150,000 from elsewhere. The mill consumption of the United States of America has followed the course shown below :—

Year.	000 bales.	Proportion of United States crop consumed by United States mills.
1911	4,301	35·6
1912	5,391	33 5
1913	5,389	38·2
1914	5,503	37·8
1915	6,088	40·3

The increase in the average United States crop for the above period over the period 1890-96 was 6,000,000 bales, of which increased consumption in the United States took 2,730,000 bales, and Continental increased consumption 2,630,000 bales, leaving only 640,000 bales for Great Britain.

The last year shows the highest percentage of any year except 1910, when the United States mills took over 40 per cent. of the very small crop of the year. It seems clear that the relative proportion of the crop taken by the local mills is bound to increase, and that any such increase will be at the expense of British spinners.

The latter have carefully examined the developments possible in different parts of the British Empire.

In comparison with Britain's African Colonies, India is a country with good communications, an intelligent agricultural population, and large areas under cotton. For these reasons, it has been held that in no other country can the requisite increase of the cotton crop be obtained so quickly. The matter is too urgent, from the point of view of the textile trade of the world, and especially of Great Britain, to admit of awaiting the results of work in so

NOTE.—The Commission understands that a preliminary version of the above note, prepared in December 1916, was placed before the Secretary of State by the Government of India, and was taken into consideration by him when sanctioning the appointment of the Cotton Committee. This body has been enquiring into the various matters raised in this note, and the Commission therefore thinks it unnecessary to revise the draft note, which, however, it desires to place on record.

* Statement No. I appended shows further details and values.

difficult a country as tropical Africa. Admitting the need, it is hardly part of our duty to enquire if a case can be made out for bringing any pressure, other than the inducement of higher profits, to bear on the Indian ryot, in order to get him to increase the area under cotton. Indeed, even an increased price for cotton will tend to fail of effect by enhancing the price of food grains, if it raises the proportionate area under cotton beyond a very easily reached limit. If, on the other hand, the outturn of the existing cotton area can be increased, then the inducement to grow cotton will be the greater, while the world, including India, will get what it wants, namely, more cotton. There is no doubt a great deal of scope for improvement. The average yield for India is 98 lbs. of ginned cotton per acre; while the figures for America and Egypt are 200 lbs. and 450 lbs., respectively.

It is agreed by various authorities that the average annual cumulative increase in the world's demand will be somewhere between 1,000,000 and 750,000 bales. An increase of 50 per cent. in the outturn of 6,000,000 bales, which may be taken as representing the present possibilities of India's crop, would satisfy this demand for three years. An increased outturn is perhaps the least difficult of the various agricultural problems connected with Indian cotton. Granted a research department to produce more prolific types, an organisation to introduce them, and an increased supply of fertilisers; and the rest is merely a question of time. The progress that has been made along these lines will be discussed when we come to speak of the work that is being done in the different provinces. But the matter is further complicated by the low money value of most of the Indian crop, the demand of Indian spinners for a longer staple, and the generally expressed doubts of European spinners to what extent any increase in the Indian short-staple will really relieve the situation, and whether India herself is not incurring grave risks by continuing to rely so largely on a single type of staple.

Increase of yield and improvement of quality.

2. We may first consider then what should be the place assigned to the rival or rather complementary policies of increasing the yield of the indigenous short-staple cotton, which has been the most important feature in the work of more than one province hitherto, and of introducing longer-staple varieties. From an imperial point of view, it is perhaps unsatisfactory, that India should export the bulk of her surplus cotton to foreign countries, while England depends for her materials on America, or has to make desperate efforts to supplement them by supplies from her younger colonies and dependencies. An unsatisfactory feature of India's large export to foreign countries has been illustrated during the war by the fact that the initial German stocks of cotton for explosives had their origin in India, and that no inconsiderable amount of Indian cotton is made up in foreign countries and re-exported to India as manufactured goods to compete with those of her own production. On the other hand, the short-staple over a very large area gives the biggest profit to the cultivator, and will apparently continue to do so for some time to come. We have, however, to consider whether India's present position is satisfactory from her own point of view in view of future possibilities.

Professor Todd (The World's Cotton Crops—pp. 383-384) believes that, with a reduced acreage during the war, the demand for cotton when the war is over will be difficult to meet, the European nations that have suffered most from the war will be apt to use cotton in substitution for the more expensive textiles that they required previously, while eastern nations, who mainly wear cotton cloth, have been less affected by the war, and will need at least a normally increased quantity of cotton cloth. There seems nothing in post-war conditions that is likely to lead to a falling-off in the demand for cotton. There is some reason to believe that the area sown with cotton in the United

States of America is not likely to increase very rapidly in future. The growers have been led by the war to see more than ever the advantages of a more mixed system of cropping. Labour is getting scarcer in the Southern States, and its wages have risen very strikingly; and the spread of the boll-weevil has shown no signs of slackening. It may be added that the increased wealth brought into the United States of America by the war will probably lead to the construction of more mills and the local consumption of more of its own cotton. These factors, while increasing the demand for cotton generally, will tend to enhance the existing premium on long-staple cotton very considerably. The premium on Egyptian over American cotton rose as between the period 1894-98 and 1909-13 from 1·12*d.* to 3·45*d.*, per lb., or from 26 per cent. to 53 per cent.

Position of short-staple crop.

3. It is alleged by Professor Todd (p. 21) that many spinners, especially on the Continent of Europe, use rather longer-staple cotton than they really need to spin the counts which they produce. The more cotton that India can produce of a slightly better type, the more of the longer-staple that these mills at present use can be released for the use of spinners who really need it. If the above is correct, in view of the greatly increased competition for American cotton that the considerations adduced in the preceding paragraph indicate, the greater would be the advantage gained by this substitution. Sir Bezonji Dadabhoy, however, stated that no one uses any longer-staple than he needs at present. Before the war, India sold much of her short-staple cotton to European countries, and it is probable that this trade will revive, and even increase to some extent, as the replacement of wool by, or its admixture with, short-staple cotton is stimulated by invention, and by the desire to use a cheaper material than wool. On the other hand, the main direction of expansion of the cotton industry in India, as elsewhere, is sure to be towards the use of finer staples and higher counts, as the standard of comfort in the less civilised parts of the world rises.

Finally, as Japan is stimulating the growth of cotton, mostly of the American type, in Corea, so at no distant date circumstances may place her in a position to increase the cotton yield of China. The Chinese crop has hitherto been a very obscure factor, but is, it would seem, capable of indefinite expansion, with improved communications and a more settled system of Government. About $1\frac{3}{4}$ million bales are said to enter commercial channels, and much is consumed internally in addition. The yield was very recently stated by a member of the Japanese textile industry at 7,000,000 piculs, or $2\frac{1}{3}$ million bales, the area having increased owing to the replacement of opium by cotton in the Shensi Province. The bulk of it is of the Indian type, and whatever may be done—and much no doubt will be done—to improve the length of staple, there will be for long a large quantity of short-staple cotton available. Whether the exploitation of Chinese cotton will, in such circumstances, ever constitute a serious menace to the price which the Indian grower of short-staple cotton in India can command cannot be foreseen, but the risk is worth bearing in mind.

The "Japan Chronicle" of 18th January 1917 stated that in 1914 Japan imported 17,550,000 kwan of Indian and 15,300,000 kwan of Chinese cotton. Owing to the neglect of cotton cultivation in China, Japan drew a relatively larger proportion of her supplies from India, but if the quality of Chinese cotton is further improved, it will be able to meet about 70 per cent. of Japan's demands.

The Indian crop and its consumption.

4. The statement below shows the final estimates of areas under cotton in India for the years since 1907-08, together with the production, deduced

from the total of exports, mill consumption and estimates of extra-mill consumption :—

Year.	Area in 000 acres.	Outturn in 000 bales of 400 lbs.
1907-08	21,630	3,782
1908-09	19,999	4,200
1909-10	20,545	4,928
1910-11	22,596	4,303
1911-12	21,615	3,985
1912-13	22,028	4,483
1913-14	25,023	5,913
1914-15	24,595	4,889
1915-16	17,746	5,109
1916-17	21,212	4,760

India's crop in 1913-14 was valued at 81 crores of rupees or £54 million sterling, which was 15 per cent. of the value of the world's total crop in that year.

The statement below shows the countries to which and the quantities in which Indian cotton was exported from 1911-12 to 1915-16.

Country to which exported.	1911-12	1912-13	1913-14	1914-15	1915-16
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
United Kingdom	418,012	305,545	381,914	707,779	833,628
Germany	890,516	950,199	1,688,070	1,239,472	...
Belgium	774,463	864,304	1,133,083	791,369	..
France	291,960	327,767	521,264	552,273	205,457
Spain	127,815	86,950	166,933	221,964	239,025
Italy	680,271	583,698	818,576	1,354,902	1,124,106
Austria-Hungary	471,580	396,152	747,041	585,735	.
China (exclusive of Hong-Kong and Macao)	48,097	118,007	84,707	116,026	296,664
Japan	3,514,651	3,591,768	4,817,560	4,414,941	5,917,663
Other Foreign Countries	40,539	56,296	105,735	169,504	140,238
Total Foreign Countries	6,839,892	6,975,441	10,115,969	9 522,176	7,923,153
Total British Empire (excluding United Kingdom).	70,619	96,526	125,429	119,09)	97,186
GRAND TOTAL	7,328,523	7,577,512	10,626,312	10,349,045	8,853,967

5. The following statement shows the estimated areas of the various classes of staple during the year 1916-17 :—

Description of cotton.	Acres.
Oomras—	
Khandesh (Bombay)	1,423,000
Central India	1,411,000
Barsi and Nagar (Bombay)	3,436,000
Berar	3,118,000
Central Provinces	1,283,000
Total	10,671,000
Dholleras (Bombay)	2,046,000
Bengal—Sind—	
United Provinces	1,184,000
Rajputana	415,000
Sind-Punjab	1,430,000
Others	73,000
Total	3,102,000
Broach (Bombay)	1,230,000
Kumpta-Dharwars (Bombay)	1,097,000
Westerns and Northerns (Madras)	1,382,000
Cocanadas (Madras)	289,000
Tinnevelly (Madras)	707,000
Salems including Cambodias (Madras)	337,000
Comillas, Burmas, and other sorts	351,000
GRAND TOTAL	21,212,000

6. The following descriptions of the leading types of Indian cotton have been selected from the table on page 81-2 of Mr. Pearse's latest report:—

Broach	Very white, good staple and silky $\frac{7}{8}$" to 1".
Kumpta and Saw-ginned Dharwar . .	Dull, yellowish and silky $\frac{5}{8}$" to $\frac{7}{8}$".
Dhollera	$\frac{1}{2}$" to $\frac{7}{8}$".
Oomra	$\frac{1}{2}$" to $\frac{5}{8}$", except Hinghanghats, which are up to 1".
Bengal	$\frac{3}{8}$" to $\frac{1}{2}$".
Sind deshi	Like the last.
Tinnevelly (Karunganni) . . .	1".
Cambodia	1".

Westerns and Northerns $\frac{3}{4}$" to 1". Northerns are rather reddish, Westerns fairly white. Both grow in North Madras.

Cocanadas $\frac{5}{8}$", like Northerns, heavy yielder.

Further details can be found on pages 26-7 of Professor Todd's book.

Figures of prices for middling American and Indian cotton (No. 1 Oomras) and for exports of the latter go to show that when the difference rise, and especially if it exceeds or even approaches one penny, the exports of Indian cotton increase.

This fact also tends to support the view expressed above, that Indian cotton, especially if slightly improved, could replace some of the American cotton at present being consumed in the spinning of comparatively low counts.

Including as long-staple cottons those varieties that produce fibre of approximately 1" in length, we have from the last forecast—Broach 1,230,000 acres, Tinnevelly 707,000, Salems 337,000—total 2,274,000 acres. Some deduction must be made from this, on account of shorter-staple cotton produced in the tracts which have been taken above as long-staple areas. On the other hand, some addition must be made for long-staple cotton, like introduced varieties and Hinghanghats, which have been included among Bengals and Central Provinces types, as not considerable enough at present for separate enumeration. No details are as yet available for outturn of the long-staple varieties, but reckoning 3 acres to the bale, which is considerably in excess of the average Indian yield of 98 lbs., the total yield is something like 400,000 bales of 400 lbs. The yield has been variously estimated by experts at from 350,000 to 500,000 bales. A considerable quantity of this is said to have gone to Japan, though this is denied by others.

Mr. Couchman in his Handbook of Commercial Information for Madras (pages 37-44) attempts a percentage estimate of the destinations of the leading types of cotton exported from that Presidency.

Tinnevellies.		Cocanadas.		Total Madras cottons.	
Country.	per cent.	Country.	per cent.	Country.	per cent.
Japan	36	Belgium . . .	35	Japan . . .	36·3
United Kingdom . .	25	Germany and Austria-Hungary . .	14	Belgium . . .	19
Germany . . .	6	France . . .	13	United Kingdom .	17
Italy	3·6	Italy . . .	12	Germany . . .	4·7
Austria-Hungary . .	...	United Kingdom .	11	Italy . . .	5·4
Belgium and China .	3	Japan . .	9	Austria-Hungary	5·3
				France . . .	3·3

A consideration of the above table tends to support the view that Japan also requires longer-staple cotton.

7. The statement below shows the imports from abroad and the production by Indian mills of low, medium and high counts of yarn during the past five years :—

Statement comparing the imports of coarse, medium and fine yarns with the production of similar descriptions by the Indian mills.

Unit—1,000 lbs.		1910-11.		1911-12.		1912-13.		1913-14.		1914-15.		1915-16.	
			per cent.		per cent.		per cent.		per cent.		per cent.		per cent.
Nos. 1-25.	Imported	1,602	·3	1,549	·3	4,149	·7	2,150	·3	813	·2	1,338	·2
	Indian	553,948	99·7	565,199	99·7	623,834	99·3	616,688	99·7	590,829	99·8	660,688	99·8
	Total	555,550	87·2	566,748	85·4	627,982	85·8	618,838	86·0	591,642	86·0	662,026	87·6
Nos. 26-40.	Imported	19,674	26·8	28,822	31·5	31,395	34·0	27,343	30·3	28,843	33·0	25,613	30·2
	Indian	53,743	73·2	58,924	67·5	60,989	66·0	62,711	69·7	58,447	67·0	59,123	69·8
	Total	73,417	11·5	87,246	13·2	92,384	12·6	90,054	12·5	87·289	12·7	84,736	11·2
Above 40.	Imported	6,627	78·3	7,131	76·4	9,768	74·9	7,858	74·4	7,021	75·9	7,512	79·3
	Indian	1,840	21·7	2,199	23·6	2,938	25·1	2,698	25·6	2,233	24·1	1,963	20·7
	Total	8,467	1·3	9,330	1·4	11,706	1·6	10,556	1·5	9,254	1·3	9,475	1·2
	Grand Total	637,434	100	663,324	100	732,072	100	719,448	100	688,185	100	756,237	100

There is very little European trade under the lowest counts for Indian mills to supplant; on the other hand, Japanese competition has recently become severe in respect of some of these descriptions. The greatest scope for the expansion of the Indian industry appears to exist under the medium and higher counts. To produce a staple suitable for counts above 40's, India would have to grow either a much higher grade American cotton than has been hitherto attempted on anything like a commercial scale, or an Egyptian cotton. The latter can certainly be grown in Sind, and perhaps in the Punjab and in Rajputana. It is stated that in the case of both the first and the last, irrigation would be needed on a far more ample scale than at present. Further enquiries will have to be made regarding the areas that can be made available for the higher classes of staple. For the present the figure for the Punjab and Sind may be provisionally placed at 3,500,000 acres. We have seen what looks like a much lower estimate, *viz.*, 350,000 acres in the Punjab within the next four years. The present area under American cotton in that province is 120,000 acres. Mr. Hailey (*vide* paragraph 8) puts the area available for American or other cotton requiring early irrigation at 500,000 acres. No information has yet been obtained for Bombay or Madras. The Central Provinces are not likely to be able to afford more than 100,000 acres for irrigated cotton.

With regard to the improvement of the indigenous staple, there is no doubt that any improvement in length, etc., while maintaining the hardiness, ginning percentage and outturn of the present type, would be a very great help. If the present cottons from which 10's are now spun could be improved so as to yield 15's or even 20's, the future of the Indian crop would be far more secure than it at present appears.

Work by Agricultural Department.

8. Having discussed the necessity for and the probable effects of :—

(*a*) an increase in the production of short-staple cotton

(*b*) the introduction of more long-staple cotton ;·

we may now examine the efforts which are being made in the chief cotton-growing provinces of India towards these ends. The statement in paragraph 5 above shows the areas under the main types of cotton in the different provinces. This is far from a complete classification by types and areas, but is a compromise between what is ideal and what is possible.

Speaking very generally, the present facts and future possibilities in the different provinces are exhibited in the statement below, and in the description which follows it of the position in the chief cotton-growing provinces.

The statement below indicates the area under cotton in each of the leading cotton-growing provinces of British India during each year since 1907-08 and the yield in bales. A reference to the table in paragraph 5 will show to some extent the types of cotton grown in each case.

Area in 000's of acres.
Yield in 000's of bales of 400 lbs.
Value in 000's of rupees.

Year.	...	Bombay and Native States.	Central Provinces and Berar.	Madras and Native States.	United Provinces.	Punjab and Native States
1907-08	Area	7,101	4,132	1,855	1,161	1,174
	Yield	1,039	595	198	268	356
	Value	9 80,39	5,26,95	1,93,70	2,12,52	2,76,88
1908-09	Area	6,241	4,176	1,576	1,392	1,562
	Yield	1,282	766	162	426	324
	Value	14,23,82	7,08,07	1,46,96	3,41,69	2,89,17
1909-10	Area	6,469	4,167	1,569	1,241	1,439
	Yield	1,661	1,070	180	384	396
	Value	19,42,50	10,96,92	1,79,92	3,50,98	3,52 01
1910-11	Area	7,334	4,487	1,873	1,317	1,385
	Yield	1,450	629	235	318	306
	Value	20,25,02	8,06,92	2,82,02	4,05,73	3.52,74
1911-12	Area	5,786	4,648	2,878	921	1,582
	Yield	695	913	335	251	241
	Value	10,27,08	12,06,16	4,02,03	3,06,38	2,99,89
1912-13	Area	6,826	4,493	2,414	1,158	1,575
	Yield	1,520	910	471	428	373
	Value	19,70,38	11,25,70	5,39,83	4,91,09	4,30,15
1913-14	Area	7,323	4,754	2,725	1,586	2,054
	Yield	1,614	961	308	484	612
	Value	20,88,95	12,40,89	3,98,01	5,42,38	7,08,42
1914-15	Area	7,796	4,708	2,115	1.551	1 857
	Yield	1,773	1,097	245	486	486
	Value	19,00,62	10,34,84	2,73,17	3,68,90	3,68,27
1915-16	Area	4,439	4,061	2,061	834	902
	Yield	934	1,106	215	262	195
	Value	8,20,31	8,95,51	3,57,11	1,98,21	1,36,81

Bombay. Bombay contains a large area, especially in the Deccan, under short-staple, that can probably be extended, though not to a very large extent. In Dharwar, there is a considerable area under an American type known as Dharwar-American, that was introduced at the time of the American war. Another long-stapled cotton is grown here, known as Kumpta. Broach and Cambodia have also been introduced, but circumstances do not seem to be entirely favourable for them, and these varieties, though they may continue to be grown in small areas, are said not to be likely to spread widely. More is to be hoped from the further improvement of the existing Kumpta variety, the weak point of which is its low ginning percentage. In Gujerat cotton covers a large area, but over much of the north of the Gujerat division short-staple cotton is found. Attempts are being made to introduce a longer-staple variety, by selection from the local varieties.

The statement below supplied demi-officially by Mr. Keatinge, Director of Agriculture, Bombay, explains the general position in that Presidency :—

Area.	Type.	Length of staple in ⅛".	Ginning percentage.	Price on January 8th, 1916.
N. Gujerat	Navsari	8—9	31	+Rs. 25 on Surat.
	Surat	6—8	32	+Rs. 15 on Broach.
	Broach	6	34	Rs. 410 (Good.)
S. Gujerat	Lalio	7	31—32	
	Waghad	6	32	
	Mathio	4	33—34	
Deccan	Khandesh	4	34—35	
Southern Maratha Country.	Kumpta	7—8	25	
	Dharwar-American	6	31	
Sind	Sindi	4	33	

Khandesh is a mixture, Mathio is identical with Khandesh, recently introduced into north Gujerat and rapidly spreading. Ghoghari, a short-staple variety with a high ginning percentage is beginning to spread in south Gujerat.

In Sind, the indigenous variety is short in staple, though a free yielder under the very indifferent cultivation that the local farmer affects. An attempt was made in the first instance to introduce an Egyptian type, but, though Sind can undoubtedly grow Egyptian cotton, for her to do so on a large scale and with reasonable certainty from the cultivator's point of view, a better system of cultivation will have to be introduced, and a more permanent source of irrigation will be necessary, for which extensive works on the Indus will be required.

The last report of the Imperial Cotton Specialist gives the following values for certain types recently introduced into different parts of Bombay. Dharwar Broach, with a ginning percentage of 32-33, can spin up to 40's and was priced at Rs. 375. Dharwar-Americans can spin 20's. Cambodias were valued at the Gadag auction at Rs. 320, and could spin 20's. This was on the following market basis: —

	Rs.
Sind-American	310
Madras-Cambodia	365
Navsari (Broach)	375
Superfine Bengal	250
Cambodia	340
Saw-ginned Dharwar	320
Kumpta	345

The price of Broach (good) is usually about 8 per cent. less than that of Americans (mid) but varied in the year before the war from 4 to 24 per cent. lower.

Central Provinces.

In the Central Provinces, there is a large area of short-staple cotton grown in the west and north of the province, which could no doubt be materially increased, and might perhaps be improved, but the main hope of introducing a long-staple cotton lies (1) in the light-soil areas now

coming under irrigation, which, as the irrigation is in all cases by storage works, can never be very extensive, and (2) in the tracts with a rainfall somewhat higher than those hitherto regarded as most suitable for cotton in this province; here Cambodia may possibly give more profit than the short-staple.

It must not be forgotten that the length of the indigenous staple in this province has steadily declined since its cotton began to be exported. The old Berar Jari, which, it is said, would spin 15's or even 20's, has been replaced by a mixture of some six types, in which the types which mainly constituted the original Jari have tended to become less predominant, and the shorter-staple but more freely yielding types to form an increasing proportion of the mixture. This inferior mixture has also gradually spread over more and more of the area which was occupied by the superior but less prolific Bani. The operations of the Agricultural Department, which were necessarily and rightly directed towards increasing the cash yield per acre for the ryot, without consideration to the requirements of the industry, Indian or British, further added to this deterioration of quality. The most prolific variety, both in respect of yield and of ginning percentage, of the Berar mixture was found to be Roseum. This was selected for distribution, and with such success, that not less than 700,000 acres were placed under this type in 1916-17. The cash benefit to the ryot has been very great, amounting to something over a crore of rupees per annum over and above the value of the ordinary local mixture. The subject will be dealt with in further detail below, but is only mentioned here as an illustration of the fact that in the case of the varieties that can be grown at present in the cotton-producing tracts of most provinces of India the premium offered for length of staple is utterly inadequate to overcome the great difference in yield and ginning percentage between such types as the short-stapled, prolific Roseum and the long-stapled, but poorly yielding Bani. The notes of Professor Gammie, Imperial Cotton Specialist, on certain attempts which have been made in the Central Provinces to evolve a superior type, by crossing a short and a long-staple cotton, contain certain figures for the cash yield per acre of different types, and for the valuation of the new crosses as compared with existing varieties, which emphasize the above principle very strongly.

Type.	Counts.	Price. Rupees.
Bani x Roseum	20's to 22's	285
Bani x Deshi Lahore	?	295

The implication in the report is to the effect that the latter type is capable of spinning at least as high a count as the former ; it has a ginning percentage of 35·5, and under the somewhat exceptional conditions under which it was grown, was a very free yielder. No definite comparison can yet be made in point of cash return between this and the local Roseum at present.

The figures below, received from Professor Gammie, are hardly encouraging :—

Species.	Yield per acre in cash. Rupees.
Cutchicum	104
Roseum	100
Bani	76
Berar Jari	74
Bani x Deshi Lahore	75

These prices sufficiently indicate, too, the reason why low-yielding long-staples like Bani and comparatively superior mixtures like Berar Jari are

being rapidly replaced, in Berar and other parts of India, by free-yielding, high-ginning, short-staple varieties.

The above prices were on the following market basis:—

Variety.	Price in Rupees.
Cambodia	350
Ghat Bani	340
Fine Akola	265
Fine Khandesh	250
Indore	280
Fine Bengal	228
Superfine Bengal	240

The above basis prices also afford an indication of the relative values of the indigenous short-staple types as compared with an exotic like Cambodia.

Madras. In Madras, there is first the long-staple Karunganni grown in Tinnevelly, till recently very largely mixed with Uppam. Efforts are being made to separate the two in order to secure a higher price for the Karunganni. Cambodia was also introduced into the same tract some years ago, and experience has shown that it can undoubtedly be grown at a profit, the yield for 1911 being estimated at 45,000 bales. The usual troubles, however, set in, owing to deterioration of that part of the crop sown on inferior lands and to adulteration. A very prolific cotton, locally called Pulichai, identical in type with the variety known as Roseum grown in Berar and Khandesh, came in a few years ago from the Deccan. Efforts have been made to stamp this out, as purely parasitic and owing its present apparent value to its use as an adulterant for the better local varieties; when it kills the value of these, as it is likely to do, unless arrested, the ryot will be left with a less profitable crop than the finer existing varieties.

In the Ceded Districts, the state of affairs is not dissimilar to that prevailing in Berar and Khandesh, and the agricultural part of the problem is being dealt with on very similar lines.

The United Provinces. The prevailing type in the United Provinces is a short-staple cotton, which ripens early and is known to the trade as Bengals.

The position here is described by Mr. Hailey, Director of Agriculture, as follows:—"The first endeavours to improve cotton growing in the United Provinces were in the direction of introducing a long-staple cotton of American origin. The experiments began as early as 1881, but it was not until 1906 that the seed, which was then acclimatised but was of a mixed character, was distributed to cultivators in the Aligarh district. It is unnecessary here to allude to the difficulties of selling small quantities of any new type of cotton. The middlemen buy on the ginning percentage and have not been accustomed to differentiate in favour of quality. They would therefore give less for a long-staple *kapas* (seed cotton), which has a ginning percentage of 30 per cent. as compared with ordinary *deshi* with a percentage of 33 per cent. The manufacturer is not accustomed to buy *kapas* and wants the lint ginned and baled. In the absence of any other agency, it was necessary for the Agricultural Department to buy in the *kapas*, gin it, and sell to manufacturers. The cultivators were promised a bonus of Re. 1 per maund of *kapas* over the current price of *deshi*, and the lint was sold by auction. This arrangement also permitted the department to maintain purity of the seed and prevent any admixture of *deshi* seed.

"It worked well enough for three years and the cultivators usually received a bonus above the stipulated premium. But it was necessary to take

an advance from Government to finance the operation, and in 1909, in consequence of the issue of orders by the then Secretary of State, the Government of India objected to the advance on the ground that it was a matter for private enterprise. As the cultivators would not sow without a guarantee from the department and no private firm would come forward to finance the undertaking, it collapsed and no more seed was distributed.

"As progress in the direction of improving the quality of the cotton seemed barred, the attention of the officers of the department was directed to improving the outturn. With this object Dr. Parr at Aligarh isolated a strain of *deshi* with a very heavy yield and a high ginning percentage of 39 to 40. It is characterised by a white flower and is known as the Aligarh white-flowered cotton. The staple is coarse and short, but the plant is hardy and a vigorous grower. In a short time it became very popular, since the buyer differentiated in its favour on account of the high ginning percentage. It is not possible to give the area under this crop, as the whole area under cotton has fluctuated so greatly of recent years, but it does not probably fall short of a lakh and a half of acres, and all the seed which the department can supply is readily bought up. Unquestionably, however, the lint is inferior to that of yellow-flowered *deshi*, and the department has always accepted the fact that, if the tide sets in steadily in the direction of better stapled cotton, a substitute must be found for this.

"Mr. Leake's hybridising experiments are directed towards this end. American cotton must be sown early and this needs irrigation. At the outside limit, the canals of these provinces could not supply water for irrigating cotton over more than 500,000 acres. The total cotton area is anything from a million to a million and a half acres, according to seasons and prices, and, therefore there is a very big area which must always be devoted to a cotton grown in the rains. Mr. Leake's crosses are of *deshi* varieties and can be grown on this unirrigated tract. At present it is sufficient to say that trials are being made on a field scale of several varieties with an appreciably better lint than *deshi*.

"I will now turn to the revival of long-staple cotton growing. In 1912 the Elgin mills offered to finance the growing of American cotton on the basis of a premium to the cultivators of Rs. 1-4 per maund (100 lbs.) of *kapas*. After this, arrangements were to be made on the basis of spot price of middling American. In the first year the crop amounted to 120 bales. From that time to the present the lint has always been sold to one or other of the Cawnpore mills, at prices which give a premium of well over one rupee per maund of *kapas* to the grower, and in 1915 amounted to Rs. 2. The department, by an arrangement with a ginning factory, gins the whole crop in a single factory, paying the cultivators as they bring in the *kapas*. The purity of the seed is thereby maintained and the shorter strains are being gradually eliminated. For the last two years the Muir Mills have taken the whole. The crop has suffered owing to a great slump in prices in 1914 and two very wet years in 1915 and 1916, during which part of it was destroyed. It has consequently not spread very rapidly. The American cotton yields somewhat more heavily than *deshi* in ordinary years, but is more susceptible to water-logging and heavy rains. Further there has been a very great increase in the area under indigo, which has usurped part of the best cotton-growing land.

"In estimating the relative advantages to the grower of American and *deshi* cotton there are certain points to be borne in mind.

(*a*) The ginning percentage of Cawnpore-American is not more than about 31 per cent., while, as pointed out above, that of Aligarh

white-flowered does not fall below 39 per cent. Consequently this defect must be made good by an appreciably higher price for the lint.

(*b*) American cotton must be sown before the rains and, therefore, on irrigated land for which canal rates have to be paid. The great bulk of *deshi* is sown in the rains.

(*c*) *Deshi* cotton is the earlier crop, and the cultivators in these provinces are in the habit of taking it up in October and sowing a *rabi* crop, such as peas mixed with barley, after it. American is longer on the ground and if a second crop is sown, late pickings cannot be taken.

"Though American cotton is sown at a time when the cultivator is ordinarily free from other work—and this constitutes its great advantage—yet it requires more care than *deshi*, and is subject to certain insect attacks, such as the leaf roller, which are of little importance in case of *deshi*. Again, American does not do well on poor soils, whereas *deshi* is often grown on the poorest lands in the village.

"Were there any great disparity of prices between the two crops, these disadvantages would fall into the background; but the prices of *deshi* have remained, except in 1914, extraordinarily good, and the demand appears to be showing no falling-off. It is most difficult to strike any balance of profit between two crops—there are so many factors to take into consideration. But it would certainly be dangerous to pronounce definitely in favour of American cotton at the premia so far obtained. It suits certain cultivators to sow their cotton early and leave themselves free for rains sowings. Others want a second crop for food purposes and prefer the shorter growing *deshi*. If there is no great difference between two crops, a backward class of cultivator will choose the hardiest, safest and cheapest crop to grow—and he is probably from his point of view amply justified."

On the same market basis as that used by Professor Gammie for Bombay (*vide* page 9), Cawnpore-Americans were valued as follows:—

Number of type.	Can spin counts.	Value. Rs
2	30's	340
9	24's	330
1, 6, 7, and 8	20's	325
Others	16's	310

The last report of the Agricultural Department of the United Provinces contains complaints that distribution of seed was carried on under difficulties, owing to lack of subordinate staff. The smallness of the average holding rendered it a matter of difficulty to discover suitable places for private seed farms. Co-operative societies, which appear to be ordinary credit societies and not co-operative unions organised *ad hoc*, are beginning to take up the work of seed distribution, and will, it may be hoped, relieve departmental officers to some extent of this task.

The Punjab. The Punjab probably offers the most immediately remunerative field for the dissemination of long-staple cotton of the American type. We are obtaining further information on the subject, but we have seen a statement to the effect that a single grower last year obtained an all-round yield of 250 lbs. of lint over an area of the same number of acres. More will be said below about the marketing problem in the Punjab and we shall have to obtain information regarding the land and irrigation water available for cotton growing, and in

particular as to the truth of a statement, that the cotton area can be increased, if the cultivators will consent to reduce the area they sow with cold-weather irrigation; and how far such a practice is desirable, if possible. The fear of encroachment by the cotton crop on the area required by food grains is less acute in the case of the Punjab than elsewhere, seeing that only a small proportion of any particular area, which has been variously stated at one-tenth and one-sixth, can, it is alleged, be advantageously placed under cotton in any single year. A proposal was put forward by the British Cotton Growing Association some years ago, revived again by the International Cotton Spinners Federation more recently, but held in abeyance on account of the war, to take up an area in one of the canal colonies, erect gins, and demonstrate how Indian cotton can be grown and prepared for market under optimum conditions, and the grower brought into direct touch with world prices. This scheme should be examined by the Commission when they visit the Punjab.

Problem of introducing a superior type.

9. The position has now been discussed in sufficient local detail to indicate the nature of the problems before the Agricultural Department, the farmer and the trade. In the first place stands the desirability of improving the lint of the existing short-staple varieties, while maintaining the yield. This is no doubt a harder problem than that of introducing longer-staple varieties from outside; its results are likely to be very gradual in showing themselves; it involves the introduction of a cross which is capable of fertilisation by the remaining local species from which it has been built up; but it is not the less important of the two problems. The only province where this policy has been pursued steadily and consistently is the United Provinces. Some work has been done on these lines in the Central Provinces, where various crosses with the indigenous type have been produced. The work has, however, not formed part of the regular programme of the Economic Botanist, but has been carried on by the Deputy Director of the Southern Circle. In view of the highly technical character of the research problems involved, this is certainly the duty of a botanist, and should be taken over by him. A much more general and sustained effort is needed for the solution of this problem than has been made hitherto, outside the United Provinces.

The short-staple crop is of great importance in the Central Provinces and Bombay, and to a less extent in Madras and the United Provinces. The Economic Botanists of these provinces have their hands already fully occupied with other work; and there would be ample employment for at any rate another botanist in each of the first two provinces for the study of this single problem. An increase of under a penny a pound in the value of the cotton produced in the 14,000,000 acres which grow the short-staple crop at *present*, would yield over 6 crores of rupees, justifying amply the immediate expenditure proposed.

We now turn to the consideration of the next problem, *viz.*, the introduction of a long-staple type, whether exotic or built up by crossing. In order to make the substitution as rapid as possible, and to obtain the advantage of a uniform type, some organisation for securing the distribution of seed true to type on a wide scale, at the minimum of cost and with the greatest probability of becoming a permanent local institution, is necessary. Such an organisation is undoubtedly to be found in the co-operative system of seed distribution. Under this system as worked in Berar, the Government farm distributes as much of the required seed as it can grow to central farms, attached to co-operative unions, but inspected by Government agency. These farms sow that seed, and distribute the seed in the second year to the seed farms of private individuals, members of the union, who grow it and sell it to the public in the

third year. Where necessary, each union gins its own cotton, thereby ensuring the purity of the seed, which is apt to deteriorate and is liable to adulteration in ordinary commercial gins. The seed farms of the private members are inspected by an agency employed by the union, but trained and supervised by the Agricultural Department. Funds are found by members contributing to their unions from the profits they make by the sale of the improved seed at a rate higher than the bazaar rate. The extent to which seed distribution can be extended by this agency, when no other difficulties supervene, may be judged by the fact that in the Central Provinces an area of 700,000 acres was estimated to have been sown by this means during the year 1916-17. To increase the yield of an existing type, by the dissemination of a variant of the same type, yielding more seed cotton (as opposed to lint or ginned cotton), is easy. Adulteration is not a serious drawback, especially when, as in Berar, the cotton which it is sought to introduce is a specially short staple variety, which is proof against adulteration, owing to its low quality.

10. The next degree of difficulty is reached when the main advantage lies, not in an increased gross yield of seed cotton, but in an increased yield of ginned cotton. The difference is not, however, one of kind, but of degree. The damage wrought by admixture is still small, and only the most short-sighted purchaser would attempt to snatch a transitory profit by refusing to pay prices based on the larger yield of lint. In a tract where, as is almost everywhere the case in India, gins abound, this refusal is not likely to be effective for long, and can in any case be overcome by departmental or co-operative ginning.

11. The real difficulty, however, arises, when the advantage in growing a new type lies not in quantity but in quality, such as strength, softness, colour or length of fibre In the first place stands the necessity of securing improved cultivation. Apart from this, however, the difference in price is seldom marked enough to appeal to the grower, unless an absolutely pure strain of seed is obtained by him, and an absolutely unmixed yield marketed by or for him. Any admixture of a cheaper variety is fatal to price. At the same time, the existence of a superior type encourages an inferior type as an adulterant (as was shown above in the case of Pulichai in Madras), which will eventually kill the superior type, owing to the fact that its presence in increasing proportion lowers the price very rapidly, so that eventually it is not worth the grower's while to grow the superior type, since the reputation of the local name goes down, and he cannot get more for the pure than for the mixed variety.

Various means have been adopted in order to resist this evil, which arises in one form or another in every part of India where an improved variety has reached the position of a commercial crop

Pure seed, as has been shown above, can always be supplied on a moderately large scale by a Government agency, and distributed through a certain number of private seed farms, supervised by a departmental agency, so long as some profit can be guaranteed to the grower, by a higher price either for his seed or his lint. Guarantees to this effect are often given by Government to start with, and were found necessary even in Berar at first.

The evil effect of gins in causing seed mixture, though real enough, can be combated by special arrangements. These arrangements, however, when the production reaches any considerable figure, impose a heavy burden on the expert agency, which is undesirable; while the gins are also in many cases the worst offenders in the matter of lint adulteration. To meet these difficulties it has been suggested that a system of licensing gins should be set up, by which

they would be compelled to keep the seed and lint of certain types of cotton unmixed, under penalty of forfeiture or suspension of license. This is a point on which evidence is desirable in Bombay and the Punjab. It seems hardly necessary to carry legislative interference beyond the gin-owner, although the case must be provided for when the cultivator or dealer brings a mixed lot of cotton to the gin. The next difficulty lies in getting the pure cotton into the hands of the buyer, whether ginner or merchant, and in obtaining the maximum value from him. In Madras arrangements have been made for ryots to sell improved Karunganni on joint account direct to ginning firms. A scheme has also been worked with some success by a league of the principal buyers with the Agricultural Department, who refuse to purchase cotton which contains any admixture of the inferior Pulichai. This latter device is no doubt likely to be effective in cases where an obnoxious newcomer can be stamped out in a short campaign of a year or two.

The history of the work in Bombay is most instructive. Broach cotton introduced into Dharwar is being sold by auction after departmental grading. Obviously this action cannot be very widely extended by a departmental agency on the existing scale. In lower Gujerat, where an attempt was being made to improve the quality of the lint, a syndicate formed by Bombay mill-owners undertook to pay 5 per cent. above the prevailing rate for the improved Broach cotton with a higher ginning percentage. (It is desirable to enquire if this rate was fair.) As soon, however, as the area sown became considerable, difficulties arose which led to a breakdown of the scheme. There was a doubt as to what the local prices were. Local buyers offered higher prices for the improved cotton, and the syndicate were called on to pay their increment on the prices so enhanced. The ryots also rigged the market, or at any rate reported sales which were believed to be fictitious. Cultivators brought in their cotton when prices were high, and held it back when they fell. During the second year of operations, there was a steady fall in prices, and the ryots who held back their cotton, got lower prices in the end; the loss so incurred seems to have been associated in their mind, quite unfairly, with the operations of the syndicate. Further, the cotton bought up-country by the syndicate was reported to have been received in Bombay in an adulterated condition. The information at our disposal regarding the extent to which the syndicate bought direct, and through what agency, and the methods adopted by the Agricultural Department to secure that the cotton came forward in a pure condition, is not sufficient to show how this happened. In Sind, the syndicate erected saw gins, as the local roller gins were not suitable for dealing with the American type. The Deputy Director thought that the syndicate should have secured a larger proportion of the crop produced. There were also difficulties arising from inferior methods of cultivation, failure of canal water, and shortage of seed. The syndicate withdrew from Sind for one year, but has since agreed to make another start. It was stated in evidence by Mr. Henderson, Deputy Director in Sind for some years, that local conditions are unfavourable to co-operation, and the most promising organisation for seed distribution is through the personal influence of leading landlords.

Only small quantities of long-staple cotton have been grown in the Central Provinces, and their inspection and marketing was effected departmentally, the Empress Mills in all cases proving a ready purchaser for full value. The growing of improved wheat through co-operative agency in this province throws an interesting light on the possibilities of a co-operative marketing organisation for obtaining value for quality. The increased value in this case is relatively small, and the cost of sowing an acre very high, compared to

cotton, but a considerable degree of success has been obtained through co-operative sales, with the help of one of the big export purchasing firms.

We have unofficial evidence of considerable interest, regarding the state of affairs in the Punjab, but it will require verification by local enquiry. To start with, the market for cotton in this province was in a far less organised state than in other provinces where more cotton is grown. Local buyers at first refused to pay more for a longer staple; indeed, the big exporting firms, it is alleged, tried to discourage the growth of such types, as it complicated the market, and required the use of expert knowledge which their buyers did not possess. A system of Government auctions was introduced, where buyers had to undertake to have the cotton ginned at specified gins under supervision. Prices 45 per cent. above the local rate were obtained at these auctions. On one occasion at any rate before the auction system was introduced, a big exporting firm had sold in Liverpool at 9*d.* a pound cotton bought in the Punjab at 4*d.*; Bombay buyers, however, gave better prices.

12. This question of improvement has been considered in a good deal of detail, inasmuch as it applies, not only to the introduction of exotic, but to any improvement of the existing varieties. Moreover, sufficient experience has been obtained to show where the difficulties lie, and where help is needed. The problem of inducing the grower to offer a pure type of cotton and the purchaser to give him full value for it, has not yet been solved, though several of the schemes so far devised look promising. The help and goodwill of the mill-owners or other buyers is readily forthcoming. The former no doubt realise that their being first in the field and in a position to secure the pure type in bulk offers them the best chance of being able to keep the long-staple cotton for their own mills in case of outside competition. A free market, however, for long-staple cotton in this country is necessary, if the cultivator is to get the world price for it, and any attempt to restrict this will prove fatal to the introduction of superior types. Little effort seems hitherto to have been made, except perhaps in Madras and the Punjab, to enlist the support of the intermediate local buying interests, often merchants of the Marwari class, who are the most to blame at present for the adulteration of improved types. The attempt is surely worth making, difficult as it undoubtedly is. No satisfactory evidence is forthcoming of the extent to which Indian long-staple cotton commands world prices in Indian markets. Statement No. II appended to this note seems to show that local prices for Tinnevellies followed the world prices for Americans more closely than Westerns, a superior cotton which relies mainly on the Indian demand. The fact that Tinnevellies are regularly quoted on the Liverpool market accounts for this, though the difference between Indian and Liverpool prices was often large, especially when the freight position became more difficult. Finally, it is clear that the first step to take is to devise some means to ensure the cotton coming forward in bulk, unmixed, and if possible, through some organic agency, capable of ultimately taking care of itself with a minimum of Government intervention; or at any rate of being carried on for as many years as possible, until an established course of trade hostile to adulteration has grown up. In small areas, departmental action might serve, but this is impossible over really large areas. In such cases, co-operation seems the most promising means; but it must be recollected that co-operation will not flourish in a soil that has not already been inoculated with its own microbe; we mean that the way to co-operative distribution must in India be paved by acquaintance with and acceptance of the benefits of co-operative credit. Communities accustomed to co-operative credit are suited for the development of an organisation for the sale of a given type of cotton on joint account. There will, however, be many

cases where, for various reasons, the people are either unsuited or unready for co-operative working; and here departmental agency, aided by an ever increasing proportion of help by the trade, seems to offer the best chance of success. The temptation of adulteration is, however, great, where the variety to be introduced is of high quality; and departmental agency must be largely relied on for a long time to replace or supplement co-operative organisation. This will necessitate large additions to the existing staff. The problem of maintaining and marketing a pure type seems so difficult and so urgent, that it deserves for the present as much attention as the purely agricultural problem of producing the type itself.

Conditions under which ryot markets his crop.

13. These conclusions bring one to a consideration of the conditions under which the cotton crop is normally marketed in India. These do not in most cases differ greatly from those prevailing in the case of other export crops. A varying proportion is taken over by merchants or money-lenders who have given advances to the growers, or to whom the latter are indebted. But still a very considerable proportion, naturally more considerable in areas where the average cultivator's holding is larger, is brought by the latter to the market town. In this case the cultivator sometimes sells to a ginnery; sometimes he takes it about from one dealer to another to obtain the best price. In other cases, again, he takes it to a cotton market; where these are well organised, with proper regulations and supervision to prevent the grower being imposed upon, the benefit to the cultivator is great, and he resorts freely to the market. The result is the elimination of unnecessary intermediaries, with profit to grower and mill-owner. An example of such a system is to be found in Berar, where a set of rules has been framed under which cotton markets are constituted and managed. The essential features of this system, which has been described fully in a note by Mr. Standen, Commissioner of Berar, are as follows:—

Commission agents, brokers and weighmen are licensed. The weights used are prescribed and inspected. Trade allowances are forbidden. The prices for the day are not published by the market committee, but become known at once in the market. Unginned cotton is inspected after removal from the market to a gin, and deductions made from the price on account of any defects. The seller need not accept these deductions and may resell his cotton if he likes.

The system, though capable of improvement, works well, and is strongly approved of by the growers. In the absence of such a special organisation, though the grower may have a pretty fair idea of the price he ought to get, yet, owing to the various tricks that are played at his expense by the buyers and the intermediate agents, he does not get it. It seems probable that much could be done for the cultivating classes by a better organised market system. In the case of export crops in particular, it would lend itself to any efforts that may be made to secure price for quality, at any rate after the initial stages had been passed. The necessity of this should be strongly pressed on Local Governments. The tendency in India is to accept as inevitable too many intermediate profits in the up-country period of the movement of an export crop. As the benefits of the co-operative movement spread, the improvements of markets will become a more urgent question. The growers who receive advances on their crop or who sell it to their creditors, in each case on unfavourable terms, will tend to become less numerous; the cultivating classes generally will demand a higher standard of efficiency in marketing, and will be less tolerant of excessive profits at their expense. Something, too, may be done, and is in places being done, by teaching cultivators a few points about marketing their crops.

Adulteration.

14. Proposals for penalising the fraudulent adulteration of cotton have been more than once put forward by various bodies in England and India. Correspondence in the records of the Government of India regarding the proposals made by the International Confederation of Cotton Spinners to Lord Crewe in 1911 may be referred to in particular. We do not propose to touch on the question of mixing cotton of higher with that of lower grades by other agencies than the gins. The experience of the working of the Cotton Frauds Act in Bombay has shown the dangers attending Government action in this matter. Similarly the watering of unginned cotton is in the first place not practised on a relatively large scale and can be put a stop to by the action of the ginners. The watering of ginned cotton by the balers is, however, a much bigger matter; it is done on a large scale and in a thoroughly organised manner, pipes and hoses being used for that purpose in many press compounds, especially in Berar. This might be dealt with without any Government inspecting staff, by allowing the private prosecution (with the sanction of Government, to prevent vexatious proceedings) of any person who actually watered cotton. This might no doubt be effected by a trade organisation; if no action were taken, no harm would be done, and the law would be temporarily ineffective. If necessary, it might be introduced for a term of years in the first instance, and, if not used, could be allowed to disappear automatically from the statute book. Opinions on this point might be invited in Bombay.

Mechanism for carrying out recommendations.

15. The proposals that have been put forward in this note are as follows:—

(1) To improve the existing short-staple types of cotton, by developing, through crossing or selection, a longer and better fibre, while maintaining the high outturn of the low quality type.

(2) In areas where the conditions admit of it, to continue and intensify the present attempts to introduce longer-staple exotic cottons.

(3) To make more determined and systematic efforts to provide a free and effective demand for improved cottons, and to see that they reach the buyer in a pure and unadulterated condition.

(4) To improve marketing arrangements generally, and to prevent some of the more dangerous forms of adulteration.

With regard to (1) it has been stated in paragraph 9 above that the problems indicated are sufficiently difficult and important to justify the appointment of two or three botanists, specially deputed for this work. The improvement of Indian cotton is an urgent matter. It is however possible to speed up research work by the employment of increased staff. This may be done either by tackling more individual problems at once, or by dealing with each individual problem intensively, *e.g.*, by following each experiment through all the life history of the plant in detail, instead of merely recording final results. The strength of the expert staff and the problems which they should take up should be settled by an authority competent to form an opinion on a consideration of the whole aspect of the case, both scientific and economic. In this connection it may be remarked that the Board of Agriculture, as at present constituted does not seem the right kind of body for this purpose. It is too unwieldy, too overburdened with details, and is not equipped for giving adequate consideration to the economic and especially to the industrial aspect of a question like this. Such a body can hardly decide, for instance, to what extent should a staple spinning 20's be aimed at, rather than one spinning 40's. The botanists selected should be required to work at the

problems prescribed for them and should not be allowed to alter these, with the sanction of an authority not less competent than that which decided the original lines.

The above are, it is thought, the principles which are best calculated to give the speediest results and in the most economical way. But the task will in any case be a long and difficult one. It is hard for a non-expert to realise what a lengthy, laborious and uncertain process is the building up of a new type. Line after line of work proves infructuous; characters cannot be fixed in combination with other characters; differences are small at first; the plants can be crossed in a single operation, but the botanist can do nothing all the rest of the twelve months but patiently await the result of this single act; and the slightest mistake or accident wastes a whole year. It has taken Mr. Leake, for instance, ten years to arrive only at the beginning of a very promising development. Results, however, occur in a satisfactory proportion of the lines taken up, if the choice is made on reasonable grounds, and the prizes of success are enormous. A gain of six crores of rupees has been mentioned above as the possible result of one particular line of work. That there is nothing improbable in this expectation may be shown by the fact that in the Central Provinces we found that, merely as a result of a botanical examination of the mixture of cottons grown in that province and the selection of the best type of the most profitable of those varieties, an annual addition of over one crore of rupees to the wealth of the local cultivators has been already made by the local Department of Agriculture, over an area of 700,000 acres sown with the seed supplied by Government.

With regard to the third point, this very necessary work is at present carried out by the expert staff of the Agricultural Department, often, it would seem, to the neglect of their more technical duties. Some arrangement should be made, either for the undertaking of these duties by a less highly trained but equally reliable class of Government employé, or for their performance by some non-Government agency.

The improvement of marketing arrangements should be taken up by Government, not only as a necessary condition for the dissemination of improved crops, but in the interest of the people generally. A great benefit would be conferred on the cultivator, and no doubt on the consumer, if the former could be given a market, where buyers would compete freely for his grain or other articles, and he would be reasonably safeguarded from the more undesirable manœuvres of brokers, touts and their allies. The matter might be enquired into, at any rate in the larger provinces, by officers deputed for this purpose; and such system of market supervision might be adopted as the result of the enquiry seemed to indicate as suitable. Moreover, the maintenance of a high standard of efficiency in the supervision of markets should thereafter form a part of the regular policy of Local Governments; a Collector should think it no less a part of his duty to see that his local markets were so arranged as to secure for the grower a fair share of the price and not to add unnecessarily to the cost of the article to the consumer, than to secure efficient sanitation by a Municipality or road-making by a District Board. The proper authority to undertake the supervision of marketing arrangements and of gins is probably the Director of Industries, but the point requires further examination.

STATEMENT No. I.

(*a*) Quantity.

Production (in bales of 500 lbs.) as given at page 395 of Professor Todd's book on "The World's Cotton Crops."

	America.	India.	Egypt.	Russia.	China.	Other Countries.	Total.	Consumption (as given on page 410 of Todd's book) in bales of 500 lbs. Total.
1902-03	10,758,000	3,367,000	1,168,000	342,000	1,200,000	801,000	17,636,000	...
1903-04	10,124,000	3,161,000	1,302,000	477,000	1,200,000	751,000	17,015,000	...
1904-05	13,557,000	3,701,000	1,263,000	536,000	756,000	893,000	20,706,000	...
1905-06	11,320,000	3,416,000	1,192,000	604,000	788,000	936,000	18,256,000	...
1906-07	13,551,000	4,934,000	1,300,000	760,000	806,000	1,027,000	22,467,000	20,605,000
1907-08	11,582,000	3,122,000	1,447,000	604,000	875,000	950,000	18,640,000	21,053,000
1908-09	13,820,000	3,602,000	1,150,000	608,000	1,933,000	969,000	22,271,000	22,387,000
1909-10	10,651,000	4,718,000	1,000,000	686,000	2,531,000	950,000	20,536,000	22,318,000
1910-11	12,132,000	3,853,000	1,515,000	895,000	3,467,000	967,000	22,829,000	24,605,000
1911-12	16,043,000	3,288,000	1,485,000	875,000	3,437,000	1,058,000	26,186,000	26,126,000
1912-13	14,129,000	4,305,000	1,507,000	911,000	3,031,000	1,171,000	26,044,000	26,863,000
1913-14	14,010,000	5,201,000	1,537,000	1,015,000	4,000,000	1,340,000	27,703,000	27,000,000
1914-15 *Estimate.*	16,500,000	5,000,000	1,300,000	1,300,000	4,000,000	1,300,000	29,400,000	...

(*b*) Value (in rupees).

1902-03	2,16,84,09,000	32,45,82,000	18,95,81,000	5,42,28,000	14,91,06,000	11,70,57,000	3,00,29,63,000	...
1903-04	2,46,77,25,000	32,14,18,000	28,38,36,000	7,56,34,000	15,51,69,000	13,00,62,000	3,43,38,44,000	...
1904-05	2,60,54,86,000	48,39,05,000	27,73,07,000	8,49,89,000	12,25,23,000	14,08,18,000	3,71,50,28,000	...
1905-06	1,69,02,17,000	35,76,12,000	22,46,02,000	8,16,55,000	10,13,36,000	13,22,15,000	2,58,77,27,000	...
1906-07	2,32,23,03,000	58,64,52,000	33,98,55,000	11,28,77,000	11,23,78,000	16,00,22,000	3,64,28,87,000	3,39,08,10,000
1907-08	2,14,70,13,000	35,09,80,000	39,78,35,000	10,81,84,000	13,62,99,000	16,09,16,000	3,31,92,36,000	3,76,58,55,000
1908-09	2,25,75,84,000	41,96,90,000	24,30,00,000	10,40,09,000	24,69,10,000	14,85,04,000	3,42,06,12,000	3,43,08,08,000
1909-10	2,00,77,13,000	58,61,87,000	24,20,62,000	10,83,63,000	42,20,37,000	16,71,11,000	3,53,35,33,000	3,92,51,78,000
1910-11	2,85,17,78,000	60,02,85,000	51,48,16,000	16,66,90,000	58,95,80,000	21,02,22,000	4,03,33,80,000	5,34,83,12,000
1911-12	3,25,47,24,000	54,30,68,000	40,63,33,000	14,80,02,000	62,85,95,000	21,02,66,000	5,19,09,88,000	5,19,25,42,000
1912-13	2,53,08,57,000	61,74,38,000	39,29,50,000	14,37,81,000	70,66,50,000	21,65,92,000	4,63,82,77,000	4,96,70,76,000
1913-14	2,91,19,56,000	80,74,01,000	44,15,03,000	16,09,41,000	74,20,00,000	27,71,46,000	5,34,09,47,000	5,58,39,37,000
1914-15	2,94,83,44,000	56,95,83,000	31,37,10,000	20,61,31,000	57,23,75,000	22,15,35,000	4,83,76,87,000	...

Note.—The valuation has been made on the basis of the prices prevailing in the different years.

STATEMENT No. II.

Showing the prices of 'Tinnies' at Tuticorin *as compared with those at* Liverpool.

Period.	Prices per lb. in annas and decimals.				Price per bale of 500 lbs. in £ and decimals of £.		
	American middling at Liverpool.	Tinnevelly at Liverpool, F. G. F.	Tinnies at Tuticorin, F. G. F.	Westerns per lb.	American middling at Liverpool.	Tinnevelly at Liverpool, F. G. F.	Tinnies at Tuticorin, F. G. F.
1	2	3	4	5	6	7	8
					£	£	£
31st December 1914 .	4·58	4·00	3·20	2·88	9·54	8 33	6·67
15th January 1915 .	4·80	4 24	3 52	2·88	10 00	8 83	7·33
29th January 1915 .	5·02	4·54	3·20	3·52	10 46	9·16	6·67
12th February 1915 .	4·97	4·54	3·52	3·36	10·35	9·46	7·33
26th February 1915 .	4 97	4·51	3 52	3·68	10 35	9·16	7·33
12th March 1915 . .	5 17	4·81	3·68	3·78	10·77	10·02	7 67
26th March 1915 . .	5·48	5 14	1·19	3·97	11·42	10·71	8·74
16th April 1915 . .	5·75	5 41	4·42	4·06	11·98	11·33	9·20
30th April 1915 . .	5·66	5·40	1·48	4·45	11·79	11·25	9·33
14th May 1915 . .	5·30	5·10	1·16	4·16	11·04	10·62	8·67
4th June 1915 . .	5 35	5·15	4·06	...	11·14	10·70	8·47
11th June 1915 . .	5·37	5·20	4 03	3 60	11·18	10 83	8·40
25th June 1915 . .	5·20	5·10	3 94	3·58	10·83	10·62	8·20
9th July 1915 . .	5·17	5·00	3·84	3·65	10·77	10·42	8·00
23rd July 1915 . .	5·13	5·05	3·78	3·57	10 69	10 52	7 81
6th August 1915 . .	5 53	5·25	4·00	3·36	11·52	10·94	8·33
20th August 1915 . .	5·42	5·15	4·00	3 36	11·29	10·73	8·33
3rd September 1915 . .	5·78	5·40	4·10	3·74	12 04	11·25	8·53
17th September 1915 .	6·14	6 05	4·80	4·00	12·78	12·60	10·00
1st October 1915 . .	6 97	6 43	4·80	4·72	14·52	13·40	10·00
15th October 1915 . .	7·23	6·85	5·31	4·83	15 06	14·27	11·07
29th October 1915 . .	7·02	6·65	4·96	4·86	14 62	13·85	10·33
12th November 1915 .	7·01	6·60	5·02	4·17	14·60	13 75	10 47
26th November 1915 .	7·28	6·90	5·06	4·64	15·17	14·38	10·53
11th December 1915 .	7·66	7·25	5·06	4·64	15·96	15·10	10·53
25th December 1915 .	...	...	4 86	4·48	..	...	10·13
31st December 1915 .	7·92	7·50	...	...	16·50	15·63	...
14th January 1916 . .	8·79n	7·75	5·50	4·74	18·83	16·15	11·47
29th January 1916 . .	7·93	7·70	5·54	4·86	16·52	16·04	11·53
11th February 1916 .	8·06	7·75	5·54	5·40	16·79	16·15	11·53
25th February 1916 .	7·72	7·50	5·79	5·63	16·08	15·63	12·07
17th March 1916 . .	7·87	7·65	6·03	5·89	16·40	15·94	12·53
31st March 1916 . .	7·77	7·50	6·08	5·76	16·20	15·63	12·67
14th April 1916 . .	7·78	7·55	5·82	5·12	16 22	15·73	12·13

STATEMENT No. II—*contd.*

Showing the prices of 'Tinnies' at Tuticorin *as compared with those at* Liverpool—contd.

Period.	Prices per lb. in annas and decimals.				Price per bale of 500 lbs. in £ and decimals of £.		
	American middling at Liverpool.	Tinnevelly at Liverpool, F. G. F.	Tinnies at Tuticorin, F. G. F.	Westerns per lb.	American middling at Liverpool.	Tinnevelly at Liverpool, F. G. F.	Tinnies at Tuticorin, F. G. F.
1	2	3	4	5	6	7	8
					£	£	£
28th April 1916 . .	7·94	7·65	5·79	5·50	16·54	15·93	12·07
12th May 1916 . .	8·44	8·10	6·05	5·80	17·58	16·87	12·60
26th May 1916 . .	8·47	8·10	6·02	5·26	17·65	16·87	12·53
9th June 1916 . .	8·42	8·00	6·14	5·76	17·54	16·67	12·80
23rd June 1916 . .	8·29	7·90	6·14	5·89	17·27	16·46	12·80
7th July 1916 . .	8·01	7·65	6·24	6·08	16·75	15·94	13·00
21st July 1916 . .	7·97	7·65	6·27	6·05	15·60	15·94	13·07
4th August 1916 . .	8·57	8·20	6·53	6·50	17·75	17·08	13·60
18th August 1916 . .	8·86	8·45	6·34	6·62	18·46	17·60	13·20
1st September 1916 . .	9·90	9·20n	6·72	6·88	20·63	19·17n	14·00
16th September 1916 .	9·51	8·95n	6·59	6·78	19·82	18·65n	13·73
29th September 1916 .	9·47	8·90n	6·53	6·78	19·73	18·54n	13·60
13th October 1916 . .	10·11	9·40n	6·85	6·78	21·06	19·58n	14·27
27th October 1916 .	11·14	10·40n	6·82	...	23·21	21·66n	14·20
10th November 1916 .	11·42	10·90n	6·75	7·26	23·79	22·71n	14·07
24th November 1916 .	11·90	11·30n	7·49	7·46	24·79	23·54n	15·60
8th December 1916 . .	12·05n	11·45n	8·00	7·74	25·10n	23·85n	16·67
22nd December 1916 .	10·09n	9·65n	8·00	7·42	21·02n	20·10n	16·67
5th January 1917 . .	10·96n	10·45n	...	...	22·83n	21·77n	...
19th January 1917 . .	...	...	...	...	...	...	...
2nd February 1917 . .	10·33n	9·90n	...	...	21·52	20·63n	...

APPENDIX C.

THE SUGARCANE INDUSTRY.

Sugar problem in India.

The sugar problem in India is capable of being stated very simply. In the last year before the war (1913-14), the area under cane in the provinces for which returns are received was 2,659,800 acres, from which a normal yield of *gur* would be 3,428,000 tons. *Gur* is also produced in some provinces from palm trees to the extent of about 150,000 tons, but the quantity apparently does not vary much from year to year, and has not been affected by the war. In the year 1913-14 the imports of sugar and molasses together were 896,800 tons. To what extent can these imports be replaced by sugar produced in India?

Production in India.

2. During three years of war the average annual imports of sugar have decreased by 256,000 tons, whilst the increased area brought under cultivation is capable of producing about 350,000 tons of *gur*. The tables given below furnish the data upon which the above statement is based.

TABLE I.

Provinces.	Normal yield of *gur* in tons per acre.	1913-14.		1917-18	
		Area in acres.	Outturn in tons.	Area in acres.	Outturn in tons
Bengal	1·3	216,500	281,400	207,000	269,100
Bombay	3 1	63,500	196,800	113,000	350,300
Madras	2·2	83,600	183,900	123,000	270,600
United Provinces	1·2	1,389,300	1,667,200	1,497,000	1,796,100
Bihar and Orissa	1·1	262,900	299,200	263,000	289,300
Punjab	0·9	410,800	369,700	502,000	451,800
Central Provinces	1·1	20,100	22,100	25,000	27,500
Assam	0·9	37,900	34,100	35,100	31,500
North-West Frontier Province	2 0	31,800	63,600	31,000	62,000
Minor Areas	1·3	24,900	32,400	22,000	28,200
Total	...	2,541,600	3,150,700	2,818,000	3,576,700
Native States	1·5	118,200	177,300	(not available).	
TOTAL	...	2,659,800	3,328,000	...	...

Table I gives the area under sugarcane in 1913-14 compared with the final forecast of 1917-18. These areas multiplied by figures furnished by the Agricultural Department for the average outturn per acre of each province give the weight of *gur* produced in a normal year from the area under cultivation. From the statement it will be seen that in 1913-14 the crop in British India, if the yield was an average one, was 3,150,000 tons, and in the Native States from which returns are received 177,000 tons; whilst in 1917-18 on the same assumption the crop in British India will be 3,576,000 tons, an increase

of 426,000 tons. Figures for the Native States are not yet available, but it is fairly certain that they would show a somewhat similar increase, *viz.*, 13 per cent., and we may, therefore, assume that the total increased production of India will be about 450,000 tons. Areas for which no figures are furnished are the Native States of Hyderabad, Baroda, Baluchistan and Sikkim.

TABLE II.

Year.	Imports of sugar in tons.	Value in £ sterling.
1912-13	772,153	9,519,172
1913-14	896,869	9,971,251
1914-15	550,120	7,014,990
1915-16	642,744	11,078,531
1916-17	512,218	10,300,210

Table II furnishes the imports of sugar into India from outside with the values expressed in sterling for the five years 1912-17. The rapid increase in the rate of importation came to an end with the outbreak of war. In the two years immediately preceding the war, imports averaged 834,000 tons; whilst in the three years of war they have fallen to an average of 578,000 tons, a decrease of 256,000 tons. The expenditure on foreign sugar shows little change; the average annual imports in the pre-war years referred to were valued at £9,748,000 and in the war years at £9,469,000. That is to say, the fall in volume of imports was almost exactly counterbalanced by the rise in price. From this it would seem that India is able to spend about ten millions sterling a year on sugar, which may be regarded somewhat in the nature of a luxury, and that for her ordinary dietary *gur* is sufficient. The rise in the price of sugar diminished the quantities consumed, and this deficiency has been made up by an equivalent amount of *gur*. The increase in cane cultivation is a very satisfactory feature of the situation, and justifies the expectation that the efforts now being made by the Government to raise the standard of agricultural practice will result in a very marked advance in the industry, both as regards area cultivated and yield of crop.

It will be observed from Table I that cane cultivation is very unequally distributed throughout India and that by far the greater area is situated in the alluvial plains of the Ganges and Indus river systems. The weight of the cane crop per acre in the south of India is, however, much greater than in the north, where the cold season is too prolonged to yield, at any rate with the present types of cane, the returns obtained in the warmer and more equable climate of the south. Further the percentage of available sucrose, upon which the weight of *gur* extracted depends, is appreciably larger. In Bombay and Madras, too, the cultivation is better, irrigation is fuller, and manuring is on a far more liberal scale. Cane growing in these southern provinces is, however, dependent for its extension on storage irrigation, though much may be done also by power pumping from wells or rivers. Any large increase from wells worked by bullock power is not to be expected. In the United Provinces and the Punjab, where snow-fed canals exist on a large scale (by far the most economical form of irrigation for a crop requiring water during the hot weather), climatic conditions are less favourable, but the cane areas

are larger than those of the southern provinces. A very large acreage is grown in Bengal, Bihar and the United Provinces, practically speaking without irrigation. In the United Provinces, even where irrigation is given, it is mostly very scanty, except where canes are grown for chewing; and it is improbable that it can be materially increased. In the small, highly-cultivated cane areas of Madras and Bombay, and to a less extent in the Central Provinces, the work of the Agricultural Departments has been more effective than in the large, ill-cultivated cane areas of the small and poor cultivators of the United Provinces.

Agricultural improvement. Results of past working in the provinces.

3. The main line along which the problem must be attacked is obviously that of agricultural improvement. The policy should be generally to continue the improvement, along existing lines, of the Madras and Bombay crops; to introduce varieties into the northern provinces which will give the best results under existing conditions of temperature, water supply and climate; and to induce the growers of the northern tracts to take up, along with better types of cane, higher manuring and cultivation. The extension of irrigation in the southern provinces will doubtless be continued on the lines best calculated to obtain for the growers the greatest benefit in return for the money expended. Some share of this is bound to fall to sugarcane. It has been found that in Bombay, at any rate, cane growers are ready to pay as much as Rs. 60 per acre for the irrigation of thick varieties, and it seems hardly necessary to press the claims of cane to any special treatment in these areas.

Madras.

Turning to the purely agricultural work done in the various provinces, we find that in Madras considerable improvements have been effected by the introduction of a disease-proof cane, with the result of arresting the decline of the cane area in the deltaic tracts. Improved methods of cultivation have also led to an increase in the area under cane, owing to the larger profits thereby obtained. No estimate is available to the Commission of the probable increased area to be looked for owing to greater irrigation facilities, or of the amount of improvement in the yield per acre that the Agricultural Department has in view.

Bombay.

Mr. Keatinge, the Director of Agriculture, anticipates that, out of the areas in Bombay over which irrigation is now to be extended, some 80,000 acres are likely to be planted with cane. The Agricultural Department, by an application of water and manure in quantities actually less than those given by the local growers, secured a crop in 1915-16 of 50 tons of cane yielding six tons of *gur* per acre. The use of ammonium sulphate together with oil cake in addition to farmyard manure was found to be the most economical form of manure. Sulphate of ammonia is admittedly suitable for sugarcane in many parts of India; and the general adoption of coke-oven recovery plants on the coal fields should lead to an increased supply at a lower price, which would be a great benefit to the cane industry.

Central Provinces.

In the Central Provinces the agricultural improvements at present being demonstrated, though promising enough in their way, are not likely to make any very large difference to the gross yield, as the area under cane is so small. Much, however, depends on the quantity of water likely to be made available for cane as the result of the numerous irrigation works under construction or projected in this province. The irrigation of cane from storage works in this part of India does not, judging from the history of the past few years, seem very promising, owing to the heavy losses from evaporation and leakage in channels, when small quantities of water are passed along them in the hot season. The extension of the storage capacity of the reservoirs feeding the Mahanadi canals may, however, afford a largely increased supply of water for

cane. Very high yields can be obtained in the south of the Central Provinces where conditions approximate to those in Bombay or Madras.

United Provinces.

An important factor in the United Provinces is the result expected from the crosses which are being produced in the experimental area in Coimbatore. But Dr. Barber, the Sugarcane Expert, reports that he will not be able to test these and give them out to the Government farms for local trial till 1921. If a seedling cane, combining the hardiness and resistance to unfavourable climatic conditions of the local United Provinces varieties with something of the increased yielding power of thicker exotic species, can be evolved, then the prospects of increased production on, and extension of, the existing area are very hopeful. But in order to make this possible, the ryots must be induced to improve their cultivation and to adopt an altogether different standard of manuring. Meantime, the report of the meeting of the Board of Agriculture in 1916 states that a Java variety can be grown successfully in the United Provinces, with slight modifications of the local agricultural methods, to yield 70 per cent. juice in a nine-roller mill, with 15 per cent. sucrose, while the local varieties, under the same conditions give only 55 per cent. juice, with 10 to 11 per cent. sucrose. The above are the results of crushing on a considerable scale at the Rosa factory, and the variety in question, which was grown by the factory, has been thoroughly tried in other parts of the United Provinces. The prospects seem very favourable, and all now depends on a successful demonstration campaign. It will be necessary to provide very large quantities of manure in the form of oil cake, for it is at least doubtful if the local supply of farmyard manure can be greatly increased in the near future.

The United Provinces Government is taking steps to popularise the use of mahua cake as a manure for cane. The example of Formosa,* where the Japanese Government advanced £2 worth of fertilisers for every 2·4 acres put under cane, on condition that the cultivator himself spent another £2-10*s*. On fertilisers, has often been quoted, and whatever may have been the result of certain other measures taken in that island for the encouragement of sugar cultivation, there is no doubt that this or some modification thereof, would afford a great stimulus in India. It is necessary however, to make absolutely certain that the new canes are in every way suitable, and are not liable to ruinous damage from local pests or diseases. It is probable, for instance, that damage from pig would be a serious matter in the United Provinces and Bihar, if thick cane were introduced, and it would be difficult to arrange for effective protection of the small scattered areas.

North-West Frontier Province.

Although situated in the extreme north-west corner of India and exposed to bitter frost in the cold weather, sugarcane is grown in the North-West Frontier Province under irrigation from river channels, on an area of 31,000 acres, and a yield of over two tons of *gur* is obtained from an average crop of 28 tons per acre. The area is said to be limited by the local demand for *gur* and the difficulty experienced by the cultivators in manufacturing it. The Agricultural Department has for some years past conducted experiments with a view of introducing a modern factory system of cultivation and manufacture, and the results indicate that the prospects of success justify the establishment of an experimental Government factory, which could be developed into a large concern drawing its supplies of cane from a maximum area of 5,000 acres. At the same time the prospects of beet sugar cultivation have been investigated with almost equally favourable results, and it is suggested that a central factory, if erected near Nowshera, could obtain supplies of both cane and beet which would enable it to operate for between seven and eight months in the year. This un-

* P. Geerligs' World's Cane Sugar Industry, 1912, page 86.

usually long period is partly due to the fact that the cane after cutting can be preserved with little or no deterioration over a period of several months. At very small cost, therefore, the gap between the end of the cane and the beginning of the beet harvest can be bridged. The beet harvest can also be prolonged by sowing in September and October and again in February and March. No information is available as to the ultimate extent to which developments in the direction of this combined cultivation could be carried, but it is probable that the initial success of one factory would lead to the establishment of others and that the ultimate limit would depend upon the extent of land which could be brought under irrigation. This might possibly be increased by the employment of pumping plants on a large scale.

There are in Assam and Burma large areas of land suitable for the cultivation of sugarcane without irrigation; but it is probable that irrigation supplementary to the rainfall will be found to be very profitable, and this can be supplied by the addition of small pumping installations capable of lifting water from the rivers and streams, which in these provinces are of a perennial character. The area under cultivation in Assam in 1917-18 is stated to be **Assam.** 35,000 acres, with an average yield of only 0·9 tons of *gur* per acre. This outturn is recognised to be much less than might be obtained with good cultivation; and, at the instance of the Board of Agriculture, the Local Administration has started experiments at Kamrup with a view to develope cane cultivation on modern lines and to work up the crop in a large central factory to produce white sugar. The experimental work commenced in 1914-15 and has gradually developed, though progress has been delayed by the difficulties in getting machinery for the central factory. Up to date nearly 700 acres of land have been broken up by steam-ploughing tackle, and 530 acres planted with cane. The erection of the manufacturing plant has not kept pace with the agricultural developments, and no commercial results are yet available. The experiment is an exceedingly important one, and, though unforeseen difficulties have been met with, the results so far obtained are very promising, and there is every reason to expect that it will ultimately prove the possibility of establishing in Assam the central factory system of growing cane.

In Burma the area under cane in 1913-14 was 15,100 acres. Here an **Burma.** attempt was made to get a central factory started, but owing to the war the idea had to be given up. The proposal was that a Rangoon firm should undertake to make experiments in the area commanded by the Minbu canal, at a cost of Rs. 20,000, half of which was to be paid by Government. If they proved successful, the firm was to lay down plant capable of dealing with an area of 10,000 acres. It is stated that crops of 30 tons per acre without manure have been obtained on the Government farm.

It seems that promising tracts exist in these two provinces, for the establishment of central factories, growing at any rate a large proportion of their own cane, but that there are many initial difficulties to overcome, especially in the matter of labour. Areas taken up for cane growing would presumably be free from tenancy rights and other incidents of our Indian revenue system. It is especially this freedom from legal difficulties that inspires a hope that a really considerable quantity of sugar might ultimately be produced in Burma and Assam. Dr. Barber, who has visited the former province, regards the conditions there, apart from labour difficulties, as very promising, and it should be the policy of Government to give out suitable areas for the establishment of central factories to reputable firms, and to invite such applications. The

system followed should provide for small cultivators growing cane alongside the larger areas of the factories, a condition which the probable necessity of importing labour renders the more important.

General.

In accordance with the recommendations of the meeting of the Board of Agriculture held in 1911, Dr. Barber has been engaged on the production of seedlings suitable for various conditions of soil and climate, and also seedlings with maximum sucrose content. Very promising results have been reached in this latter direction as the result of two seasons' work. An agricultural question of importance to the factory owner is the extension of the period during which cane can be obtained ready for crushing, by selecting varieties that ripen at different times, or by extending the period of planting so as to prolong the ripening period. If, as stated in the note prepared by Mr. Coventry on cane growing in Bihar and printed in the Report of 1916 (page 90) of the Board of Agriculture, early planting does not lead to early ripening, this may be owing to the cold of the early winter months, as in the warmer climate of the south of the Central Provinces, the opposite was found to be the case. Two different classes of cane, one early and one late ripening, could, however, as Mr. Coventry stated, be grown in Bihar side by side, thereby extending the period.

Manure.

4. In view of the shortage of farmyard manure, it is necessary to employ some substitute which can replace farmyard manure wholly or partially. This exists in the form of various kinds of oil cake, which, at any rate in the case of heavily manured and well cultivated land in Bombay, gave the most economical results when used with ammonium sulphate. The stimulation of the oil-pressing industry that would arise from an increased demand for cake would be a desirable end. Sulphate of ammonia was sold in India before the war (June 1913) at Rs. 257 per ton; it should be possible to sell sulphate of ammonia produced in India at a much lower price than the imported article.

Cost of cultivation and availability of cane.

5. The cost of cane cultivation and the prices paid for cane by factories are of interest in this connection. The usual price paid for the poor class of cane obtained by factories in the United Provinces and Bihar before the war was four annas a maund. The price however varied between $3\frac{1}{2}$ and 6 annas, according to the price of *gur* and competition between factories. Higher prices were said by the Bihar witnesses to have been paid since the war, but generally the price in Bihar is much the same as in the United Provinces. In places where a thicker class of cane is grown, much higher prices are the rule, although, except in Madras in the neighbourhood of the sugar factory at Nellikuppam, there is very little purchase of cane on a commercial basis in such tracts. The ryot in Madras and Mysore takes his cane to the power-driven mill and gets it crushed and the juice boiled down to *gur*. For this he pays the charges levied by the owners of the mill, and then he sells the *gur* himself, obtaining a price equal to 10 to 12 annas per maund of cane. The lowest price in pre-war times was eight annas a maund. Enquiry in connection with experiments in the Hadi process in the Central Provinces showed that nine annas a maund was the lowest figure that would satisfy the cultivators. In Bombay, it cost the Agricultural Department slightly over four annas to grow a maund of cane in 1915-16. Most Bombay and Madras canes have a much higher percentage of extraction and usually of sucrose than the northern canes, but not, it would seem, enough to account for the great difference in price. Canes which are doubtless somewhat of the same class as those grown in Bombay

and Madras are grown in Fiji and Mauritius. In Fiji the nett cost to the factory is three annas a maund, including the expense of planting, cutting and transporting, which is borne by the factory. In Mauritius, the Indian growers get 5·3 annas a maund. The Formosan grower receives on an average 4½ annas a maund for a cane with 11 per cent. sucrose contents. This approximates fairly closely to United Provinces conditions. Until the Bombay grower is ready to sell his cane at a price which may be provisionally stated at six annas a maund or a little more, on a pre-war sugar price basis, it does not look as if a central factory would have much chance of success in that Presidency. Efforts have been made in the United Provinces to induce the ryots to sell their cane on a basis of extraction, but without success. If improvement were taken up on a large scale, the growers of better cane would doubtless be ready to sell on a basis of extraction results; and if so, the growing of inferior types would no doubt tend to decrease more rapidly.

In the southern provinces, on the other hand, the problem would seem to be one of increasing the area under cane until the market for *gur* is overdone. If the yield is so large as to make the growing of cane still profitable on a lower price basis for *gur*, and therefore for cane, an opening for the central factory will at once be created. If, however, a fall in the price of cane to a point still above what a central factory can afford to pay, leads to a decline in area, the future prospects of sugar making in these tracts are not promising. Here the Agricultural Department can be of assistance, by showing the cultivator how to grow as much cane per acre as possible in the most economical way. Another difficulty, however, which must be faced, is that due to the small area of cane in any given tract, and efforts will have to be made to bring about a greater concentration in favourable situations, so as to diminish as much as possible the cost of transport to a central mill.

Agricultural improvement future work.

6. It would seem, then, that there is a possibility within the next few years (1) in the southern provinces of a considerable increase in the area under the irrigation works combined with some increase in outturn, (2) in the northern provinces, if the policy laid down by the Board of Agriculture is vigorously pursued, of a very large increase in the outturn of the existing area, and possibly of an extension of that area in consequence of the more profitable nature of the crop. This is so much larger than all the southern areas together, that no effort should be spared to promote improvements on lines already ascertained to be suitable. In particular, the establishment of a sugarcane farm in the part of Bihar north of the Ganges should be no longer delayed. In this tract we found the main sugarcane areas and practically all the factories of the province, and it adjoins a part of the United Provinces where much cane is grown. The establishment of central cane factories (3) in Assam and Burma offers promising prospects.

There seems no reason why the various increases above indicated should not yield *gur* or sugar, equal or more than equal to the quantity of sugar at present imported.

Limitation of area due to prices of other crops.

7. There is, however, another very important factor which affects the area under cane—*viz.*, the price of other crops. This is especially marked in the case of jute in Bengal.

The cane areas in Bengal (including Assam) and in the United Provinces in the year 1890-91 were 1,146,611 acres, and 1,104,334 acres respectively (Agricultural Statistics figures). In the year 1907-08 they were 616,032 acres and 1,471,831 acres, although the yield in Bengal is certainly higher than in

the United Provinces. One reason for the decline in the case of Bengal may be seen from the statement below:—

Period.	Price of jute, per bale, Calcutta.	Total area under jute (India) acres.	Price per maund Valley *gur*, Calcutta.	(Final forecast) Area under cane (Bengal).
	R a. p.		*R a. p.*	Acres.
Average of 5 years ending 1904-05	33 8 11	2,530,308*	3 14 9*	680,880
Year 1905-06	57 8 0	3,140,822	4 8 3	623,100†
1906-07	50 11 8	3,523,558	4 3 2	606,700†
1907-08	39 1 5	3,942,675	4 3 5	607,200†
1908-09	32 9 4	2,835,454	6 3 9	553,000†
1909-10	36 10 8	2,756,820	6 12 2	507,800†
1910-11	40 9 8	2,828,669	6 2 0	515,600†
1911-12	54 4 0	3,090,827	4 12 0	521,000†

* Average for 3 years only.
† Including Assam.

Gur fell even lower in the next two years; but during the above period the price of *gur* rose 18 per cent. and that of jute 61 per cent. The area under cane declined by 23 per cent. and that under jute rose by 22 per cent.

Demands for *gur*.

8. It is difficult to draw definite conclusions from such statistics as are available regarding either the production of *gur* or the prices realised in free markets. *Gur*, as ordinarily made, does not keep well in damp weather, and immediately after the cane harvest season the crop is thrown on the market, owing to the inability of the ryots to hold it for any length of time. Consequently there are violent fluctuations in price, and the bulk of the crop has to be sold at the time when prices are lowest. Average rates, therefore, are totally misleading as regards the actual cash returns received by the growers.

There is no reliable evidence of a decreased demand for *gur*, as the percentage of the Indian cane crop which is made into sugar is still small, and the figures show that, if anything, there has been in recent years an increase in the area under cane, which is likely to become of greater importance now that the price of imported sugar has risen.

The rapid increase in the imports of sugar is, therefore, due to the increased demands of the people for saccharine matter, consequent upon a rise in the standard of living, and it is an open question whether the anticipated increase in the production of sugarcane in India will be used in the form of *gur* or manufactured sugar. If the demand is for *gur*, the prices for that product will remain high, and it will be difficult for factories producing sugar to obtain supplies of raw material. On the other hand, if the demand is for sugar, the present ratio of prices between *gur* and sugar will not be maintained, *gur* will become cheaper and the sugar refineries will be able to purchase it. Hitherto, sugar has been the only article of food which, to any considerable extent, has been imported into India, and the cane grower and therefore the *gur* producer have been subject to competition from an overstocked market which was artificially supported by bounties and cartels. While world prices for food grains and fibres capable of being grown on land suitable for sugar have risen, the prices for sugar have steadily fallen, and consequently the Indian sugar

grower has found his cultivation less profitable. His methods of cultivation have remained unchanged, but to some extent his returns have been increased by the use of iron sugar mills. Recent work by the Departments of Agriculture and of Industries in some provinces has, however, demonstrated definitely that there is scope for great advances in the yield of cane by better cultivation and in the extraction of its sugar contents by the use of power-driven milling machinery. The adoption of these new methods and appliances will increase the returns per acre without increasing the cost of production in a similar ratio, and, the margin of profit being thus extended, the area under cultivation will grow till the returns cease to offer inducements for any further expansion.

Economic limits of central factories.

9. No reliable information is at present available regarding the economic limitations of the central factory system in India. There is both an upper and a lower limit, but the former need not concern us as it is never likely to be reached in India. The lower limit depends on the degree of efficiency in manufacture which can be obtained when working on a small scale, and on this point the experiments in progress in the United Provinces have not yielded any satisfactory data. That the efficiency will be less than would be obtained with larger plant is certain, but the loss on this account may be counterbalanced by the diminished cost of transport, when the cane supplies have to be carried only a short distance and there is a local market for the whole outturn. The cost of management is also a factor of some importance, and small Indian central factories should be able in this respect to hold their own against the somewhat expensive control of the larger factories. At the present time the lower limit of the factory system seems to be a mill capable of dealing with 250 tons of cane per day, or with the produce of an area of 25 acres in the north of India or of 10 to 12 acres in the south. Assuming a working season of 100 days, the smallest central mill will require 2,500 acres of cane in the north of India and from 1,000 to 1,200 in the south. Only in a few places can such large areas be secured, and it is urgently necessary to encourage concentration of cane growing as much as possible, simultaneously with the technical development of sugar manufacture on a small scale.

Working of Indian sugar factories.

10. There were in 1915, 23 sugar factories in British India employing 50 or more persons, and three in Native States. Of the above, nine were in the United Provinces, seven in Bihar and Orissa and five in Madras. Some obtained their sugar from *gur* only and not from cane directly, some worked only on cane, and others on both. Some of these factories also worked as distilleries; and in one or two cases they turned to account the carbonic acid gas from the fermentation vats by compressing it in steel cylinders for the use of manufacturers of aerated waters. One factory has carried the sugar industry to the stage of producing sweets.

The limited commercial success attained by sugar factories and refineries in India until somewhat recently, was largely due to imperfect appreciation of the conditions under which the industry must be carried on in India, and to bounty-fed competition from abroad. At the present time the price at which sugar is landed in India is not the only factor in determining whether a season's work will result in a profit or a loss; this depends to a large extent on the current prices of *gur*, which often bear no relation to those of sugar. If the season is poor, *gur* is dear, and unless sugar is also dear, the mills cannot make a profit. But war conditions have, for the time being at any rate, enabled sugar factories to work at a considerable profit.

Obviously the greatest help for existing, and the greatest security for projected mills is a plentiful supply of suitable cane. If this is not available, nothing short of very high protection will have much effect.

Difficulties from point of view of central factory.

11. It must be understood that the peculiar conditions under which cane is grown in India present certain special difficulties, from the point of view of the central factory. As in many other countries, cane cannot be grown in India to advantage continuously in the same plot, except where it is ratooned; it has to be rotated, preferably on at least a three years' system, with other crops; and the areas in which it is grown are very small and scattered. It is, however, sometimes grown by a number of small cultivators in one block, fed either by tanks or canals. In the latter case, rates and water supply are often regulated so as to concentrate cane in blocks, in order to economise water. In Bihar and the United Provinces in particular, holdings are very small, and where cane is grown without irrigation, or from wells, the result is a number of very small isolated patches. In tracts which are subject to the ravages of wild animals, an additional inducement to concentration is found in the facilities given thereby for watching and fencing the crop.

The tenancy law in most parts of India renders it impossible for a capitalist to acquire continuous areas for factory cultivation, and it is more than doubtful if Government would be justified in permitting the compulsory acquisition of these, or if it would be practicable for a factory to acquire such by private negotiation, supposing that a clear title could be passed. The number of cultivators to be expropriated would be very large in proportion to the industrial results; and the process would have to be repeated every time a new factory was started. It would be almost impossible to provide other land for the expropriated cultivators, and much hardship and discontent would be created.

Difficulties retarding expansion of cane growing.

12. Another factor that has to be taken into account is the lack of available bullock power for crushing cane. It will be remembered that by far the greater proportion of Indian cane is made into *gur*, the cane being crushed in bullock mills and the juice boiled by the cultivator himself. As a rule, the cattle power is insufficient to deal economically with the cane grown. The cattle are overworked and weakened by the hard toil of the mill, following on the continuous ploughing of the monsoon and the *rabi* sowings. The temptation to the cultivator to slack off the mill, with much resultant loss in extraction, is great. Again the crushing season is often prolonged till the canes have deteriorated. One or more of these conditions are usually to be found in all areas where cane is grown to any considerable extent. It is manifest, therefore, that the expansion of cane growing, in the absence of a central factory, will be held up, unless some suitable means of crushing cane otherwise than by bullock power can be devised. The replacement of cattle by mechanical power plant, however, will further accentuate the shortage of farmyard manure, to which we have already alluded, and render the necessity of artificial manures more urgent.

The original form of cane mill in India was the old stone pestle and mortar, revolved by bullock power, with an extraction of about 33 per cent. in its most primitive form. This type has now almost disappeared. The mill with wooden rollers was an improvement on it, but worked very heavily, with much strain on the bullocks; it gave an extraction of about 50 per cent. Various types of iron mill have now for the most part superseded both, and these are sometimes purchased by the cultivator, but are also often hired out by firms, especially in northern India and Bengal, at so much a day, the cultivator finding the bullocks and labour.

Efficiency of bullock-driven mills.

13. The highest extraction that can be effected by the best type of bullock-driven mill is about 68 per cent., or in the case of one or two types 70 per cent. This high rate can only be got from thick cane, and can only be maintained

by the use of good bullocks regularly relieved. Under similar conditions, about 62 per cent. might be obtained from medium-sized canes, such as the *sarathi* grown in the United Provinces. From 50 to 60 per cent. extraction is effected by the less efficient types of mill, according to the class of cane crushed, the number of rollers and their setting. A two-roller mill gives about 56 per cent. under the most favourable conditions; but it must be remembered, first, that a cultivator has by no means always enough cattle to work his mill up to its highest extraction capacity, and is often tempted to slack the setting of his rollers to enable the mill to work faster. The result is that he burns under his evaporating pans one-third of the sugar he produces, to turn the other two-thirds into *gur*. In the next place, the rollers are not usually of hardened metal, and get worn more in the middle than at the ends. This also causes much waste of juice.

Small power plants to crush cane for *gur* making.

14. The real remedy is obviously to introduce power-crushing plant of sizes suitable to the cane area available and to the purchasing power and technical skill of the people. The success of such mills, in the comparatively few instances in which they have been tried, has resulted in a tendency to concentrate cane growing in their neighbourhood.

There is a very great difference between the rate of working of power and bullock mills. The results of comparative trials at Poona showed that a three-roller mill, with rollers 20″ × 14″, driven by an oil engine, could crush 4,500 lbs. of cane an hour, against 750 lbs. with a four-bullock mill, and 450 lbs. with a two-bullock mill. Experiments in the south of India with three-roller mills of horizontal type, with rollers 12 inches in diameter and 18 inches in length, driven by oil or gas engines, have conclusively shown that they can on an average extract 15 per cent. more juice from the cane than is usual with bullock mills. Such mills require about six b. h. p. to drive them; they can deal with from a ton to a ton and a half of cane per hour, and extract sufficient juice to yield from 200 to 250 pounds of *gur* per hour. Under favourable conditions, the output of such mills will rise to 300 pounds of *gur* per hour. Roughly, their rate of outturn is equal to that of six pairs of cattle working six bullock mills. As they can be driven almost continuously day and night through the working season, these power plants will do as much work as 24 to 30 pairs of bullocks, and bullocks can only be worked from five to six hours a day each without causing undue deterioration. Evidence is forthcoming to show that such power-driven mills can economically replace cattle for areas as small as 40 or 50 acres, and that even smaller types of power-driven mills can be advantageously employed for areas as low perhaps as 25 acres.

Where these small power-driven mills have been introduced, it has been definitely established that they have increased the value of the product from a given area of land by from 25 to 30 per cent. Part of this is due to the fact that the increased milling power enables the crop to be handled at exactly the time when the sucrose contents are greatest.

In Mysore such plants have been installed by sugarcane growers cultivating large areas; others have been installed at State expense in places where the concentration of cane growing justified the experiment; and more recently several have been established by co-operative societies which have been largely financed by State loans. No evidence has been produced to show that any one of these plants has been completely successful in regard to the important matter of continuous working during the season; but, year by year, it is claimed that the results are improving and that the ryots in the neighbourhood are beginning to rely more and more upon them.

The remarks below indicate the experience which has been gained in Mysore.

"There is as yet but little evidence to indicate the best way to encourage the development of these power plants. Most of the large growers of sugarcane have already adopted them. The ideal method is to form co-operative societies amongst the growers of the cane who will employ qualified experts to run the plants. In those instances in which small capitalists have taken over factories originally started by Government, there seems to have been a considerable amount of friction which has been injurious to both parties. Although a very considerable measure of success has been achieved, a great deal yet remains to be done to determine the nature of the organisation which should be encouraged to carry on and develope this method of preparing *gur* for the market. But an infinitesimal portion of the Indian sugar crop is so far dealt with in these small mills; yet the results obtained justify further work on a greatly extended scale."

It seems proved, then, that if the area under cane is to be increased, if heavy crops are to be grown, and if the present tremendous waste of juice is to be avoided, small power plants will have to be introduced in very large numbers. The preliminary demonstration work must be undertaken by Government. Progress has been hitherto very slow, except in Madras and Mysore. Every use possible should be made of *takavi*, of co-operative finance, and of the assistance of landlords, but it seems that, for some time to come, the most promising policy would be to encourage small capitalists to crush for local custom.

Improvements in *gur* manufacture and its effect on refineries.

15. The subsequent disposal of the juice is the next point for consideration.

The three main directions in which improvement of the *gur*-making process is being attempted are—(1) economy of fuel, (2) production of a better quality of *gur*, (3) avoidance of waste from burning and skimming. As regards the first point, there is no doubt that over quite considerable tracts, the cultivators find it possible to boil the *gur* without other fuel than the megass and trash. The Poona furnace has been for long demonstrated in various parts of India, and is an improvement on most local methods. Concurrently with the experimental work involved in replacing cattle power by oil engines or gas engines, efforts have been made in Madras to improve the arrangements for boiling down the juice, and, while finality in this direction has perhaps not been reached, great improvements have been effected by the introduction of a properly constructed megass-burning furnace, the hot gases from which pass under a series of pans. The price of *gur* varies a good deal according to quality; but the best qualities do not in all cases suit local tastes. There is, however, no reason why, with instruction, the ryot should not produce a very much better type of *gur* than at present. The soft, dirty *gur* of Bihar and the eastern districts of the United Provinces sells for only Rs. 4 per maund, while cleaner *gur* from the northern districts fetches Rs. 5. The former is mainly in demand for refining, and the production of a better *gur* in Bihar and the eastern United Provinces districts, with a consequent rise in prices, would also probably be fatal to the refining industry in the north. This would scarcely be a matter for regret, inasmuch as the cultivator turns out *gur* which fetches a far lower price from the refiner than he could get for a better made article from the ordinary consumer, while the refiner, by dealing with a sugar product which has already passed through a process which renders it less suitable for sugar manufacture than the juice from which it is made, wastes a proportion of the sugar available in the cane.

The amount of sugar obtained from *gur* refining is about 4·4 to 6 per cent. against 7 to 8 per cent. obtained by direct sugar manufacture from the cane. On the other hand, the decay of the refining industry has led to a rise in the price of molasses from Re. 0-9-6 a maund to three times that price, thereby affording a market for Java molasses, at one time a waste product, whilst at the same time enabling Java sugar to compete in India on more favourable terms.

The two main advantages to the large factory refining *gur*, as compared with the direct process of sugar manufacture are—(1) that the work can go on continuously throughout the year, and (2) the heavy capital outlay and recurring cost of crushing and concentration are avoided. The process as at present carried on, both as a sole industry and by cane-crushing factories in order to extend their working season, is not likely to die out for a long time, but it does not seem desirable to take any special steps to assist it.

16. In this note proposals relating to agricultural improvement have been given the greatest prominence. They are generally as follows :— **Summary of proposals.**

The present improvement of cane should be encouraged in the southern provinces. In the United Provinces, a very special effort should be made by demonstrations, by grants of *takavi* loans, or by any suitable modification of the Formosa system, described in paragraph 3, to induce the people to take up the growing of superior canes and to manure them as heavily as the local factors of limitation will permit. A no less insistent campaign should be waged in favour of the small power mill. *Takavi*, co-operation, hire-purchase, and any other suitable system should be employed. Care should be taken to see that the machines are inspected often enough to keep them in good running order, and that *mistris* are made available for running them. Finally, in new areas like Burma and Assam, where agricultural conditions are naturally favourable, and the encumbrances of tenancy and other rights do not exist, every effort should be made by fair offers to induce concessionaires to come forward and build up a cane industry on modern lines. It seems probable that from these areas alone India may be able to obtain a very large proportion of the cane sugar that she now imports.

The above measures would undoubtedly lead to or render possible the establishment of more sugar factories, and, so far as European-managed factories are concerned, little more in the way of help is needed. For the benefit of small factories which cannot afford European supervision, however, separate expert advisers should be available for the United Provinces and for Bihar and Orissa. The propaganda of small power mills should not be in their hands; it can be carried out as well by a less highly paid specialist with a proper staff. The sugar expert's services should be given freely and fully to the smaller capitalist, especially at the start of his operations. For the conduct of his work, he should be enabled to experiment freely and under suitable conditions. He should have a small factory under his charge for this purpose and to train foremen for the use of the factories in his province.

APPENDIX D.

THE DEVELOPMENT OF THE INDIAN TANNING TRADE.

Extent of Indian trade in hides and skins (raw and tanned).

It has been calculated that in India there are about 180 million cattle and 87 million sheep and goats. Though it is only possible to form an approximate estimate of the total number of hides and skins which become available, there is very detailed information regarding the nature and value of such portion of the supply as is exported, either raw or in the form of leather, partly or completely manufactured. The value of the exports in the last four years extracted from the sea-borne trade returns is given below :—

Year.	Value of raw hides and skins exported. Lakhs.	Value of leather and tanned hide and skins exported. Lakhs.	Total. Lakhs.
1914-15	7,82	4,76	12,58
1915-16	9,79	5,64	15,43
1916-17	14,41	9,44	23,85
1917-18	7,84	6,37	14,21*

* Provisional figures.

Except to those engaged in the trade, the voluminous figures contained in the statistical returns are of little interest; the history of the foreign trade is largely a record of the results of fiscal regulations. The United Kingdom has always taken the bulk of the tanned or dressed hides and a very large proportion of the tanned or dressed skins, while the raw material has gone to those countries which protected their manufacturers by the imposition of heavy duties on all but raw products. Till the war broke out, Germany, Austria, and Italy were the principal destinations to which raw hides were sent, and roughly three-fourths of the raw skins were purchased by the United States. Very little information is available regarding the internal consumption of hides and skins. Probably half the hides and nine-tenths of the skins available in the country are exported.

Effects of increasing value of raw materials.

2. Hides and skins may be regarded as a by-product of agriculture, the supply to the market being but little affected either one way or the other by the demand. The export trade, nevertheless, has, from the beginning, steadily expanded both in volume and value, and even more rapidly in value than in volume. Indian raw material fills an exceedingly important place in the leather markets of the world. Prices have constantly tended to rise, and important changes have thereby been brought about in respect of the internal consumption of leather. These will be discussed later on.

A return of the exports by sea from Fort St. George for the year 1846-47 shows that 48,212 hides valued at Rs. 22,423 were exported to the United Kingdom, the average value of each hide being Re. 0-7-5, whilst in 1912-13 the sea-borne trade returns show that 13,450,913 raw hides were exported from India valued at Rs. 8,05,86,105, or an average of Rs. 6 each. Similarly, raw skins in 1846-47 were worth Re. 0-3-2 each and in 1913-14 Re. 1-9-6.

This increase in the value of the raw material has naturally affected rural economy to some extent by stimulating the improvement of the organisation for collecting hides and skins. Formerly, they were the perquisite of the village *chuckler* or *chamar*, who tanned them in a primitive way and supplied the needs of the villagers in the matter of leather. The increased value of the hides and the ease with which they can be marketed have led the *chuckler*, in many places, to abandon the tanning business and to sell the hides to dealers for cash. It has also led the villager to dispute the *chuckler's* right to the hides and to employ him instead as an intermediary in the disposal of them; while he now purchases leather in the open market from the agents or middlemen of the organised tanneries and hands it over to a *chuckler* to make up into whatever he needs.

Peculiarities of Indian hides.

3. Indian hides differ a good deal in size according to locality and breed; speaking generally, the larger hides come from the Punjab, the north of the United Provinces, and parts of Bombay and Madras. The inferiority of Indian hides is only partly due to the poor quality of the cattle. Branding depreciates their value enormously and, as many of the cattle are used for draught work, their hides show signs of wear and tear. Only in the large towns, and more especially in the cantonments, are cattle killed for food, and the bulk of the hides available are those taken off animals which have died from disease, old age, or injury. "Slaughter-house" is an elastic term and is often applied to hides of good quality taken from animals that have died from natural causes, but strictly it is only applicable to those obtained from cattle which have been fattened up for killing. Slaughter-house hides proper are usually of good quality and, in the case of cow hides, might well be used for making sole leather; but their number is small. Hindus are very averse from killing animals, and they allow their cattle to linger on in sickness and old age. The animals suffer and naturally their hides deteriorate, but the most fruitful source of injury is the merciless way in which cattle are branded. This is carried on to such an extreme that many thousands of hides are absolutely ruined, and large numbers of them are depreciated fifty per cent in value through branding, which is done to satisfy the owner's æsthetic eye or calm his troubled mind. It is supposed to be efficacious in keeping away evil spirits and preventing disease, and it is also largely practised as a remedy for many diseases, especially in the nature of staggers or fits.

The prejudice against killing cattle is, however, disregarded in some parts of the country. In the Central Provinces and the United Provinces, "jerked" meat for export to Burma is prepared on a large scale, and there are a number of slaughter-houses at Agra, Damoh, Rahatgarh, Khurai, and other places, where thousands of cattle are slaughtered every day, and a trade not very dissimilar from that of the meat packers of Chicago is carried on. These establishments furnish large numbers of hides of a quality somewhat superior to those taken from the animals that die from natural causes, though the animals sent there for slaughter are usually past work.

Indian skins.

4. The term 'skins' is technically applied only to pelts of sheep and goats. Goat skins are larger, heavier, and of much better texture than sheep skins. Unlike hides, the majority of skins are derived from animals which have been slaughtered for food, and the pelts are, therefore, in a much better condition and will compare favourably with similar classes of skins from other parts of the world. The tanning of skins is practically confined to Bombay and Madras, and the bulk of the business is done in the latter Presidency, the tanners of which supplement the local supplies by importing largely from other parts of India The quality of skins varies very much with the season of the year; but, unlike hides, they are generally at their worst during

the rainy season when the animals become feverish through exposure, and the effect shows in the pelts. The hair or wool grows longer on account of the cold, and this leads to loss of tissue, with the result that the pelt is thin and papery. The majority of the dried skins are exported to be chrome tanned in America or Europe and converted into glacé kid. Skins tanned by the chrome process do not gain substance like those prepared by vegetable tanning, and plump well-nurtured skins are, therefore, in great demand by chrome tanners. Anything less than a spread of 75 square feet per dozen skins is regarded as unsatisfactory. Moreover, every skin should be at least 21 inches wide, so that when converted into glacé kid, it may be possible to cut two sets of upper sides from each skin.

Establishment of western methods of tanning in India.

5. It is difficult to obtain information regarding the tanning of leather in India before the industry came under the influence of western methods. Judging by what is now done in remote districts, where the village tanner is still uninfluenced by modern methods of procedure, it is probable that the indigenous industry was in an extremely primitive condition and that only very inferior kinds of leather were produced. Tanneries of considerable size must have existed to supply the harness and saddlery for the enormous numbers of troops and retainers who were kept under arms by the numerous rajas, zemindars, and petty chieftains, who formerly exercised more or less independent sovereign powers throughout the country. The requirements of the town population were probably small and confined chiefly to sandals and vessels for holding oil and ghee; but the ryots used large quantities of village-tanned leather for water bags, for leather thongs, and for ropes.

European methods of tanning hides were first introduced by the military authorities to manufacture superior leather suitable for harness and other military accoutrements. Contemporaneously in the early forties of last century, a French Eurasian of Pondicherry, named D'Souza, introduced improvements in the native methods of preparing skins. He is said to have visited the island of Mauritius and to have there acquired a practical knowledge of the French processes of tanning and, on his return to Pondicherry, he started a tannery and, a little later, came to Madras and set up several small tanneries in the neighbourhood of that city, the products of which were probably exported to England. Of his improvements the most important was the immersion of the tanned skins in a bath of myrabolams after the ordinary tanning had been completed. This prevents a very objectionable change in colour which otherwise takes place on the exposure to sunlight of leather or skins tanned with *avaram* bark. There is no clear evidence that from his time till the advent of chrome tanning any further changes in the methods of tanning skins have been introduced into India. The small demand for highly finished skins in India was met by importation from Europe, and the somewhat crudely prepared Indian-dressed skins were welcomed by the tanners in Europe as the raw material from which to prepare the very best classes of light leather.

Growth of modern tanning industry.

6. The developments of leather manufacture in contradistinction to the light tannages of Madras and Bombay are almost entirely the outcome of military efforts to obtain suitable supplies for boots and accoutrements. Where arsenals were established, tanneries usually followed. At Cawnpore, the Government Harness and Saddlery Factory was started in 1860 on an experimental scale and, as it proved a success, it was placed on a permanent basis in 1867. Shortly afterwards, Messrs. Cooper and Allen started the Government Boot and Army Equipment Factory and, at the outset, they received a considerable amount of financial assistance from Government. A marked

degree of success has attended the efforts to develope the leather trade in Cawnpore, and, up till the time of the outbreak of war, the factories which have come into existence, though largely dependent on the army for orders, were by no means appanages to the military department.

The successful establishment of the industry on a large scale is due to the following facts:—(1) Cawnpore is a convenient centre for the collection of hides from Northern India; (2) at the outset, there were large supplies of cheap *babul* bark, an excellent tanning material; (3) the business was in the hands of enterprising Europeans; and (4) their efforts were viewed with favour, and largely assisted by Government, who provided a market in the early days for the bulk of the outturn. Working on similar lines, but on a much smaller scale, an enterprising Khoja Muhammadan, Adamjee Peerbhoy, established at Sion, in Bombay, the Western India Army Boot and Equipment Factory. In Europe and America machinery is very largely employed in tanneries and leather-working factories but, although it has been employed on a considerable scale in the Cawnpore and Sion factories, elsewhere, till quite recently, it was conspicuous by its absence in the Indian tanneries, which produced the whole of the half-tanned leather and skins that bulk largely in the export trade of the country.

Chrome tanning in India.

7. The action of various chemicals on hide substance has been the subject of scientific investigation for many years past and, about 1895, the method of producing leather by means of chromium salts was thoroughly established in America on a commercial basis. The process was also taken up on the Continent and, somewhat more slowly and at a rather later date, by English tanners. Some experiments were made in India both in Cawnpore and Madras; but they resulted in nothing practical till, in 1903, the proposal was made in Madras to use leather prepared by this process for water bags for the country *mhots*. The experiments proved successful and resulted in the establishment of a Government factory, in which chrome leather was manufactured on a considerable scale and applied to a variety of purposes in place of bark-tanned leather. The history of this factory will be found in Appendix J. That it was prematurely closed there seems to be no doubt, as the progress of chrome tanning in India has been much slower than it is reasonable to anticipate would have been the case had Government assistance in pioneering the industry been given for a longer period. The developments have followed the line of least resistance, and, in the hands of private individuals, immediate profit has naturally been of greater importance than ultimate development. Of the chrome tanneries which were started, seven or eight have survived the initial difficulties and are now mainly employed on the manufacture of leather for sandals and boots and shoes. The manufacture of black and brown box sides has been developed on a considerable scale, and this completely finished leather has found a profitable market in Great Britain.

At the outset, it was thought that there would be a very large market for chrome leather for water bags, but progress in this direction has been comparatively slow. The rise in the price of leather has led the ryots to use light iron buckets, and competition with them left comparatively little profit to the chrome tanner. The Madras Tannery was the first in the south of India to introduce the use of machinery in the tanning processes, and the success with which such machinery has been working has led to its adoption to some extent in bark tanneries. This latter development is a matter of some importance, as it has engendered a more progressive attitude amongst the Indian tanners.

Efforts of the Munitions Board to stimulate manufacture of leather articles.

8. Evidence of this is visible in the success which has attended the efforts of the Indian Munitions Board to stimulate the manufacture in India of certain classes of leather goods previously imported from abroad. The scrutiny of applications for priority drew attention to the possible market for locally manufactured roller skins, picker bands, leather belting, and raw hide pickers. Early in June 1917 the Board accordingly informed Indian firms that if they could satisfy it, by production of suitable samples, that these articles could be made in India, priority applications for import from abroad would be refused. A number of the more recently established tanneries of the improved type took the matter up with most encouraging results and, with regard to roller skins and picker bands, it is understood that they have no difficulty in disposing of their outturn. The manufacture of leather belting and of raw hide pickers proved a matter of greater difficulty, and experiments are still in progress. Excellent belting has been made from specially selected hides, but the general average is not yet up to the required standard. In regard to pickers, the large sizes used on jute looms are working satisfactorily, but the smaller pickers for cotton looms still leave much to be desired.

Effects of the war on the tanning and leather trades.

9. The position of the leather trade in India at the present time may now be summed up briefly. The highest developments of manufacture at the outbreak of war were to be found in factories most intimately associated with the supply of material for military purposes and in the smaller tanneries devoted to the production of chrome leather. The bulk of the leather made in the country was either for internal consumption and of inferior quality or for export as half-tanned leather, to which the trade applied the term 'East India Kips'. Practically, the export trade was confined to Madras and Bombay, and was chiefly to Great Britain and, to a much smaller extent, to the United States of America and to Japan.

Some time after the outbreak of war, the value of the 'East India Kips' as upper leather for army boots was realised in England, and efforts were made to increase and regulate the supply. From August 1916 the Indian Government, at the request of the War Office, assumed complete control of the trade and took over from the tanners the whole of their output. The arrangements made by the Commerce and Industry Department were transferred to the Indian Munitions Board, after its creation in March 1917. In pre-war years, the exports were below 200,000 cwt., of a value of less than two crores of rupees. In the year 1917-18 they reached 360,000 cwt., of a value approaching five crores of rupees. Roughly, in four years, the output of the Indian tanneries for this class of leather only has been doubled. The control of the trade has enabled some minor, but very important, improvements to be effected, the chief of which are the prevention of adulteration and the elimination of faulty flaying. This great development of hide tanning has been accomplished in the face of grave difficulties due to inelasticity in the supplies of tanning bark, and it has been necessary to take action in several directions to maintain the output of tanned hides. The Indian export trade in tanned hides and tanned skins was confined to the south of India where the bark of Cassia auriculata, known in Madras as *avaram* and in Bombay as *tarwad*, is obtainable. Elsewhere, the cost of railway freight makes tanning with this bark commercially unprofitable. The increased demand for tanning materials has led to a great rise in prices and has more than doubled the cost of tanning. The attention of Local Governments has, therefore, been directed to the urgent necessity for measures to increase the supplies of *avaram* bark, either by more careful collection or by cultivation on an extensive scale. To meet the increasingly urgent demands of the military

authorities for more leather, it became necessary to prohibit the tanning of skins, which not only rendered available for hide tanning the bark previously used for skin tanning, but led to many of the skin tanners taking up hide tanning instead. These measures have produced immediate results; but attention is also being directed to the provision of substitutes for *avaram* bark. To this end, the Indian Munitions Board has entered into an arrangement with the Esociet Company at Maihar in Central India, whereby it has taken over the experimental tannery and the staff employed on research work, and it has purchased a tannery in Allahabad with a view to ascertaining the commercial value of the conclusions reached in the research factory. Promising results have already been obtained from a variety of mixtures of Northern and Central India tan-stuffs and it is anticipated that, ultimately, it will be possible to provide tanning material of as good a quality as *avaram* bark for a great extension of tanning in Northern and Central India. As will be seen in the sequel, the success of these efforts to develope fresh supplies of tanning materials will greatly strengthen India's position in the leather trade after the war.

Possibilities of expansion of tanning in India.

10. The problem of the future is how to obtain for India a larger share in the work of preparing her abundant raw material for the market. The limits of reference preclude any discussion of the tariff question and, though the trade has been, and will continue to be, affected by whatever fiscal policy is adopted, in what follows it is assumed that if sufficiently good finished material be produced, it will be possible to sell it at profitable prices. The steady rise in the value of Indian hides in the years immediately preceding the war may be reasonably accepted as evidence that the demand for the commodity was in excess of the supply, and it may be contended that the contribution to the world's markets which India is able to make is of sufficient importance to enable her to dictate in what form it shall leave the country.

The position is perfectly clear. There is a very large, but limited, supply of Indian hides, which was not sufficient to meet the demands made upon it in pre-war times, and it may be confidently anticipated that these demands will increase after the war, owing to the diminution in the number of cattle in belligerent countries. It seems certain, therefore, that for a long time to come there will be a very serious shortage of hides and leather. From the Indian raw material, by the exercise of skill, experience, and technical knowledge, a valuable leather can be made either on the Continent, in Great Britain, or in India. If it is made in India, by exactly the quantity made will the stock of hides available for export be diminished. For India to obtain advantage from the situation it is necessary to make as good a leather out here from the local hides as can be made from the same hides elsewhere. The production of an inferior quality of leather will involve heavy loss, as it will only fetch a low price in competition with good leather made from similar material. There must, therefore, be no waste in this direction.

It is, therefore, not altogether unreasonable to assume that the future of the Indian leather trade can be usefully discussed without any reference to tariffs, although these will of necessity play an extremely important part in the transition period during which the export trade is being changed from one mainly in raw hides to one of tanned hides or finished leather.

Necessity for expert investigation.

11. While the best Indian raw hides are distinctly inferior to the best produced under more favourable conditions in temperate climates, the Indian goat skins are of high grade and suited for first-class work. But from these skins Indian tanners have not so far been able to produce finished goods of anything like the quality that can be manufactured from them in Europe and

America. In explanation of this, it has been alleged that in India it is too hot to produce first-class work, and there is no doubt whatever that the high temperature of the soaks and lime pits is a disadvantage. Tanning under tropical conditions has never been carefully studied by experts with both a scientific and practical knowledge of the trade. The experimental tannery started by the Department of Industries in Madras was the first practical recognition of the necessity for such work. It is unfortunate that, for reasons arising out of the war, there has been delay in taking up this matter, and it is unquestionably urgent that the obstacles which have hitherto prevailed should be overcome as soon as possible. It may almost be accepted as axiomatic that the development of the Indian leather trade can only be accomplished by bringing to its assistance technically trained men, qualified to deal with the local problems and capable of modifying European and American methods to suit local conditions.

It is obvious that India cannot afford to neglect any of the advantages enjoyed by the tanning trade in other countries, and it may be regarded as essential that adequate provision should be made, as early as possible, for the investigation of tanning methods in India. The Madras experimental factory was a step in the right direction; but it was started on a scale that is now inadequate to meet the more urgent situation which has arisen since it was first proposed.

The experimental work at Maihar under the Indian Munitions Board has already been mentioned and the results obtained so far are sufficiently promising to warrant its continuance with a stronger expert staff. We understand that Maihar was selected by the Indian Munitions Board because important researches had already been started there and the expense of establishing a new laboratory and factory could be avoided, but it will be necessary to consider later the locality most suitable for a permanent research station. If found necessary, these experimental investigations should be transferred to a site better adapted for the wider scope of the work now contemplated. Already, we understand, no little inconvenience has been caused by the distance between the research work at Maihar and the commercial experiments which are in progress at Allahabad. The conditions in India in respect of the supply of raw material, both hides and skins and tan-stuffs, vary considerably, and it is possible that there may be scope for combined research laboratories and experimental tanneries at such centres as Calcutta, Madras, Allahabad, and possibly Bombay. It will also probably be necessary, when the research work has yielded the expected results, to establish Government tanneries elsewhere, in which to demonstrate the value of the new tanning materials and the changes in tanning practice involved in their use. We contemplate that, ultimately, these factories should be handed over to private enterprise, but not while they are found to serve a useful purpose either by way of demonstration or as training centres.

Proposals for training Indian tanners.

12. The question arises as to what provision should be made for the technical instruction of men who will afterwards be in charge of tanneries. Neither experimental nor demonstration factories are suited for such work, and it is not advisable to use them for this purpose.

Hitherto, the Indian trade has been run by *mistris* possessed of much practical experience, but absolutely ignorant of the most elementary knowledge of the principles underlying their practice. It is generally recognised that this can no longer continue, and that if India is to gain the position in the leather world to which she is entitled by reason of the abundance of raw material at her command, the tanning and leather industries must pass under

the control of expert technologists, and scientific methods must replace empirical and rule-of-thumb working. Tanning is a chemical industry, in certain stages of which bacteria play an important part, and those who, in the future, would control the industry must be capable of understanding the scientific principles underlying its technique. This means that the students before admission to the tanning trade school should have received a scientific education and should possess a fair knowledge of physics and chemistry. We may take it that the expert tanner of the future should be a graduate in science, and it will be best that his technical studies should only begin after he has completed a university course in pure science. The training in technology must be followed by work in a factory to gain practical experience. These tanning trade schools should be placed alongside the research institutes, which we contemplate will be necessary, and they should be linked up with a college of science on the one hand and a tannery on the other. Ideal conditions would suggest that they should be established in centres of the tanning trade which possess science schools of the highest grade. In such places it would then be convenient to carry on all the work connected with the scientific development of the tanning industry, and the experts dealing with the various branches would be in close touch with one another. There would be the experimental laboratories in which investigations would be going on. Adjoining them, but under independent control, would be the tanning trade schools and, as near as industrial considerations and municipal regulations permit, should be the factories in which the processes worked out in the experimental laboratories would be tried, and where the students from the trade schools would acquire practical experience.

The inferior quality of Indian products is also due to the inferior skill and knowledge of the Indian workmen, especially in respect of the finishing of leathers. Outside the factories engaged on military work, and outside the few small ones which have sprung up as a result of the Madras efforts to introduce chrome tanning, neither currying nor finishing leather is understood or practised, and whatever work is necessary in this direction is undertaken by the Indian *chuckler*, as a preliminary to the actual work of making the article which he has in hand. This can be remedied in the demonstration factories if skilled workmen are obtained from Europe to act as instructors.

Prospect of other industries in India.

13. The imports into India of finished leather and of goods made from leather are not unimportant, but many of them are the products of specialised factories, which it will not pay to establish in this country till the demand is very much greater than it is at the present time. These imports include :—

(1) Boots and shoes to the value of three or four hundred thousand pounds a year, of which probably two-thirds might well be made in the country.

(2) Belting: the value* of the imported leather belting is very considerable and is likely to increase with the industrial development of the country. Belting can be made in India from selected hides. From the average raw material available it is certain that India will not be able to compete in quality with imported belting, and it is, therefore, unlikely that there will be any serious development in the direction of replacing in ports by local manufactures.

*1912-13 . .	£138,085
1913-14 . . .	167,527
1914-15 . . .	132,315
1915-16 . . .	166,554
1916-17 . . .	203,018

(3) High-class finished leather and heavy leather: the imports are not very large; but it is hardly likely that they will be replaced by leather of equal quality tanned in the country.

(4) Finished skins are imported in large numbers, but there is absolutely no reason why, when skin tanning is properly carried on, these should not be almost entirely made in the country.

The textile mills require large numbers of roller skins, and hitherto these have been imported; but, owing to the stress of war, they are now being made in the country, and in the future importation should entirely cease. The same should be the case with other mill requisites, such as picker bands and raw hide pickers.

The rest of the imports, including saddlery and harness, are of a miscellaneous character, and though some may ultimately be replaced by goods of equal quality manufactured in the country, it is likely that the bulk of these will increase with the growing needs of the country rather than diminish.

The internal consumption of Indian-made leather is by no means accurately known. There are few parts of the country in which the village tanner does not still exist, and there are many small local tanneries of a slightly improved character in the south of India from which the agricultural population gets what it wants.

By far the most important item for which leather is required in India is the water bag by which water is lifted from millions of wells for the irrigation of the fields. To an appreciable extent, in recent years, iron buckets have replaced leather, and efforts are now being made to introduce cheaper fabrics made from vegetable fibres. It is not improbable that the use of leather for this purpose will steadily decrease, and, if such be the case, it will increase the visible supplies of hides on the market.

The Indian demand for boots and shoes and sandals is on the increase; but it is small as yet compared with the vast population. That it will grow in the future is a certainty, and it is likely that for boot uppers and sandals chrome leather will be very largely used. Chrome sole leather has been extensively tried and has proved extremely durable, and, in a country where pavements do not exist, the objection that it is slippery in wet weather has not the force which has practically precluded its use for footwear elsewhere.

The Indian tanning trade must, therefore, look to foreign markets for the sale of its products, and the quantity of raw material is so enormous that it will ultimately need very many large establishments to deal with it, and a high degree of specialisation seems at least possible.

Suggested developments of chrome tanning and leather manufacture.

14. There is not the smallest doubt that foreign countries will endeavour to secure the Indian raw material and to refuse Indian-manufactured leather, as in the past. Assuming, however, that they cannot get the former, they will undoubtedly accept the latter. Future developments must to a large extent depend upon the work done in the experimental factories which have been recommended; but already sufficient experience has been accumulated to show that it is possible to export from India finished leather which meets with a ready market in the United Kingdom. The export of black and brown box sides has reached considerable dimensions, and it is unfortunate that the exigencies of the military situation have temporarily put a stop to this business. A considerable proportion of the Indian cow hides is eminently suited for this class of work and, if it is taken up on a sufficiently large scale under the control of experts in this branch of the leather trade, there are

reasonable prospects of a very extensive commercial development. A large capital will be required to carry on the industry, as this branch of tanning requires workshops equipped with modern machinery. Two important factors will determine the best sites for this branch of the trade:—

(1) The factory must be situated at a centre convenient for collecting the raw material, and this centre should, if possible, be a port where power can be cheaply generated.

(2) There should be in the neighbourhood a sufficient population of the castes willing to work in a leather factory, and capable of being converted into skilled workmen by careful training. The suburbs of both Calcutta and Madras probably best fulfil these requirements, and it is recommended that attention should first be drawn to them as possible sites for the factories which, we hope, will be started.

As has been already indicated, the skins exported from India are of excellent quality; but the attempts to produce finely dressed skins in India have hitherto proved a failure. It is alleged that this is due to the climate, but we are unable finally to accept this verdict. Experimental work under the direction of highly qualified men should be undertaken, and there is little doubt that it will result in success, and in the future it is reasonable to hope that glacé kid, which is now largely made from Indian goat skins, will be exported; also that other finished leathers, such as morocco, roans, calf skins, and roller skins, will be manufactured not only to meet the needs of India, but to supply those of other countries.

It must, however, be admitted that a very large amount of preliminary work has yet to be done before this branch of the trade can be established so as to compete with the products of countries in which the manufacture is now carried on.

Strong position of India after the war.

15. Till the war is over, and it is possible to form some idea of the international adjustments which will follow, it will be difficult to propose, even in broad outline, the policy which India should adopt to secure for herself the advantages arising out of her resources in hides and skins. The outstanding feature at the present moment is the large increase in light tanning, but this, owing to the scarcity of suitable tanning materials, has to some extent been accomplished at the expense of the skin trade. The continuance, therefore, of the present expansion after the war depends, so far as India is concerned, on the success of the measures which have been taken to provide further supplies; also on whether the external demand for these light tannages for boot uppers remains when military orders cease to dominate the situation. It may be taken as practically certain that there will be a very large increase of tanning materials; but it is less certain that the demand for light tannages will continue on the present scale, and of course much less certain that it will increase. For civilian footware chrome-tanned uppers are now mainly employed, and there is little prospect of any change in this. In the years immediately preceding the war Germany exported to Great Britain on an average more than a million pounds worth of this class of chrome leather and over £400,000 worth of enamelled or patent leathers. Presumably these leathers were largely made from raw materials exported from India, as the German imports were eminently suited for the purpose. In the future, it may be anticipated that this trade will not revive, and that the English market will either be supplied by home tanners working with raw hides imported from India, or by Indian tanners, provided the latter can turn out a finished

product of suitable quality. What will actually happen, apart from fiscal regulations, will to a large extent depend upon the manufacturing capabilities of India.

The depreciation in the value of money has been much smaller in India than in Europe, and it is unlikely that for a long time to come there will be any serious depression in the present high range of prices. This must naturally benefit countries whose currency has been but little affected, and especially those in a position to do a large export trade. The wages of labour have risen in Europe and must be maintained at a much higher level than prevailed before the war. Relatively to the western world, therefore, the cost of manufacturing operations will be less in India than was formerly the case and, to the extent that this is true, Indian industrial development will be encouraged. India has greatly benefited in recent years by her growing importance as a source of raw material for the leather industries. In the future, her position should be even stronger, and it seems almost certain to us that western countries will be prepared to take whatever we are in a position to offer; whether it be raw hides and skins, half or lightly tanned leather, or highly finished products ready for the manufacture of leather goods. To obtain to the full the advantages of the position, it may be necessary to have recourse to retaliatory fiscal regulations; but though the discussion of this is outside our province, we do not consider that there is likely to be much hesitation in applying them. So far as bark tanning is concerned, great progress has already been made, and further developments may be confidently anticipated. On the other hand, for chrome tanning but little has been done, and it is to that branch of the leather trade that attention should be directed. Finally, it is necessary to train workmen in large numbers in the currying and finishing of leather and in skin dressing. The general lines on which Government can best promote industrial progress are explained in our report, and they can be applied to tanning and leather dressing. Only here it must be pointed out that the need for immediate action to take full advantage of the situation is urgent, and that private enterprise is keenly interested and only requires intelligent guidance.

Conclusions.

16. We may now state concisely the conclusions we have reached. India produces a very large, but not definitely ascertained, number of hides and skins which are accounted for under the following heads:—

1. Those wasted in rural areas by the carelessness of the local *chucklers*, or owing to the fact that the hides themselves have become valueless.
2. Those made into inferior leather by the village tanners.
3. Those made into a good class of finished leather by modern tanneries.
4. Those half or lightly tanned and exported.
5. Those exported as raw hides.
6. Those exported as finished leather, and chiefly as chrome box sides. So far, these exports have been insignificant in volume, but they are of great importance as indicating future possibilities.

There seems to be little doubt that after the war new tanneries will be started to produce finished leather for export, and their fate will largely depend upon the quality of the leather which they turn out. Here Government can render valuable assistance by assuming to a large extent responsibility for the technological investigations which have been indicated. Success will result in an improvement of the industry all along the line, beginning with a decrease of waste in rural areas and the diversion of the hides used by the village tanners to modern tanneries, in which a better class of leather will be produced. There will obviously be an increase in the amount of visible raw material: but

whether this will be sufficient to meet the growing requirements of the country is a matter on which no definite opinion can be expressed. The general improvement of the technique in tanning will lead to an increase in the exports of finished leather and to a corresponding decrease in the exports of hides. The extent to which exports of finished leather will grow will depend upon the demand from foreign markets not closed by tariffs, and on the extent to which protected markets can be forced to accept leather made in India. Judging by the very great value of the imports of leather into Great Britain from the Continent and from America in the years immediately preceding the war, there is obviously a very important market open to Indian tanners if they can manufacture material of sufficiently good quality. Access to the protected markets is a matter of less certainty ; but there are powerful means which will doubtless be used to ensure it. The position of the manufacturer of half or lightly tanned leathers is less assured. He should be prepared to meet the contingency of a possible decrease in the demand for his products ; and this he can best face by being in a position, if necessary, to direct his energies to the production of chrome leathers.

APPENDIX E.

THE MANUFACTURE OF GLASS IN INDIA.

1. The history of the various attempts which have been made during the last 20 years to establish the glass industry in India is extremely instructive, and well worth the careful study of any one interested in the development of the natural resources of the country. It is a record mainly of failure, and such success as has been achieved by a certain number of factories is due entirely to the abnormal conditions created by the war. The cessation of imports from Belgium and enemy countries, and the great scarcity and dearness of freight, have created a position in which about a dozen small factories have found it possible to work with some degree of success. Almost all of them are run on identical lines, and they mostly draw their supplies of raw materials from the same sources. Direct inquiries have established the fact that some of them are, while others are not as yet, working at a profit, and the general conclusion must be that the industry is still on a very precarious basis, and that its continuance will be seriously affected by a return to peace conditions, although the improbability of pre-war prices or freights being reached till some time after the war is a factor in its favour. War profits and increasing practical experience have greatly strengthened the position of manufacturers; but the technical knowledge at their disposal is limited, and rapid progress is only possible if adequate steps are taken to remedy this defect. **Present position of glass industry in India.**

2. The glass industry, even in its simplest forms, is highly technical and can be efficiently carried on only by scientifically trained managers and expert workmen. The present stage has been reached by importing men, only partially equipped with the necessary qualifications, from Europe and Japan, and by sending Indian students abroad to pick up what knowledge they can. The glass industry is a closed trade and its secrets are carefully guarded, so that the latter method has not proved conspicuously successful. More has been accomplished by the men brought out; though their failure to secure commercial success for their employers has generally exposed them to unduly severe criticism. They were practical men accustomed to working under conditions different from those prevailing in India, and their technological skill was quite inadequate to solve the problems presented by a new country. Moreover, they had to produce results as quickly as possible, and were not given sufficient time to make themselves acquainted with the local factors, such as climate, raw materials and the potentialities of the untrained labour available. **Reasons for past failures.**

It can hardly be questioned that among the imported men, chiefly from Austria and Japan, the Japanese have achieved the greatest measure of success, as they have introduced a small direct-fired pot furnace suitable for melting soft glass, which has been generally adopted with satisfactory results, and they are responsible also for the present supply of trained glass blowers. The gas-fired regenerative furnaces of the Siemens' type were naturally introduced by the continental experts; but they require the employment of a higher grade of fire-resisting material in their construction than until recently was available, and also more skill and experience in their actual working. Quite a number have been erected and have failed; but some degree of success has latterly attended the work of an Austrian, by name Mozina, who was first brought out as a glass blower to the Rajpur factory, was subsequently employed at Jubbul-

pore and Allahabad, and is now at Firozabad making bangle glass in a ten-pot gas-fired furnace at the Indian Glass Works in that town.

India's demands for glass.

3. The demand for glass in India is to some extent indicated by the imports in the sea-borne trade returns which are classified under the following heads :—

Articles.	1913-14.	1916-17.	1917-18 (Provisional figures.)
	Value in lakhs of rupees.		
Bangles	80	43	35
Beads and false pearls	24	21	24
Sheet and plate glass	22	28	23
Lampware	17	11	19
Bottles and phials	14	16	37
Soda-water bottles	6	9	
Table ware	8	7	10
Miscellaneous	19	15	15
Total	190	150	163

The effect of the war is shown by the figures for 1916-17 and 1917-18. But the returns are only comparable, if it be remembered that values have increased enormously, and it can be safely said that India is now importing less than one-half the quantity which came into the country in the year immediately preceding the outbreak of war. The glass manufactured in India is chiefly bangle glass, almost exclusively made at Firozabad, where six factories turn out about 15 tons a day, and soft glass for such articles as lampware, tumblers, jars and carboys. No data are available from which an accurate estimate of the outturn of all the factories can be framed, but from the values furnished by the owners of some factories it is probable that the total output for all India is now worth about 20 lakhs of rupees a year. This is not a very encouraging result after an expenditure of probably not less than 50 lakhs of rupees in the various attempts which have been made to establish the industry. But it is sufficient to suggest the possibility of great expansion with proper help and guidance.

Classification of problems to be solved.

4. With these preliminary remarks, we may pass on to a more detailed discussion of the various problems which must be solved in the immediate future, if the Indian glass industry is to be placed on a more permanent basis. These may be classified under the heads :—

(1) Raw materials;
(2) Direction;
(3) Labour;
(4) Climate;
(5) Location; and
(6) Markets.

Consideration of these factors will show clearly the necessity of co-ordinated research by a properly equipped Government Department of Industries.

Raw materials.

5. The most important raw materials are sand, lime, soda, fireclay and coal. For the last it may be presumed that Bengal will continue, as at present, to be the chief source of supply; but in regard to the main constituents of

glass—sand, lime and soda—it is by no means certain that further prospecting work would not reveal new and possibly more suitable sources of supply. Most of the existing glass works depend upon the sandstone found at Logra, about 11 miles from Naini, and it is used in factories as far apart as those at Ambala, Allahabad, Talegaon and Bombay. Suitable sand has also been found, and used at one time or another, at Jejo in the Jullundur district, at Jubbulpore, and at Ennore near Madras. Lime of suitable quality occurs more frequently than sand, but it is by no means conveniently distributed in reference to the majority of the glass works, and its cost is an item still susceptible of considerable reduction. A cheaper source of soda is, however, a matter of much greater importance, and to this end attention may be seriously directed to the *usar* soils of northern India, which contain both the carbonate and the sulphate. The quantity available is large; but it is doubtful if the deposits are anywhere rich enough to make it worth while to extract these salts. Although perhaps a forlorn hope, the investigation should nevertheless be undertaken.

In respect of both furnaces and crucibles or pots, the Indian glass manufacturers have so far been at a great disadvantage, since, in order to obtain a reliable material, they have had to import either from Europe or Japan; but matters are improving under the stimulus given by the development of the iron and steel industry. Jubbulpore and Kumardhubi are the two Indian centres of greatest moment in respect of the supply of fire-resisting materials; but it is doubtful whether as yet the best results have been obtained from the clays and minerals available. Local attempts are being made by the managers of most glass works to prepare their own pots, but so far with limited success, and the industry is still to a very undesirable extent dependent upon Japanese ware. The temperatures in the Indian glass furnaces are by no means high, but the wear and tear of the inferior material employed greatly adds to the cost of production.

Direction.

6. By a process of trial and error, a method of manufacturing glass from Indian raw materials has been evolved; but, as already stated, it is only profitable because of the abnormal state of the market. The present stage is obviously transient; but it is important, inasmuch as it gives some degree of confidence to capitalists to move forward, and it provides an opportunity to train blowers and workers in glass. There is no one in the country capable of developing the industry adequately either on its technical or commercial side. The economics of the glass industry have doubtless been studied with care by those in the trade; but the conclusions have never been published, and to a large extent the data on which they are based are not available. It is held by some that the glass industry should be located near its market; by others that it should be near the source of the supply of raw material, particularly fuel. These are opinions based upon inadequate data regarding the cost of carriage to assemble raw material and to distribute the manufactured goods. It is possible that the selection of a site should be governed by other considerations, of which a free supply of labour may be the most important, though again it may be largely influenced by climate. Much might be learnt by a study of the distribution of the glass industry in other parts of the world, and information could be collected which would throw some light on these debatable points. It seems necessary that this should be done; and it is certain that it can only be undertaken at Government cost, as it will involve expenditure which cannot be balanced by commercial assets.

The industry so far has been developed in a haphazard way, and without that preliminary investigation by qualified experts which is essential to meet

competition from other parts of the world. It is not desirable that the present state of affairs should continue. Such success as has already been achieved has been purchased at too great a cost, and the future is likely to be barren if more intelligent and less expensive methods are not introduced. The glass industry is the result of experts working in co-operation, and there is no such individual as the "glass expert," capable of expressing an authoritative opinion on all the points which must arise in pioneering the industry in a country where it has not hitherto existed, and which possesses no marked natural advantages to help it in the initial stages. An organisation is wanted to take up the whole industry, including men who can deal with the furnace problem, the preparation of refractory materials for furnaces, crucibles and pots, the chemistry of glass, the manipulation of the crude product and its conversion into finished forms, whether by skilled blowers or by highly complex and semi-automatic machinery.

It is impossible to say meanwhile whether the future of the industry in India lies in the small factory and the development of the skill of the operative, or in the establishment of large works and the extensive employment of machinery. Preliminary enquiries by competent economic investigators are required to determine tentatively the best method of procedure, and, with these results in hand, technical experts should be called in to review the situation and indicate the direction for further efforts. Protective tariffs may bolster up the existing factories, but they will prove ineffective, unless they give rise to scientific inquiry and expert treatment of the many problems involved. To establish a tariff and then to trust to private effort is not likely to be productive of satisfactory results. Clearly, the State should take the lead, employ the experts, and place them in charge of practical work; and if tariffs are employed, it should only be so far as is necessary to protect the industry in its infancy.

Labour. 7. The glass blower is a skilled workman whose training is unusually costly, as in the process of acquiring his skill, not only does he waste a large amount of raw material, but it is raw material which has to be maintained at a high temperature. A good deal of experience has been accumulated in India regarding the training of glass blowers; but it has not yet been sifted carefully to ascertain what general principles emerge for future guidance. Every factory complains of shortage of labour and the difficulty in training fresh hands. Useful work has been done by the Paisa Fund at the Talegaon glass works, and it is certain that the recent developments of the glass industry in India have only been possible by reason of the blowers trained in this factory. At present the glass blower dominates the situation, and there is much friction between masters and men. No great amount of progress is possible without a much larger number of blowers, and as the training of each man is a heavy expense, masters are reluctant to incur it without some guarantee that they will reap where they have sown. Factories might be subsidised by Government to do more work in this direction; but what is more likely to prove effective is the institution of a system of apprenticeship, whereby the master engages to train apprentices in the art of glass blowing, and in return secures a lien on their services for a period sufficiently long to recoup him for his initial expenditure. Experience seems to indicate that boys between 12 and 14 may be taken on as apprentices, and that in a year or two they become sufficiently expert with the blowpipe to turn out blown glass of marketable quality. Seven years was usually the period of indentures in England before the days of polytechnics and technical schools, and it is believed to be still the customary period in many trades, especially those which are closely governed by Trades Unions. A seven-year system of apprenticeship might, therefore, well be adopted in the Indian glass trade, and

there is no doubt that, with suitable provision for remunerating the apprentices fairly in proportion to the degree of skill they acquire, it would be popular. Whether the apprentices should be bound to the proprietor of the factory or to the master glass blower is an open question. Unless the master glass blowers have an interest in the matter, it is hardly likely that they will prove efficient instructors of the apprentices.

Climate.

8. Experience also seems to show that climate is not such an important factor as was originally supposed, and no real difficulties with labour have occurred which can be attributed to the high temperatures that prevail during the greater part of the year in India. It is necessary, however, to close down for a short period in order to rebuild and repair the furnaces, and this might well be done in the hot weather. Though climate may be no very serious matter in the working of a glass furnace, so far as the human element is concerned, it by no means follows that it can be neglected in considering the design and construction of the furnace itself.

The high temperature of the air, when combined with a high percentage of humidity, probably affects the working of the furnaces very unfavourably, and it is possible that not a little of the irregularity in the quality of the product turned out in the Indian glass works is due to this cause. The effect of moisture on the working of the blast furnaces in America is well known, and in certain parts of the country the air supplied to these furnaces is artificially dried with great advantage. No evidence regarding these conjectures has been brought forward by Indian glass blowers, and it is only suggested that the point is worth investigation. For instance, before establishing large glass works in the neighbourhood of the coal fields of Bengal, where the atmosphere for many months in the year is very humid, it would be desirable definitely to ascertain to what extent the humidity of the atmosphere is likely to be prejudicial to the satisfactory working of the furnaces.

Location.

9. One object of this note is to draw attention to the absence of information which ought to be available regarding the conditions under which glass can be made in this country, and to point out that this unfortunately has not so far been collected. Till the economics of the industry have been carefully studied, till all the sources from which raw material can be drawn have been investigated, and till the effect of the climate upon the working of the glass furnaces is determined, it is impossible to indicate the best location for the glass industry. The question ought to be studied in a scientific way, and not left to be determined by the evolutionary process of the survival of the fittest.

The cry for protection, especially for infant industries, is partly engendered by the haphazard way in which pioneering work has been done in the past. The question of protection is not now under discussion, but it is relevant to point out that there is much less necessity for it when proper preliminary investigations are made previous to the actual starting of work. There can hardly be any doubt that the very meagre results, which have attended the efforts to establish new industries in India, have been due to the lack of this essential precaution. The glass industry is a conspicuous example of the unscientific, whilst the steel works at Sakchi are an equally conspicuous example of the scientific, method of starting new industries. The splendid financial results in the latter case are largely due to the war; but there is no reasonable doubt that, even if there had been no war, these steel works would have eventually been a very successful commercial undertaking. At the present moment, all that can be said with regard to the location of the glass industry is that the balance of advantage seems to lie in the neighbourhood of the coal fields of Bengal, and for the two reasons that fuel there is cheap and that the largest market for glass in India is in close proximity.

Markets. 10. In normal times, the principal demand for glass manufactured in India was in the form of bangles and beads; but, since the outbreak of war, glass for utilitarian purposes forms a much larger percentage in the imports. A very considerable proportion, probably half, of the lamp glass required in the country is now manufactured in India by the glass works which have been established in recent years. As has been already pointed out, the very great rise in the value of glass imports is largely due to the increased cost of the glassware, and not to increased quantities imported. In the case of "beads and false pearls," "bottles and phials", and "sheet and plate glass," information regarding the quantities imported is also available. These show that in the case of "beads and false pearls" prices have nearly doubled; that in the case of "bottles and phials" they have increased over 50 per cent; while in the case of "sheet and plate glass" prices have more than doubled. Under what may be termed extraordinarily adverse conditions of price and supply, the demand for glass has been fairly well maintained, and it may be assumed that after the war it will largely increase. Usually, no small amount of glass comes into the country in the form of bottles, phials and jars containing liquors and preserved provisions of various kinds. This unrecorded import has seriously decreased, and with it, therefore, the second-hand supply of such glassware; on the other hand, this second-hand supply is in much greater demand than was formerly the case and has, therefore, been more fully utilised.

Conclusions. 11. The foregoing preliminary discussion of the glass industry in India has shown how numerous are the factors, technical and economic, which require examination before any hopeful line of advance can be indicated with safety. Chemical investigations into the nature of the raw material, into questions of climate, the behaviour of furnaces, and the suitability of the various refractory materials available, will have to be conducted concurrently with the collection of information regarding the availability of the materials, the cost of their transport as compared with that of the manufactured article, the extent of the demand and the degree of its concentration in different markets. It is also desirable to know how these factors have affected the location of glass works in typical places outside India. Such an enquiry really indicates the necessity of a department which can command and co-ordinate the services of the different technical experts required, and is able to examine the economic questions involved. The interdependence of all these factors shows the hopeless wastefulness of isolated inquiries by individual experts in different parts of India. On the assumption that the problem is approached with due seriousness, the prospects seem promising. There is no reason why India should not be made self-supporting in the matter of lampware of all kinds, except of the very highest quality, why, under proper technical and scientific guidance, it should not be able to manufacture all the bottles, phials, jars and containing vessels which it is likely to need. There is a sufficient demand for sheet glass to justify attempts to manufacture it in the country; but progress in this direction will inevitably be slow, as the industry is still one in which machinery plays a very small part and the manipulation requires great experience and a high degree of skill.

APPENDIX F.

SALTPETRE.

The Indian saltpetre trade.

1. The principal sources of saltpetre in India were, before the war, in order of importance, Bihar, the United Provinces and the Punjab. It is prepared, as will be described in more detail below, by solution, concentration and subsequent refinement from earth containing nitrates, the product of bacterial action in the soil in and round villages, where a large quantity of nitrogen is derived from the excreta of men and animals and the decay of vegetable matter. Up to 1860 or a little later, India was almost the only source of saltpetre, and, when the French were deprived of the Indian supply during the Napoleonic wars, they found it necessary to meet their war requirements from artificial nitre beds. Prior to the Indian supply becoming available, saltpetre was obtained in England, at any rate, by the removal and treatment of earth from the neighbourhood and even the interior of dwelling places, under the authority of the Crown, a measure which was often worked very oppressively.

The discovery of a method of making saltpetre artificially from the nitrate deposits of South America and the German potash beds hit the Indian trade very hard, and not the less so that this discovery nearly synchronised with the imposition of an export duty of Rs. 2 a maund by the Government of India in 1860. Though the duty was removed after a few years, the trade to England and the United States of America, who were India's principal customers for highly refined, or, as it is called, low refraction saltpetre, declined until after the outbreak of war. This is proved by the following export statistics :—

Annual average of period.	To U. K.	To U. S. A.	Total Exports.
	Figures are in cwts.		
Year 1862-63 ...	..	...	105,060
Year 1864-65 ...	...	...	220,860
15 years ending 1905-06 ...	96,605	102,755	368,461
5 years ending 1910-11 ..	80,187	119,128	360,698
3 years ending 1913-14 ...	47,696	47,622	279,801

There is, however, a very well maintained demand from China, mostly for the manufacture of fireworks, and from Ceylon and Mauritius for manure. In these cases the saltpetre is shipped on a high refraction basis. It is not clear why an impure variety of saltpetre is apparently preferred for manurial purposes. Nothing is gained in the price paid for the actual saltpetre, while freight is heavier, and the impurities appear to possess no direct manurial value. The figures given above do not differentiate the classes of saltpetre shipped.

Figures for prices are shown in the statement below.

Prices at Calcutta per factory maund of 74·67 lbs. of saltpetre (5 per cent crude) during January and July of each year 1897 to 1916.

Year.	January.			July.			Year.		January			July		
	Rs.	A.	P.	Rs.	A.	P.			Rs	A.	P.	Rs.	A.	P.
1897 . .	6	1	0	6	4	0	1907 . .		8	4	0	9	8	0
1898 . .	5	5	0	5	12	3	1908 . .		8	10	0	8	8	0
1899 . .	6	5	0	6	7	0	1909 . .		8	2	0	8	6	0
1900 . .	6	12	0	6	8	0	1910 . .		8	8	0	9	0	0
1901 . .	6	5	0	6	12	0	1911 . .		10	8	0	11	8	0
1902 . .	8	11	0	7	0	0	1912 . .		11	4	0	11	8	0
1903 . .	6	9	0	6	14	0	1913 . .		11	12	0	11	8	0
1904 . .	7	0	0	7	4	0	1914 . .		12	3	0	11	4	0
1905 . .	8	8	0	9	0	0	War 1915 . .		11	12	0	11	4	0
1906 . .	8	6	0	8	8	0	War 1916 . .		13	4	0	15	8	0

Effects of the war on the industry.

2. Shortly after the outbreak of war, steps were taken to increase the output of saltpetre, which had already been stimulated by the rise in price. *Nunias'* license fees in the United Provinces were reduced from Rs. 2 to Re. 1, the Bihar license fee already being only 4 annas ; some of the areas hitherto closed to saltpetre extraction on account of the relatively high proportion of salt contained in the earth were thrown open, licenses were issued through the agency of the Post Office, and refiners were allowed to compound for the common salt that they were likely to manufacture. The effect of these measures and of the rise in price is shown in the increased export during the next two years:—

Years.	Quantity in 000 cwts.
31 years ending 1913-14 (average)	280
1916-17	525
1917-18	456

In order to secure the maximum supply for munitions, the export of high refraction saltpetre to the Colonies and China, which had risen in price in greater proportion than the low refraction quality, was stopped for some time. Subsequently, owing largely to market manipulation rather than to any increased price obtained by the *nunias*, selling rates rose so high that they had to be artificially restricted, and the export of saltpetre was prohibited if shipped at any higher prices than £28-10 per ton for 95 per cent. and £25-15 for 90 per cent. purity. These rates were subsequently increased and readjusted.

The following extract from a note by the Commissioner of Salt Revenue in Northern India, illustrates the recent development of the industry under war conditions.

"With the increased demand for saltpetre that arose with the war and the good prices that have been obtainable the industry has been resuscitated and, but for the extraordinary rains, exports in 1917 in all probability would have reached 40,000 tons, and, as nothing but low refraction saltpetre can be exported, this is really the equivalent of at least 50,000 tons in normal times. The following figures are of interest:—

	Number of licenses issued for production of crude saltpetre.			Number of refineries			Production of refined saltpetre in maunds.		
	Bihar.	United Provinces.	Punjab.	Bihar.	United Provinces.	Punjab.	Bihar.	United Provinces.	Punjab.
1913-14	24,545	5,275	1,371	213	82	32	1,85,373	1,69,756	87,010
1914-15	29,970	6,270	1,618	205	83	33	2,22,123	1,88,386	1,06,176
1915-16	30,501	8,495	2,291	213	95	37	2,19,565	2,36,658	1,52,301
1916-17	30,251	11,169	3,467	227	128	48	2,41,038	3,00,566	2,45,976

Licenses were applied for in the case of only 400 formerly proscribed villages, but 1,500 other villages were worked for the first time. The development of production in the Punjab has been remarkable and has not yet reached its maximum."

Government control of saltpetre manufacture.

3. Before dealing with the methods pursued for the extraction of saltpetre from the soil and its subsequent refinement, it may be of interest to discuss in more detail the gradual increase in the restrictions imposed on the industry in Bihar and the present position of the preventive organisation in Northern India.

Prior to the year 1869, the control of saltpetre production, which was maintained in the United Provinces by the Inland Customs Department, did not extend to Bengal. But the results of an enquiry proved that, in addition to the 330,000 maunds of saltpetre manufactured in the latter province, 300,000 maunds of salt of a quality suitable for human consumption were also made at a loss to the salt revenue estimated at 10 lakhs of rupees. The control which was at first introduced did not extend to the *nunias*, who

produce the crude saltpetre from the village earth, but was applied only to the refiners. In 1880 the Government of India placed the control of saltpetre manufacture in the Patna Division under the Commissioner of Inland Customs, and in 1889 the jurisdiction of the Commissioner of Northern India Salt Revenue, as this officer had by that time become, was extended to the Bhagalpur Division. In the course of the enquiries which led to these steps being taken, a good deal of information was elicited regarding the necessity of supervising the operations of the *nunia* and refiner. The system of control which was then created has been maintained on much the same lines ever since, and now extends to the Punjab, United Provinces and Bihar. But in 1877 the opinion of the Bengal Government was that the import of duty-paid salt into a district was low, when the production of saltpetre and, therefore, the eduction of salt was considerable, and *vice versâ*. At the same time, it was stated that the production of this class of salt was likely to decrease with a rise in the standard of comfort of the people, the *pakwa* salt, as it was called, being very inferior, and only being eaten by "the poorest and most miserable of the population." The reason, it was alleged by the Bengal Government, why their system left the operations of the *nunia* uncontrolled was that, unless he was allowed to make what he could out of the salt, he was unable to earn a living. No information can be obtained as to the effect of the restrictions imposed on these two occasions on the Patna and Bhagalpur Divisions; Mr. Ashton, who enquired into the matter on behalf of the Salt Department in 1888, reported that the conditions of the industry in the Bhagalpur Division were no better than in the Patna Division, where the industry was under close control. The preventive staff now employed is quite insufficient to stop any deliberate attempt at the production of illicit salt. In the Saran circle of Bihar, one circle officer and five inspectors attempt to supervise 18,000 workers scattered over an area of 6,000 square miles. There is no circle officer and only one inspector in the whole of the Punjab; and it is certainly time to consider whether this inadequate control should not be terminated or put on a fresh basis.

The degree to which the restrictions on the manufacture of saltpetre, imposed in the interest of the salt revenue, might justifiably be relaxed, depends on the demand for saltpetre—whether as a source of explosives or other manufactures, or for its manurial value in India and countries comparatively near India—a factor which is likely to be affected by the degree of importance which may be attached to the maintenance of a British Empire source of supply. It is likely that the demand for these purposes will assume considerable importance. Gunpowder will always be wanted in large quantities, while the preservation of foods and the manufacture of glass also require saltpetre. The lines of action that should be pursued should be, in the first place, to systematise, improve and cheapen the processes of manufacture. This will give a suitable basis for the next step, the increase of the sources of production by means that will be described below.

Description of the *nunia's* processes of manufacture.

4. The *nunias* manufacture crude saltpetre as follows. During the dry season they scrape the earth from village roads, mud walls, etc. For this privilege they pay rents to the zamindars and tenants, which have, since the rise in prices occasioned by the war, become very heavy. The earth so collected, mixed with an equal weight of residual earth from the previous season's working (*bhinjua*), is placed in a filter consisting of a low wall of clay with an orifice at the bottom; the wall surrounds a smooth surface of clay, sloped towards the orifice. Above this surface is placed a false bottom of bamboo and straw or matting, and the earth to be dealt with is very carefully heaped on it. Water is poured over the earth, and the liquor that runs through, which

contains salt and other substances as well as saltpetre, is allowed to settle and is then boiled in iron pans or evaporated by the heat of the sun; when this process has sufficiently concentrated the liquor, it is then left to cool, and the crude saltpetre, still containing a good deal of salt, crystallises out, and is scraped off and sold to the refiners. Under the terms of his license, the *nunia* is not allowed to carry the process further and extract salt.

5. The Imperial Agricultural Bacteriologist, who has prepared a bulletin on the subject of the *nunia's* operations, describes the way in which the *nunia* makes use of the nitrates left over by his process. He collects (1) the final fraction of the liquor, too weak to concentrate by itself, that comes out of his earthen filter, and mixes it (2) with the residual earth from the filter, from which most of the saltpetre has been dissolved out, (3) with the mother liquor in his pot, remaining after the separation of the first lot of saltpetre by crystallisation, and (4) with some ashes from his furnance. Some of this mixture (*bhinjua*) is stored till the following season; this is only the case with what is left over unused; most of the *bhinjua* is used as soon as it is prepared; but the residual earth (*sitla*) from the filter is kept for a year before being made into *bhinjua*. By these and other means, the *nunia* saves a great deal of the saltpetre that remains over from his original process. Were he allowed to carry concentration by boiling further in that process, he would recover at once a larger quantity of saltpetre, but would also destroy a proportion of the remaining nitrates in doing so. The Imperial Agricultural Bacteriologist thinks that more investigation is needed to discover whether, supposing the *nunia* were allowed to continue with his concentration process to a further stage, any considerable proportion of the nitrates at present wasted by the combined process described above could be recovered. He has found that something like 25 per cent. of the total nitrate passing through the *nunia's* factory must be lost, unless the *nunia* proceeds further and recovers it by what is at present an illicit process; while that process is itself so inefficient that, even if the *nunia* were allowed to pursue it unmolested, it would probably result in the loss of at least 40 per cent. of the 25 per cent. at present wasted.

Returning to the description of the *nunia's* ordinary process, it must be also noted that he takes the organic and earthy impurities thrown down in his concentration process and adds them to the crude saltpetre which he sells to the refiner. This is partly to impress the salt subordinates with an idea of his *bonâ fides* from the dirty appearance thereby given to the saltpetre, proving that the *nunia* has not proceeded beyond the legitimate stage, and partly because this substance contains some organic nitrogen, as well as saltpetre residue, which the refiner uses in a way which will be described later. The process, therefore, is not so entirely wasteful and illogical as supposed by the present Director of Agriculture in the United Provinces, who has also discussed the subject, as the refiner is able to save what might otherwise be wasted by the *nunia* under existing conditions, though the *nunia* could no doubt make better use of this refuse by adding it to the mixture which he makes already for use in the following season.

Manufacture in the refineries.

6. In the refineries, which are rather more systematised than the *nunia's* humble outfit, saltpetre is produced in two ways. The *nunia* brings the crude saltpetre to the factory, and this is dissolved in the mother liquor from the crystallising vats, which is already saturated with sodium chloride. By heating to the boiling point, the potassium nitrate is dissolved, and during subsequent concentration the sodium chloride is deposited as crystals and fished out. There then remains a saturated solution of both potassium nitrate and sodium chloride which, on cooling very slowly in a separate vat, yields large

crystals of nearly pure potassium nitrate. This is due to the less solubility of this salt in cold than in hot water, while the solubility of sodium chloride is almost unaffected by change of temperature. It is necessary that the cooling should take place extremely slowly to allow of the growth of the crystals to a large size. Rapid cooling would lead to the deposit of small crystals from which it would be difficult to drain away the mother liquor. In the improved process devised by Dr. Leather, formerly Imperial Agricultural Chemist, this difficulty is eliminated by the use of centrifugals for drying the saltpetre crystals. The other refinery process consists of the treatment of the earth round the refinery, which is saturated with the waste saltpetre resulting from the working of the factory and has had added to it the impurities from the crude saltpetre, which partly consist of the refuse of the *nunia's* boiling pans. The saltpetre is recovered much on the same principles as those adopted by the *nunia*, but with rather better plant and greater care. The Imperial Agricultural Bacteriologist gives good reason to believe that, both in this case and in that of the earth taken by the *nunias* from village sites, the saltpetre content increases, if the earth is stored under proper conditions for a period. Salt is educible by the above process just as in the case of the *nunia's* working. The refiner has the option under his license of paying duty on his salt and passing it into consumption, or of having it destroyed. The proportion of salt produced from crude saltpetre depends on the composition of the nitrous earths. In the United Provinces these generally contain a great deal more salt than in Bihar. Estimates for the latter province made some years ago allow for anything between 10 and 20 per cent. of salt being educed from the total of the crude saltpetre taken into refineries and of the nitrous earth dealt with by them under the second process described above.

The Imperial Agricultural Bacteriologist explains that the reason why this double process is followed is partly owing to the fact that the refiner can store his refuse earth, and can start work on it immediately after the rains and before the crude saltpetre produced by the *nunias* has begun to come forward.

Under the terms of his license, for which a sum of Rs. 50 is charged, the refiner must not change the number of his pans and boilers without sanction, must maintain a register showing his purchases and production, and must not remove any saline substance other than saltpetre without sanction; and, if such substance be salt, without payment of duty thereon, unless he elects to destroy it.

The position in the Punjab and in the Muttra district of the United Provinces is different. The refiner is, as a rule, a man of capital, who takes out licenses for the manufacture of crude saltpetre in his own name, employs his own servants in the manufacture and is responsible for all contingent expenditure. Moreover, owing to the greater cost of fuel, the process adopted is usually that of evaporation by solar heat, and this is not possible till later in the season than when evaporation is effected by artificial heat.

How far the system of control is necessary.

7. The Imperial Agricultural Bacteriologist forms no definite conclusion regarding the practicability of any relaxation of excise precautions. He states, however, that the resulting salt is so inferior, on account of the admixture of chlorides and sulphates of potassium, magnesium and calcium, that it is practically unmarketable for human food; and that the same is, in fact, the case with the refiner's salt, who usually destroys it, rather than accept the small margin, some four annas per maund, between its sale price and the duty he has to pay. This statement is quite at variance with Mr. Ashton's statement that the salt produced by the Calcutta refineries is practically unidentifiable from Liverpool

salt with which it was sometimes mixed, except by the presence in the former of a trace, at least, of saltpetre. The percentage of sodium chloride in this so-called *pakwa* salt was between 80 and 94, after refinement. It was produced by no better processes than are available to the refiner in Bihar; and it is the opinion of the present Northern India Salt Revenue Commissioner, based on the results of numerous seizures of illicit salt, that even the *nunia* can undoubtedly, if left to himself, produce a thoroughly marketable article.

So far as the disposal of the salt produced by the refiner throws any light on the use and nature of the *pakwa* salt, the only figures available seem to be the following. In 1881, *pakwa* salt was sold by the refiners at rates which were usually between Rs. 3 and Rs. 3-8. The duty at the time was Rs. 2-8. Apparently the above sale prices included the duty. In 1883-84, the salt educed was 38,550 maunds, of which 27,547 maunds were excised. In 1905-06, 19,718 maunds were educed, of which 16,262 maunds were excised. The consumption of duty-paid salt per head in Bihar was 9·89 lbs. in the three years 1881 to 1884; in the three years 1903 to 1906 it was 9·82 lbs. The Salt Commissioner doubts the correctness of the previous figure. A better selection of periods would have shown how far the improved control increased the consumption of duty-paid salt, but figures are unfortunately not forthcoming.

In 1868 the price of salt was Rs. 6-7-10 per maund. The price of salt less duty immediately before the war was much lower than the price of salt during the period when excise precautions were being increased, less the higher duty then prevailing. The margin of profit to the seller of illicit salt for local consumption would thus now be less, not only by the reduction in the duty, but by the drop in the cost and profit apart from that duty. Thus in 1914 salt was reported by the Commissioner, Northern India Salt Revenue, to be selling at Rs. 2-2-4 per maund at Allahabad, inclusive of Re. 1 duty. The duty has since been raised to Re. 1-4-0, but the danger of illicit sale will be much less now than in the days when it was found necessary to impose restrictions, at any rate when normal supplies are again available. The actual amount of salt likely to be produced is not considerable. In 1907 it was calculated that the *nunias* of Bihar and the United Provinces, if left to themselves, could produce about two lakhs of maunds of edible salt. It was officially reported from the United Provinces in 1914 that the salt from refineries was worth only 4 annas a maund over and above the duty of Re. 1. It must be remembered that the salt educed is, though edible, below standard quality. The illicit trade might bring some profit to the *nunia*, but whether it would result in any decrease in the consumption of licit salt seems very doubtful.

In addition, however, to the areas which are regularly worked for saltpetre, there are others of considerable importance which produce so large a proportion of salt that they would not yield enough saltpetre to pay expenses, and the output of salt would be a serious item. The entire withdrawal of the preventive staff would lead to these areas being worked freely, without any appreciable increase in the outturn of saltpetre. We have also seen that, in spite of assertions to the contrary, the *nunia* and the refiner are both able to produce edible salt in quite appreciable quantities. It seems, therefore, inadvisable to release the manufacture of saltpetre entirely from excise precautions; but there is a strong case for changing the existing arrangements in directions which will encourage the output of saltpetre, while not adding seriously to that of illicit salt. The method in which this may be done will be indicated below.

The Imperial Agricultural Bacteriologist makes a suggestion that, if it is not considered practicable to abolish excise precautions, the saltpetre pay a duty of four annas a maund and that the salt be allowed to go free. If the duty

took the form of an excise, the *nunia* and refiner would be allowed to carry their processes to the utmost extent that was profitable, but supervision would have to be exercised over both of them, to see that they did not escape duty. The result of this control would not be perhaps less irksome and deterrent than the present system, though of course there would not be the same direct incitement to waste. As a practical proposition, however, it does not appear that the saving of the waste would help the industry nearly as much as the saving of the worry inflicted on the *nunias*. In any case, some watch would have to be kept to see that *nunias* did not work in areas that contained a minimum of saltpetre and a maximum of salt. It is believed that there are fairly numerous areas that would have to be entirely prohibited for this reason.

Suggestions for increasing the sources of saltpetre.

8. The Imperial Agricultural Bacteriologist's general conclusions are summed up as follows. The existing sources of saltpetre are not fully utilised owing to certain drawbacks, which include the control of the Salt Department and the low price of crude saltpetre. This latter feature is due to the inability of the *nunias* to combine and to the mastery of the situation thereby possessed by the refiner, who pays Rs. 5 for crude saltpetre containing about 50 lbs. of the pure article, and sells refined saltpetre, containing about 72 lbs. of the pure article for Rs. 12. The question of introducing co-operation among *nunias* is worthy of consideration, but the most probable solution of the difficulty appears to be the establishment of model factories under Government control, or belonging to a more reliable class of private owners.

Artificial nitre beds, in which nitrates are produced in the soil by the decomposition of *sann* hemp (Crotalaria juncea) or other easily obtainable organic matter might be a useful additional source of supply, especially if concentrated round a central factory for economy of manufacture and, if necessary, of control. They have a special advantage in the practical absence of salt from the saltpetre so obtained. A few experiments in this direction have been already made at Pusa, with promising results.

Improvement of methods of production.

9. The *nunia's* present methods result in the waste of some 25 per cent. of the available nitrates. It is necessary to ascertain whether more efficient methods can be devised, and, if so, whether these would assist in the withdrawal of the present system of control. It has already been stated that Dr. Leather devised a process which is a considerable improvement on that at present adopted by the refiner. This process was shown in the Allahabad exhibition, and the plant is still lying at Pusa. It does not seem, however, that any steps, at any rate effectual steps, have been taken to demonstrate it. The method may be looked at, however, merely as an initial attempt to improve the industry and as a sample of what may be expected from methodical work on a commercial scale. The results of the Imperial Agricultural Bacteriologist's investigations also give ground for hope that the saltpetre contents of the earth can be improved, and that saltpetre may be generated artificially in considerable quantities. The position justifies experimental working on a large scale with expert assistance and control. There is sufficient work for a bacteriologist, a chemist, and a chemical engineer in the initial stages; and the result may very likely be a great increase in the output of saltpetre, with a saving of waste and a cheapening of production. The work should at first be taken up by the Imperial Department of Industries, or by a single Local Government, and the results so obtained should be demonstrated by the provincial Departments of Industries.

Transference of control to Local Governments.

10. Whatever may be the risks of illicit salt production in saltpetre manufacture, it is clear that the present system, with a microscopic preventive staff working over enormous areas which contain thousands of *nunias*, is

ineffective. A better course would be to hand over to the Local Governments of the Punjab, the United Provinces, and Bihar and Orissa the control of salt excise, and therefore of saltpetre production, whether by *nunias* or refiners, making any financial adjustment that may be necessitated by the cost involved on provincial revenues and the receipts obtained from what has hitherto been an imperial source of revenue. The local Excise Departments might, as in Bombay and Madras, be the agency for the control of salt production, and their larger staff and better local organisation would, in point of efficiency at any rate, make them a preferable instrument to the Northern India Salt Department. The encouragement of the industry on the lines suggested above would be the concern of the local Departments of Industries, and co-operation between these and the Excise Departments would, no doubt, result in the control being reduced to a minimum and exercised in the least vexatious way. The Department of Northern India Salt Revenue could then devote its energies to the production of salt, and arrange for the fuller and more efficient exploitation of the vast sources of salt under its control.

APPENDIX G.

SERICULTURE AND THE SILK INDUSTRY.

Basis of note.

1. The silk industry in India has recently been the subject of detailed enquiry by Mr. H Maxwell Lefroy, assisted by Mr. E. C. Ansorge, I.C.S., and their report to the Government of India has been communicated to us. Both gentlemen appeared before us as witnesses, and to a large extent the following notes on the position of the silk industry in India are based upon information collected by them.

Extent of sericulture in India and existing position of the industry.

2. The subject is one of great complexity, requiring considerable technical knowledge for its elucidation, and it can only be dealt with here from a general administrative point of view. At the present time, there are three tracts in which sericulture is an industry of some importance:—(1) In the south of India, the southern half of the Mysore plateau, with the adjoining taluk of Kollegal in the Madras Presidency; (2) Bengal, chiefly in the districts of Malda, Murshidabad, Rajshahi, and Birbhum; (3) Kashmir and Jammu, with the neighbouring sub-montane districts of the Punjab. There is also a considerable industry in Chota Nagpur, Orissa, and part of the Central Provinces, dependent on the *tasar* silkworm, and in Assam, on the *muga* and *eri* silkworms. The *tasar* is stated by Mr. Lefroy to be a wild silkworm, never successfully domesticated, which lives in forest areas chiefly, and which feeds on a variety of trees. The *muga* is a semi-domesticated worm reared entirely in the open on trees, chiefly *soom* (Machilus bombycina) and *hualu* (Litsaea polyantha). The *eri* is a domesticated worm yielding a silk which cannot be reeled but has to be spun, its principal food plant being the castor plant.

There is no very accurate statistical information regarding sericulture in India, except that deducible from the sea-borne trade returns, and this must be treated with caution, as it is not always certain what the classifications adopted actually cover. From the early days of the East India Company in Bengal silk was an important article of trade. From 1776 to 1785 the export of Bengal silk to England averaged 560,285 lbs., and it is probable that this figure only covers reeled silk. Whether the industry made any great progress in the 19th century or not depends upon this point, as the total figures usually quoted from the sea-borne trade returns for the exports of Indian raw silk include not only reeled silk, but chassam, or silk waste, and silk cocoons. The exports reached their highest level in the years 1866 to 1874, when the average annual exports were 2,203,000 lbs., of which not more than 600,000 lbs. were reeled silk. The development of exports during that period is due to the work of Mr. Lister, afterwards Lord Masham, who introduced methods and machinery for spinning silk waste and created a demand for this material. In the production of one pound of silk there results from two-thirds to one pound of chassam, and the exports of this material are probably the best guide as to the total quantity of silk produced in India, though they do not include the quantity used in the two silk-spinning mills in Bombay, and do not make any allowance for the imperfect collection of chassam, which is a by-product of comparatively small value in silk reeling. To estimate, then, the Indian production of silk, we shall be fairly safe in calculating that it is at least equal to twice the export of chassam. On this assumption, the sea-borne trade statistics yield no evidence of any serious decline in the silk industry, the

falling-off in the production of Bengal being fully compensated for by the expansion in Kashmir and the south of India. Taking the export figures for chassam as a guide, the Indian production of silk during the last 30 years has ranged between two million and two and a half million lbs. The exports of raw silk reached their maximum in the years 1906-07, when they averaged over 750,000 lbs., and they have fallen since to 82,700 lbs. in 1914-15, recovering in 1916-17 to 218,000 lbs. In the same year the exports of chassam and cocoons amounted to 1,325,467 lbs.

The South Indian silk industry is of comparatively modern origin; it is supposed to have been started by Tippu Sultan with seed received from China, and it is now responsible for two-thirds of the total output of silk in India. Both in Bengal and the south of India silk production is by multivoltine worms fed on the leaves of the shrub mulberry. In Kashmir, where the industry is now a State monopoly, the tree mulberry is the source of leaves, and only univoltine worms are grown. The first attempt by this State to develope the industry commenced in 1863 but, owing to the appearance of pebrine, it collapsed within ten years. In 1895 a second attempt was made which, as soon as the futility of relying upon local seed was realised, yielded successful results. Development has now reached the limit prescribed by the number of trees available for leaves, and the State derives from the monopoly a nett revenue of about 11 lakhs of rupees per annum. The output of silk is approximately 100,000 lbs. of reeled silk a year, the whole of which is exported. But the conditions under which sericulture has been developed in Kashmir are unique. Full details regarding them will be found in Mr. Lefroy's report, but they are of little value in considering the question of sericulture in British India, where conditions preclude the possibility of organising the industry on similar lines.

The following table, taken from a paper contributed by Mr. Lefroy to the Royal Society of Arts and published in March 1917, furnishes approximate figures regarding the production of mulberry silk in India in the year 1916:—

Mysore	1,152,000	lbs.
Bengal	600,000	,,
Madras	400,000	,,
Kashmir	96,000	,,
Burma	15,000	,,
Assam	12,000	,,
Punjab	1,800	,,
TOTAL	2,276,800	lbs.

These figures agree very closely with the estimate of silk production based upon the exports of chassam and show clearly the very slight effect which the war has had upon the Indian silk industry. The growing prosperity of the country enables it readily to absorb large quantities of silk, and the diminished exports are probably due to the better prices obtained in India. In this connection, it is interesting to quote from a recent report on Indo-French trade by Messrs. Chadwick and Black, in which they state:—

"Lyons is of course the great centre of silk, and regret was expressed at the almost total disappearance of Bengal silk; whereas, some years ago, Bengal silk was obtainable at 10 fr. per kilo, they now offer 70 fr. a kilo and can hardly get it. It was unrivalled for taking brilliancy, and so was almost entirely used for making the tall silk hats so popular with the last generation, but now going steadily out of fashion. It was, however, so badly reeled and prepared that it was not useful for weaving fabrics. Another house in Lyons takes most of the Kashmir silk and is very well satisfied with it. They said they had heard of so many attempts to improve the silk of the Indian plains that they were becoming doubtful whether anything permanent could be obtained."

Necessity for improvement of sericulture.

3. There can be no question that it is desirable to make a serious attempt to improve sericulture in India. Though it can hardly be said to be flourishing anywhere, the scale of operations in Bengal and the south of India is considerable, and there is not the least doubt that its present unsatisfactory condition is due to remediable causes. The first serious attempt to deal with the problem was the employment of Mr. Maxwell Lefroy as Imperial Silk Specialist and, without presuming to endorse his conclusions on technical points, we are of opinion that his report throws much light upon the subject and should be taken as the basis for further action. In the evidence tendered to us, he has definitely stated that large tracts of India are suited for the development of raw silk production and that much of the silk, both raw and in the form of manufactured goods, now imported into India might be produced in the country. As the imports amount to more than 3½ crores of rupees per annum the matter is one of very considerable importance.

Criticism of Mr Lefroy's proposals for an Imperial Department of Sericulture.

4. Mr. Lefroy has proposed the establishment of an Imperial Department of Sericulture, working under the Revenue and Agriculture Department of the Government of India and provided with a suitable staff of specialists to carry on the work which, he thinks, should be undertaken. The head of the department would be the Director of Sericulture, and the future of the industry would largely depend upon his personal views; and, if the measures initiated by him happened to prove unsuited to local conditions, the consequences might be disastrous. No single expert can deal adequately with the whole question. Developments in some parts of the country will depend upon the planting of mulberry trees, which is an horticultural matter; in others, upon the turning over of land for the cultivation of mulberry shrubs and the provision of irrigation facilities. Questions of land tenure and water rights may easily become of great importance. Whether univoltine or multivoltine worms should be reared is possibly not a difficult matter to determine; but what race should be encouraged can only be settled by experts with an intimate local knowledge of the conditions of rearing. It is significant that when Mr. C. M. Hutchinson, the Imperial Agricultural Bacteriologist at Pusa, at the instance of Mr. Lefroy, examined the Pasteur method of obtaining disease-free seed by selection, he discovered that disease, in the case of flâcherie and pebrine, was not being eliminated by the methods successfully pursued in Europe, and that it was necessary to devise a modification suited to Indian conditions. It appears to us that the creation of a special Department of Sericulture would involve considerable difficulties; it would be out of touch with the numerous local interests, official and non-official, whose co-operation is needed to achieve success, and it would be unnecessarily expensive. Granted that central research and co-ordination of local efforts by advice and information are wanted, these can be secured by the employment of an imperial expert, located at a suitable centre and working under the Imperial Department of Agriculture; but the difficult work of investigating local problems and of demonstrating the results can only be successfully achieved by an agency with local interests and connections.

Improvement more important than extension of sericulture.

5. Unquestionably, the most important matters are the provision of arrangements for the distribution of disease-free seed and the introduction of more hygienic methods in the rearing houses. In each locality where sericulture is largely pursued a special officer will be needed to supervise such work, and he should be attached to the provincial Department of Agriculture. It seems to be more important to deal with those tracts in which sericulture is already an established industry than to introduce it into areas where, even if the climatic conditions are favourable, there may be great difficulties arising from

the prejudice of the people and their unwillingness to take up an entirely new venture.

Mr. Lefroy in his report, page 32, paragraph 12, states:—"The Mysore State is climatically the most suitable area for multivoltine silk in India and there is scope for a very large extension of this profitable industry". Also on page 38, paragraph 22:—"The only area in Madras now known to produce silk is the Kollegal taluk of the Coimbatore district, bordering on Mysore and geographically part of the Mysore plateau". Similarly, in Bengal, the history of sericulture in that province indicates the possibility that a scientific study of existing conditions may result in very great improvements of the present methods, which would make the industry more profitable and enable it to recover ground. There is, of course, no reason why efforts should not be made to introduce sericulture into other places where the natural conditions are suitable; but, in the beginning at any rate, this should only be done where it is probable that the industry will be welcomed and will expand freely as soon as it has been demonstrated as a certain addition to the resources of the people. This is a matter which may well be left to local administrations. At the outset, whether an Imperial Department of Sericulture is established, or whether the problems presented by the improvement of sericulture are dealt with in the Imperial Department of Agriculture, attention should be first concentrated upon improvement in existing areas.

Distinction between sericulture and the silk industry.

6. Sericulture may be regarded as an agricultural occupation similar to bee keeping or poultry farming. It is essentially a cottage industry, and the rearer of silkworms may or may not grow on his own land the food on which they feed. It seems unlikely that this feature will be disturbed as experience in the past is clearly against the establishment of large rearing houses.

A question of no small importance arises as to where sericulture ends and the silk industry begins. Mr. Lefroy draws no distinction between the two in regard to the organisation which he proposes should be created to deal with the silk industry in India. On the other hand, we are of opinion that a clear line of demarcation should be drawn, and that, too, at the earliest possible point. The duties of the silk rearer should end with the production of cocoons. Sericulture is, and should remain, a cottage industry; but the subsequent preparation of the silk for the market is best undertaken on a large scale and with modern machinery. The success of the Kashmir filatures is evidence in favour of this view. There is no difficulty about the marketing of silk properly reeled. Different markets require different qualities of silk, and all that is necessary is that attention should be paid to these points.

Development of sericulture.

7. The future progress of sericulture in India depends entirely on the cost of production. The profits of the industry at the present time are greatly restricted owing to the presence of disease. It has proved difficult to obtain any accurate information regarding the loss of silk from this cause; but, enquiries made in the south of India, which is possibly more favourably situated than Bengal, seem to indicate that the mere elimination of disease will at least double the output of silk. The extent to which silk can be produced is limited by the amount of food available for the worms. The price which can be paid for mulberry leaves depends upon the value of the silk produced by the worms feeding on those leaves, and if, by the elimination of disease, the quantity of silk so produced is greatly increased, it becomes possible for the rearer to pay a higher price for mulberry leaves. This will encourage the cultivation of the shrub mulberry; but, in tracts where the industry is dependent upon mulberry trees, it is very unlikely that private initiative will bring about any extended development. From five to ten years must elapse from the planting

of the mulberry tree from seed before it becomes capable of yielding a fair crop of leaves, and it is obvious that the expansion of the industry will be very precarious unless the planting of trees is fostered by Government.

Development of silk industry.

8. The development of sericulture in India will have little effect one way or the other upon the future of the manufacture of silk in India. The Indian silk weaver is already largely dependent upon China for his raw material. The steadily increasing prosperity of India has led to a proportionately greater demand for more clothing on the part of the people and for more expensive clothing among the growing number who can afford to indulge in luxuries in the way of dress. The silk weaver, even more than the cotton weaver, is in need of special technical instruction. Given this, there is hardly any doubt that he could successfully compete with the manufactured goods which are now so largely imported.

Hitherto, hand-loom weaving has been regarded almost entirely from the point of view of the weaver of cotton goods, and only incidentally have any attempts been made to assist the silk weaver. This is possibly due to the fact that the silk weaver is generally better off than the cotton weaver. The industry is in the hands of a more intelligent and wealthier class of weavers, and there is evidence to show that the increasing demand for their goods has been accompanied by corresponding attempts to improve their methods of production. Nevertheless, much more can be done to put the Indian silk weaver in a better position. This is a problem which, in the future, Departments of Industries will have seriously to tackle.

At the present time, the weakest spots in the Indian silk industry, regarded apart from sericulture, are the primitive and inefficient processes used in preparing the silk yarn. It is desirable that attention should be drawn to the necessity for improving these, and the establishment of model silk filatures, twisting mills, and dye houses seems clearly indicated. To such factories for the preparation of silk yarn silk-weaving establishments may well be attached, as it is not unlikely that the same advantages may accrue therefrom as have resulted from the addition of weaving sheds to cotton mills.

APPENDIX H.

SCIENTIFIC AND TECHNICAL SOCIETIES.

Absence of scientific and technical societies in India.

1. We desire to attract attention to the almost complete absence of scientific and technical societies in India. So long as the majority of the men in this country from whom such societies would naturally draw their members belonged to Government executive services, the subordination essential to discipline was unfavourable to their inception and growth; but this phase is gradually passing away, owing to the much wider diffusion of scientific knowledge, to the rapid expansion of organised industries, and to the greatly increased number of scientific and technical experts in private employment.

In the past, the scientific and technical services were recruited at home, and not a few of their members belonged to the great English societies, which have been formed to promote the interests of special branches of science and technology. As an example, we may cite the Public Works Department. It has a long record of magnificent achievements to the credit of its officers, and their contributions to scientific and engineering literature are found in the journals of many societies, notably the Proceedings of the Institution of Civil Engineers. It has undertaken extensive researches to solve special problems connected with Indian engineering, and from time to time efforts have been made to issue a regular series of professional papers; but for one reason or another, the supply of suitable material has after a time ceased. Only to a very limited extent is it possible for trade and technical journals to serve as *media* for the publication of professional and scientific work. No prestige attaches to original communications offered to the world in this way, and the ephemeral character of these journals militates against their permanent preservation. Hitherto, therefore, the bulk of the original work done in India has been published in the transactions or proceedings of English societies. There is, however, a limit to the possibilities of this and the history of much work of more than transient or Indian interest is buried in the records of Government departments.

In Great Britain the volume of research work, enquiry and practical experience has increased so rapidly, and specialisation has developed to such an extent, that it has become necessary, at frequent intervals, to establish new institutes or new societies to deal with the new groups of problems which have arisen. The members in the larger societies have also increased so greatly in numbers and they are so widely scattered that they have had to form themselves into branch associations, to attend more especially to matters of local interest.

It is unnecessary for us to dwell at any length upon the advantages which arise from a free interchange of ideas between men working in the same field of scientific investigation, and the stimulating effect of instructed criticism on men engaged in technical pursuits.

Necessity for the establishment of certain societies in India.

2. We are of opinion that the interests of India demand the establishment of Indian institutes, societies and associations analogous to the Institution of Civil Engineers, the Chemical Society, and the British Association for the Advancement of Science. Action in this direction is urgently required to provide for the growing needs of Indians. It is true that they have free access to the English societies on the same terms as any other subjects of the

Empire, and they are also freely admitted to American societies; but beyond the prestige attaching to membership and the periodic receipt of copies of publications, they derive little or no benefit from such distant associations, and they are altogether deprived of the advantages which arise from personal intercourse between the members. In matters connected with administration, the value of personal discussion has been recognised by Government, and every year an increasing number of conferences and committees meet to discuss specific problems. Men are convoked from all parts of India to exchange views, and experience shows that such meetings are well worth the time devoted to them and the expense incurred in bringing the officers together. But something more than this is necessary, and the movement in favour of it has found expression in the establishment of the Indian Science Congress, which was started four years ago and holds annual meetings in the month of January in one or other of the capital cities of India. Government supports it by the grant of travelling allowances to selected scientific officers attending its meetings, and the Congress is doing useful work and is stimulating the growth of conditions favourable to the prosecution of research in a great variety of directions.

Proposals for an Indian Institution of Engineers.

3. Some attempt also has been made, with an encouraging degree of success, to establish local and specialised associations. The principal mining interests of India are centred in Calcutta, which is at no great distance from the Bengal coal fields, and in 1906, with the help of the Inspectors of Mines and officers of the Geological Survey, the Mining and Geological Institute of India was founded "to promote the study of all branches of mining methods and of mineral occurrences in India, with a view to disseminating the information obtained for facilitating the economic development of the mineral industries in the country." It now includes among its members a large proportion of the mining engineers working in Bengal and, to a less extent, those engaged in other parts of India. Calcutta is also the largest centre of mechanical engineering in India, and the resident members of the Institution of Mechanical Engineers, London, have formed a local branch under the standing rules framed by the parent society. The members meet from time to time to read and discuss papers and, as a purely local body, it has met with some success; but it has not sufficient prestige to attract many members from other parts of India. This points to the necessity for a wider basis of membership and a broader field of common interests which, we think, would be found in an Indian Institution of Engineers embracing all the branches of engineering practised in India. The majority of engineers are in the service of Government; but the number of those not so employed is considerable and is likely to increase rapidly in the future with the development of industries. In a country like England, where engineers are very numerous, clearly marked divisions have naturally arisen, and when the interests of any section have become of sufficient importance, a specialised association has been established to promote them. In India the total number of engineers is still too small to permit of this subdivision with advantage, and all that seems possible at the outset is to establish an institution for the profession as a whole. The same gradual process of evolution as in England may be anticipated, and when any special branch has become strong enough, it will probably follow the same course.

4. From such enquiries as we have been able to make, we consider that a satisfactory precedent would be found in the English Institution of Mechanical Engineers, which has its headquarters in London with a number of provincial branches, and annually holds a summer meeting in one or other of the large provincial centres of engineering; whilst it also occasionally fraternises with

similar societies on the Continent. Papers prepared for the Institution are read and discussed at meetings of the members held nearly simultaneously in London and in any of the provincial centres where they are likely to be of interest. The same thing could very well be done in India. There would be great advantages arising from a strong central society covering the whole of India, as membership thereof would confer a much greater prestige. Apart from the reading and discussion of professional papers, such a society would inevitably interest itself in many problems with which the State has to deal, and in which it would be advantageous to obtain the considered opinion of such a representative body. Many such matters have come before us in the course of our enquiries, among which we may mention the education and training of engineers, the necessity of certificated attendants on boilers, the working of the Acts affecting the engineering profession, and the grant of concessions in respect of mining rights or water power. Such an institution should be an entirely independent body, to which Government might very well make an annual grant or subsidy in return for the indirect advantages which the country would enjoy in consequence of its establishment. We have in view an institution whose activities would be mainly devoted to professional and technical questions; its existence therefore would be of great value in establishing a standard of professional conduct and efficiency. Almost every civilised country in the world has an engineering association of some kind, and we think that India should no longer be deprived of the advantages accruing therefrom. But the conditions in this country are unique, and it seems hardly likely that a successful institution of engineers could be established without encouragement and some pecuniary assistance from Government.

APPENDIX I.

STATISTICAL EVIDENCE REGARDING THE DEVELOPMENT OF HAND-LOOM WEAVING IN INDIA.

Three causes have contributed to the existing general impression that hand weaving in India is a declining industry. They are (1) the enormous increase in the production of mill-made cloth; (2) the bad financial conditions under which the hand weavers work, and especially the extent to which they have had to receive famine relief; and (3) the census figures. The second reason, which has been discussed in the body of the report, is undoubtedly a corollary of the first, which is an evident fact. This note will, therefore, deal mainly with the third factor, *viz.*, the census figures.

2. In paragraphs 91 and 92 of the Madras Census Report for 1911, Mr. Chatterton has examined the figures and concludes that there has been little, if any, diminution in the number of weavers in that province. The passage in question is as follows:—

"91. The condition of hand-loom weavers is generally assumed to have steadily deteriorated owing to the effect of competition, and of indirect evidence there is plenty in support of this idea. The weavers themselves complain that their condition has steadily become worse, that they have to work harder and that now the coarse weavers, even by the most unremitting toil, are only able to make a bare livelihood. The present census is the fifth that has been taken, and if the classification of the returns had been uniform throughout, it would have been possible to state definitely whether the number of weavers was increasing or decreasing; but unfortunately there have been many changes in the methods of grouping trades or branches of a trade at each census, and it is difficult to arrive at any certain conclusion. The following tabular statement has been compiled to show what comparable returns are available since 1871 regarding those employed in the more important branches of the cotton trade:—

		1871.	1881.	1891.	1901.	1911.
Cotton-ginning, cleaning and pressing.	Mill	.	..	.	1,961	1,824
	Hand	24,714		15,041	10,682	18,243
		24,714	24,714	15,041	12,643	20,067
Cotton manufactures .		..	188,157	.	.	.
Cotton-spinning and weaving. Spinners	Mill	...	..	7,306	6,851	16,615
	Hand	...	...		6,414	6,414
		...		7,306		369,503
Weavers	Hand	.	376,561	196,610 ...	365,112 ..	383,142

"92. From an examination of this table, it is clear that in 1871, there were 376,561 weavers (males) but in 1881, 188,157 males are returned as cotton manufacturers, and the weavers only number 196,610. The total comes to 384,767, and probably includes cotton ginners and cotton spinners. We may assume approximately that these numbered about 20,000 and that, therefore, the number of weavers in 1881 was slightly over 360,000 showing a probable decrease of 15,000 weavers in the 10 years. This result would not be unexpected remembering the havoc caused by the great famine of 1877. In 1891 the weavers are returned as 365,112 and in

1901 as 383,132. So far as can be ascertained these numbers are comparable, and would show a slight increase in the actual number of weavers. The figures for 1911 are reported as 385,124, but this includes all mill hands and persons engaged in power factories connected with spinning and weaving. The number of these latter is 16,615, and deducting these, we obtain that the number of hand weavers in 1911 is 368,509. I think, therefore, we may safely accept the following conclusion:—That in the last forty years the number of hand-loom weavers has remained practically stationary, but that owing to stress of competition they now turn out a larger amount of finished goods than was formerly the case; that is to say, the majority of them have to work harder to make a bare living. One might also add that their lot would probably be greatly improved if they could be induced to accept outside assistance, which can only be effectively rendered by the establishment of small hand-loom weaving factories. The individual weaver suffers because he is still trying to carry on a complex series of operations without recognition of the advantages of subdivision of labour."

3. The conditions of the Madras hand-loom industry are, however, in some respects peculiar. The proportion of fine weaving is higher than in most other provinces; the industry is more concentrated in localities, and it relies to some extent on a regular export trade in certain special lines.

It is necessary to examine the position of other provinces of India, where equally favourable circumstances do not exist. The difficulties and uncertainties arising from the manner in which occupations have been recorded at the different censuses are considerable. Owing to lack of homogeneity among the systems employed in the earlier censuses, figures have had to be selected carefully and no general and complete presentment of the case is possible. We may examine, in the first instance, the figures from 1891, for various branches of the cotton industry in Bengal, Bombay, the United Provinces, the Central Provinces (excluding Berar), and the Punjab (including the North-West Frontier Province). The figures are in all cases taken for British India only, in order to eliminate the possibilities of error arising from the less efficient management of the earlier censuses in Native States:—

Totals of Bengal, Bombay, United Provinces, Central Provinces (excluding Berar) and the Punjab (including the North-West Frontier Province).

—		Workers.	Total workers and dependents.
Cotton ginning, pressing and cleaning.	1891	.....	455,644
	1901 Hand workers .	136,495	306,929
	1911	122,293	255,080
Spinning, sizing, weaving and yarn beating.			
	1891 Factory hands .	.....	133,461
	1891 Spinners, etc. .	.....	725,751
	1891 Weavers . .	.....	3,478,531
	Total hand workers .		4,204,282

Totals of Bengal, Bombay, United Provinces, Central Provinces (excluding Berar), and the Punjab (including the North-West Frontier Province)—contd.

			Workers.	Total workers and dependents
Spinning, sizing, weaving and yarn beating—*contd.*	1901	Mills . . .	137,675	246,194
		Hand weaving .	1,182,086	3,173,855
		Spinners, sizers, and beaters.	291,636	747,037
		Total hand workers .	1,773,722	3,590,892
	1911	Ginning, pressing and cleaning.	122,293	255,030
		Ginning, pressing and cleaning factories.	46,937	.....
		Nett hand workers .	75,356	.....
		Spinning and weaving.	1,500,662	3,012,601
		Spinning and weaving factories.	204,476	.....
		Nett hand workers	1,296,186	.....

NOTE.—(1) In the Central Provinces (excluding Berar) where separate figures are given for spinners and weavers in 1911, working spinners are 14 per cent. and total spinners (workers and dependents) 11 per cent. respectively on workers and total of spinners, weavers and sizers. If this ratio be assumed all through, hand weavers in 1911 for the total of the provinces selected would be as under :—

Workers 1,290,569

Total workers and dependents . . . . . 2,681,215 (from which factory workers 204,476 and their dependents must be deducted)

(2) Even in 1911, hand and factory textile workers were not recorded separately; the latter were enumerated at a separate and subsequent industrial census with the result that dependents are not shown and there is no basis of comparison.

The following comparison may now be made :—

	Total workers and dependents.	Workers.
1891	3,478,531	(separate figures not available.)
1901	3,173,855	1,182,086
1911	2,681,215*	1,290,569

* from which factory workers 204,476 and their dependents must be deducted.

For 1881 we have the following figures :—

	Males.	Females.	Total.
Workers in cotton and flax—	1,642,429	...	...

Figures for females, and totals for the United Provinces are unfortunately not available. But if the average proportion existing in other provinces is also taken for the United Provinces, the totals would be :—

Males.	Females.	Total.
1,642,429	1,886,447	3,528,876

The above figures were apparently inclusive of the following number of weavers :—

	Males.	Females.	Total.
Bengal	361,739	100,211	461,950
Bombay	...	...	224,343
United Provinces	367,774	...	...
Central Provinces	(Not available.)		
Punjab	286,523	91,136	377,659

Assuming that the males only were workers, the above figures compare with the totals in subsequent years for hand weavers in the United Provinces, Bengal and Punjab.

1881	1,016,036	Workers (males).
1891	2,750,117	Total workers and dependents.
1901	1,170,808	Workers (males and females).
1911	839,349	Workers (by applying C. P. formula for deducing spinners).

In order to take the figures back to 1872, we must confine ourselves to Bengal and the United Provinces the totals for which were :—

1872	590,702	Workers (males).
1881	729,511	
1891	1,828,616	(Total workers and dependents).
1901	837,731	Workers.
	1,849,855	(Total workers and dependents).
*1911	538,189	Workers.
	1,155,272	(Total workers and dependents—from which factory workers 23,693 and their dependents must be deducted).

* Figures for spinners deduced as above.

5. We may check these results by pursuing a parallel line of enquiry and comparing the totals of all workers and dependents in the weaving industry in the only province for which figures are available, *viz.*, Bengal :—

1872	291,590	(apparently only actual workers).
1881	461,950	
1891	923,986	
1901	901,982	
1911	458,762	(includes spinners).

The figures for several provinces are available from 1881, *viz.*, Bengal, Bombay and Punjab; the totals (workers and dependents) for these are given below :—

1881 . . .	1,063,952	
1891 . . .	2,139,996	
1901	1,947,574	
1911	1,897,191	(from which factory workers 178,047 and their dependents must be deducted).

The uncertainty of these figures may be conjectured from the following comparison :—

	Bombay.	Bengal.
1872	73,015	291,590
1881	224,343	461,950
1891	294,509	923,986
1901	227,303 (+ 168,043 for factories).	901,982 (+ 7,829 for factories).
1911	614,214	458,762†

† (includes spinners) from which factory workers 164,069 and 10,838 respectively and their dependents must be deducted.

It is clear that considerable differences of method seem to have existed in bygone censuses in deciding what persons should be recorded as weavers by occupation.

6. A few figures are available regarding the extent to which weaving castes are actually working as weavers Only those cases have been chosen in which figures appear reliable.

Bengal *Jogi*—

Workers in all occupations—

	Males.	Females.
1911	101,179	18,055
1901	76,738	13,480

Working as weavers—

1911	32,676	10,352
1901	39,633	8,980

NOTE.—Figures for 1901 include certain occupations allied to weaving.

Tanti and Tatwa—

Workers in all occupations—

1911	99,034	26,074
1901	226,999	87,897

Working as weavers—

1911	42,178	9,109
1901	90,025	30,403

There seems some doubt if *Tatwas* are included in the 1911 figures; but the proportion of the total workers working as weavers in each year is worth noting.

		Per cent.
Males	1911	42
	1901	39
Females	1911	34
	1901	32

Central Provinces *Balahi* (very coarse weavers).

Workers in all occupations—

1911	32,480
1901	28,036

Working as weavers—

	Per cent.
1911	2,009
1901	12,388

Kori (medium weavers).

Workers in all occupations—

1911	18,715
1901	18,821

Working as weavers—

1911	7,415
1901	7,246

Koshti (fine weavers).

Workers in all occupations—

1911	85,522
1901	84,551

Working as weavers—

1911	68,767 (including 32,217 females).
1901	36,699

It looks as if a different criterion had been applied to decide what contitutes a female weaver in 1911 from that adopted in 1901, and thereby some doubt is thrown on the figures for other castes than the above.

Mahar (coarse weavers)—

Workers in all occupations—

1911	752,157
1901	410,171

Working as weavers—

1911	83,773
1901	89,406

Panka (very coarse weavers)—

Workers in all occupations—

1911	82,627
1901	93,691

Working as weavers—

1911	10,486
1901	20,471

7. The figures seem very doubtful. It is clear that, apart from lack of homogeneity and other causes, there has been an absence of agreement as to the point where the line should be drawn between weaving castes working as weavers and working at other occupations, *e.g.*, cultivation; and it also seems likely that females helping their husbands by reeling, sizing, etc., are sometimes recorded as weavers, sometimes as sizers and sometimes as dependents. Again the famines of 1897-1900 compelled changes of occupation in many cases, especially among the coarse weavers, which may or may not become permanent. The following conclusion may, however, be drawn, though only with caution and reserve. There has been some apparent tendency for the total number of weavers to decrease; but there is reason to believe that this

reduction, so far as it is real, is confined mainly, if not wholly, to the coarse weavers, who are often not whole-time weavers, whose products are less specialised and more exposed to mill competition and who find it more easy to take to unskilled labour.

Attempts at any form of industrial census are rare in India; but an enquiry made into the number of looms in certain districts in Madras in 1913-15, as compared with the results of an enumeration of looms made in 1900 for the Madras Statistical Atlas, shows, if the figures are to be relied on, an increase of 69 per cent. over the latter total.

8. We may now consider the figures for the consumption of yarn by hand weavers. If we take the imports and internal production of yarn in mills, and deduct from these the exports and the quantity of yarn corresponding to the quantity of cloth produced in mills, we shall obtain a figure showing the balance of mill yarn not woven into cloth or exported, and therefore, allowing for the small quantity made into such articles as rope, tape, etc., wholly or almost entirely used by hand weavers. At present the quantity of hand-made yarn woven by hand weavers is negligible. It was almost certainly very small in the former of the two periods taken in the statement below (Statement I), and is not enough to account for the difference revealed by the comparison between the two periods. The inference, therefore, is that there has probably been a small increase in the amount of yarn woven since the period 1896-97 to 1901-02; and it is precisely since that period that the decline in weavers exhibited by the census figures is apparently largest and most certain. If the figures for yarn production are correct, it follows that either the census figures do not correctly exhibit the actual state of affairs, which is highly probable on other grounds, as we have seen, or that the remaining weavers have been more actively employed. But, in any case, we may fairly conclude that there has been no general falling off in the employment of hand weavers. This conclusion does not conflict with that reached by Mr. Chatterton in the case of Madras.

9. In order to eliminate, as far as possible, the effect of the famine years of 1896-97, 1899-1900 and 1900-01 in reducing the production of the basic period and thereby vitiating to some extent the comparison, a further statement (Statement II), based on figures supplied by Sir B. D. Mehta, of the Empress Mills, Nagpur, has been added, showing the production, consumption, exports and imports of yarn, year by year, since the figures for mill production have been recorded. An extract (Statement III) from a letter by the same gentleman, giving his views on the subject, is also appended.

10. The position of the weaver cannot, however, be estimated solely from the weight of yarn which he converts into cloth. On yarn of fine counts he expends a very much larger amount of labour per lb. of material used than on coarse yarn. For instance, in the manufacture of a turban cloth made of 100's counts 1·3 lbs. of yarn were used which cost Rs. 3-4-0, the labour charges came to Rs. 5-8-0 equivalent to Rs. 4-3-8 per lb. of yarn, whilst in the manufacture of cloth from 20's counts 3½ lbs. of yarn costing Rs. 2-0-0 were used, and the labour charges amounted to Re. 1-9-0 or slightly over annas 7 per lb. These examples are extreme cases and an intermediate example of a dhoti made from 60's counts may be cited. The cost of the yarn was Re. 1-8-0 per lb. and the cost of the labour Re. 1-2-4 per lb.

11. Statement IV shows in tabular form the imports of yarn from 1890 to 1914. For the first 5 years of the period they averaged 44·78 millions of lbs. per annum, whilst during the last five years ending 1913-14 they averaged 41·79 millions of lbs. per annum. In the 5 years 1900-1905, consequent upon the effects of famine, the average imports were only 33·07 millions of lbs. per annum. The figures however require examination in detail, and the information available is tabulated in Statement V, which gives averages for 5 year

periods from 1899-00 to the end of 1913-14; these show that while the imports of coloured yarn are steadily decreasing in respect of the lower counts, there has been a very marked rise in the imports of grey yarn of counts over 40's. From 41's to 50's the average increase is 119 per cent. and over 50's it is 95 per cent. Up to the outbreak of the war, then, there is definite evidence to show that the weavers of India were not only using more yarn but that, so far as imports were concerned, there was a very marked increase in the consumption of fine counts.

12. Corroborative evidence regarding the vitality of the hand-loom industry is furnished by Statement VI which gives the number of handkerchiefs and shawls exported from India from 1890 to 1914. Although the variations from year to year are very considerable, there was no marked change in the trade till about 1904, since which date there has been a distinct upward tendency, so that the last 5 years' exports show an average increase of 27 per cent. over the average of the 10 years 1894-1904.

13. As we have seen, the evidence regarding the number of hand-loom weavers in India yielded by the census returns is of little value, but there is no uncertainty as to the facts deduced from the trade statistics, which clearly indicate that the consumption of yarn is increasing and that it is most marked in respect of fine counts. We may, therefore, conclude that the hand-loom industry is at present holding its own, and that there is good reason to suppose that the universal adoption of technical improvements such as warping mills, fly-shuttle slays and jacquard harness would greatly enhance the material prosperity of the largest group of artisans in the country.

STATEMENT I.

	Average of 1896-97—1901-02.	Average of 1908-09—1913-14.
	lbs.	lbs.
1. Yarn imported { by sea	44,955,812	41,748,910
1. Yarn imported { by land	1,008	79,744
2. Yarn made in Indian mills	473,000,044	648,559,400
Total	517,956,864	690,388,054
3. Yarn* exported { by sea	209,397,927	200,831,400
3. Yarn* exported { by land	7,610,064	14,631,904
Total exports	217,007,991	215,463,304
4. Nett (quantity available in India)	300,948,873	474,924,750
5. Cloth made in Indian mills†	98,728,909	248,917,909
6. Equal to yarn‡	88,150,812	222,248,133
7. Yarn (mill-made) available for hand-loom weavers (Col. 4 *minus* Col. 6)	212,798,061	252,676,617

* Including Re-export.

† All woven goods.

‡ Calculated at the rate of 100 lbs. yarn = 112 lbs. cloth.

STATEMENT II.

Statistics of production and distribution of—

(*a*) Cotton yarn manufactured in Indian mills.
(*b*) Cotton yarn imported.

(In crores of pounds.)

Official year.	Production of yarn in Indian mills.	Imports of yarn.	Total yarn available, columns 2 and 3.	Production of cloth in Indian mills.	Mill consumption of yarn ($\frac{18}{20}$ of column 5).	Exports of yarn including re-exports of imported yarn.	Total mill consumption and exports, columns 6 and 7.	Balance available for hand looms, column 4 *minus* column 8.
1	2	3	4	5	6	7	8	9
1895-96	43·24	4·64	47·88	...*	...	18·55	...	...
1896-97	42·32	5·02	47·34	8·29	7·40	19·74	27·14	20·20
1897-98	46·26	5·83	52·09	9·13	8·15	20·17	28·32	23·77
1898-99	51·24	4·55	55·79	10·17	9·08	22·12	31·20	24·59
1899-00	51·39	4·26	55·65	9·81	8·76	24·26	33·02	22·63
1900-01	35·30	3·48	38·78	9·87	8·81	11·93	20·74	18·04
Average .	45·30	4·63	49·93	9·45	8·44	19·64	28·08	21·85
1901-02	57·29	3·83	61·12	11·97	10·69	27·42	38·11	23·01
1902-03	57·57	3·37	60·94	12·26	10·95	25·00	35·95	24·99
1903-04	57·88	2·80	60·68	13·80	12·32	25·36	37·68	23·00
1904-05	57·84	3·06	60·90	15·87	14·17	24·92	39·09	21·81
1905-06	68·09	4·58	72·67	16·39	14·63	29·85	44·48	28·19
Average .	59·73	3·53	63·26	14·06	12·55	26·51	39·06	24·20

* Production statistics available only for February and March 1896.

STATEMENT II—*concld.*

(In crores of pounds.)

Official year.	Production of yarn in Indian mills.	Imports of yarn.	Total yarn available, columns 2 and 3	Production of cloth in Indian mills.	Mill consumption of yarn ($\frac{9}{10}$ of column 5).	Exports of yarn including re-exports of imported yarn.	Total mill consumption and exports, columns 6 and 7.	Balance available for hand looms, column 4 *minus* column 8.
1	2	3	4	5	6	7	8	9
1906-07	65·37	3·77	69·14	16·58	14·80	24·43	39·23	29·91
1907-08	63·83	3·73	67·56	18·91	16·88	21·67	38·55	29·01
1908-09	65·76	4·15	69·91	19·24	17·18	23·61	40·79	29·12
1909-10	62·76	4·03	66·79	22·88	20·43	22·84	43·27	23·52
1910-11	60·69	3·25	64·24	24·58	21·95	18·44	40·39	23·85
Average	63·74	3·79	67·53	20·44	18·25	22·20	40·45	27·08
1911-12	62·50	4·20	66·70	26·66	23·80	15·23	39·03	27·67
1912-13	68·85	5·00	73·85	28·55	25·49	20·47	45·96	27·89
1913-14	68·28	4·12	72·70	27·44	24·50	19·89	44·39	28·31
1914-15	65·19	4·29	69·48	27·70	24·73	13·43	38·16	31·32
1915-16	72·24	4·04	76·28	35·22	31·45	16·10	47·55	28·73
Average	67·41	4·39	71·80	29·11	25·99	17·02	43·01	28·79

STATEMENT III.

Extract from a letter dated 18th April 1917 from Sir B. D. Mehta of the Empress Mills, Nagpur.

I enclose a memorandum from which you will see the Mill-Owners' Association would appear to assume the weight of yarn to be increased by 12 per cent. in weaving. The increase, as you know, is due to the extra weight added in the sizing and finishing processes. The percentage assumed by the Mill-Owners' Association must be an empirical one, as the exact additional weight depends on the quality of every description of cloth. However, coming, as it does, from such an authority, it may be taken as a roughly correct approximation. I also send another statement prepared from the statistics appearing in the Mill-Owners' Association Report, which I send you for what it is worth in connection with the investigation you are after. It seems the consumption of hand looms has, at all events, not decreased during the last twenty years; rather it is very slightly the other way. Of course the consumption by power looms has expanded by leaps and bounds, but this has been made up by the increased production of yarns *plus* diminution of exports to China.

It is very likely hand-spun yarns were used in fair quantities on hand looms 20 or 25 years ago. The hand-spinning industry is now practically extinct.

MEMORANDUM.

The Annual Reports of the Bombay Mill-Owners' Association give statistics of the production and distribution of cotton yarns manufactured in Indian mills. The following is an extract from the Report for 1916 :—

> "The quantity of yarn produced in India during the official year 1915-16 amounted to 722,424,579 lbs. Of this amount, 314,512,996 lbs. were consumed in the production of 352,254,556 lbs. of cloth and 160,231,736 lbs. exported to foreign countries during the official year 1915-16, leaving a balance of 247,679,847 lbs."

The Association assumes in the above that every 100 lbs. of yarn used in weaving give out a cloth production of 112 lbs. Accepting this authority, the factor for turning cloth into yarn is $\frac{100}{112}$ or $\frac{25}{28}$, *i.e.*, multiply the weight of cloth in pounds by 25 and divide by 28, and you get the weight of the yarn which goes to the making of that cloth.

The balance of yarn left after deducting the quantities exported and consumed by mills is not all consumed by hand weavers. A small proportion of this must be used for making rope, twine, etc. In a paper, which he read before the First Indian Industrial Conference of 1905, Sir Vithaldas Thackersay estimates this proportion to be about 10 per cent. of the balance. The remainder of course must ultimately find its way to hand looms.

STATEMENT IV.

Imports.

Total Cotton Twist and yarn—

	Quantity.	Value.
	lbs.	Rs.
1890-91	50,970,950	3,76,83,624
1891-92	50,404,318	3,51,46,195
1892-93	38,276,545	2,68,38,496
1893-94	42,806,991	3,10,89,407
1894-95	41,482,847	2,85,12,542
1895-96	46,354,766	2,97,10,904
1896-97	50,173,890	3,32,58,708
1897-98	58,290,717	3,49,30,384
1898-99	45,545,668	2,55,16,342
1899-00	42,621,854	2,45,00,108
1900-01	34,803,334	2,48,92,147
1901-02	38,299,409	2,64,70,267
1902-03	33,681,300	2,29,75,871
1903-04	28,016,565	2,14,20,756
1904-05	30,575,855	2,48,76,477
1905-06	45,776,742	3,42,53,987
1906-07	37,673,288	3,22,31,592
1907-08	37,315,737	3,69,32,448
1908-09	41,524,055	3,64,88,312
1909-10	40,300,460	3,31,95,673
1910-11	32,508,657	3,13,72,555
1911-12	41,958 910	3,79,07,055
1912-13	50,035,210	4,44,74,655
1913-14	44,171,167	4,16,42,445

STATEMENT V.

—	Grey.			Coloured.		
	1899-00 to 1903-04.	1904-05 to 1908-09.	1909-10 to 1913-14.	1899-00 to 1903-04.	1904-05 to 1908-09.	1909-10 to 1913-14.
Average of Imports of 1-10's. . .	137,858	163,673	114,649			
„ „ 11-15's. . .	115,837	64,062	93,618	1,885,145	1,153,983	794,235
„ „ 16-20's. . .	298,695	460,958	372,741			
„ „ 21-25's. . .	29,653	52,324	152,307	1,658,985	1,107,739	847,309
„ „ 26-30's. . .	2,765,031	2,587,154	2,541,808	997,298	1,035,055	829,399
„ „ 31-40's . .	8,215,144	9,070,880	9,211,832	12,736,034	13,092,257	13,997,879
„ „ 41-50's. . .	1,108,668	1,800,201	2,129,033	763,307	902,245	589,161
„ „ above 50's. . .	1,871,725	2,938,292	3,664,064	673,899	1,034,231	919,912

N.B.—The figures are in pounds

STATEMENT VI.

Exports of Indian Merchandise.

Handkerchiefs and shawls in the piece—

	Numbers.	
1890-91	1,868,988	
1891-92	1,938,177	
1892-93	1,031,439	
1893-94	997,202	
1894-95	1,232,989	
1895-96	1,464,214	
1896-97	2,058,431	1,633,923 Average.
1897-98	1,760,112	
1898-99	1,653,867	
1899-00	1,275,384	
1900-01	1,424,161	
1901-02	1,741,727	1,591,311 Average.
1902-03	1,744,678	
1903-04	1,770,605	
1904-05	2,613,138	
1905-06	1,892,602	
1906-07	1,179,586	1,985,014 Average.
1907-08	2,115,582	
1908-09	2,124,161	
1909-10	1,886,370	
1910-11	2,124,495	
1911-12	2,868,852	2,044,759 Average.
1912-13	1,949,550	
1913-14	1,394,532	

APPENDIX J.

MEMORANDUM ON THE DEPARTMENT OF INDUSTRIES IN THE MADRAS PRESIDENCY.

Early History

In December 1897 the Superintendent of the School of Arts in Madras fell ill, and Mr. A. Chatterton, who was then Professor of Engineering at the Engineering College, was placed in charge of the school. Mr. Chatterton, who had already devoted much time to the question, obtained a small grant from Government in the beginning of 1898 for experiments in the manufacture of aluminium vessels in the School of Arts, and, by August 1899, so much progress had been made in the introduction and development of the industry that the Government applied to the Secretary of State for permission to employ Mr. Chatterton for a term of three years in furthering the progress of technical and industrial education in the Madras Presidency. It was further proposed that he should devote himself to the restoration, organisation and development of those technical trades and industries, especially metal work and connected arts, which appeared most likely to prove successful, and that he should pay special attention to the following matters:—

(1) The development of the aluminium industry;
(2) the inspection and reorganisation of existing industrial schools and the establishment of new ones;
(3) the development of indigenous industries; and
(4) the establishment of a manual training class in the College of Engineering workshops or elsewhere.

The Government of India recommended these proposals for sanction, subject to the remark that too much had been done in the way of the commercial development of the aluminium industry; but the Secretary of State sanctioned the proposals, merely remarking that he noted that the aluminium industry would be left to private enterprise as soon as the success of the industry was assured, and that trade would benefit by the methods which had been adopted under Government supervision. The date of this despatch was 15th February 1900, and it may be noted that when it was written, the aluminium department of the School of Arts was already working on a considerable commercial scale, its sale receipts in the year 1898-99 having amounted to Rs. 44,621, while in the year 1899-1900 they rose to Rs. 91,432. It is evident, therefore, that in 1900 the Secretary of State had no objection to the working of pioneer industries by Government on a commercial scale, provided that, as soon as their success was assured, they were handed over to private enterprise.

2. The aluminium industry, together with his work as Superintendent of the School of Arts, occupied the greater part of Mr. Chatterton's time during the term of his special duty, but the period was also marked by the inception of experiments with hand-loom weaving, with oil engines and centrifugal pumps for lift irrigation and with chrome tanning. Consequently, when Mr. Chatterton went on leave in 1904, he was deputed to make enquiries into the American system of well irrigation, the possibility of introducing an improved pump for irrigation purposes, the possibility of introducing warping and sizing machinery suitable for the weaving industry of the Presidency, and the methods of chrome tanning as practised in America. On return from leave, he was again placed on special duty for the purpose of exploiting and developing

technical trades and industries in the Presidency. He was entrusted with the direction of industrial education and technical education, in so far as it was connected with the exploitation of industries, and with the superintendence of experiments in irrigation and pumping. His special instructions were first to devote particular attention to the development of irrigation by pumping and to the encouragement of the chrome-tanning and weaving industries. As Inspector of Technical Schools and of the School of Arts, he was placed under the Director of Public Instruction, and in regard to his other work he was subject to the control of the Board of Revenue.

Department of Industrial and Technical Enquiries.

3. These orders were passed in March 1905, but at the same time Government had a more important scheme under contemplation. Hitherto, Mr. Chatterton had been on special duty, and the temporary nature of his appointment prejudiced the development of his work on a stable and orderly basis. Consequently, later on in 1905, a step in advance was taken, and a scheme was submitted to the Government of India for the further advancement of the industrial development of the Presidency. To that end it was proposed to create a department which should make a survey of existing industries and should investigate the possibility of creating new ones. It was not proposed to work industries experimentally on a commercial scale, but merely to initiate experiments which might assist private enterprise to take up fresh industrial undertakings. It was also proposed to establish a bureau where the best available advice on industrial methods might be obtained. By this time Lord Morley had become Secretary of State for India, and, in view of subsequent developments, it is not surprising that he did not view the general principles underlying the scheme with much favour. He regarded with scepticism the prospect of attaining satisfactory results from the direction of State effort towards the creation of industries, and he doubted whether the lack of industrial energy and progress in the Madras Presidency might not be due to economic causes beyond the reach of State endeavour. However, by way of experiment, he sanctioned the creation of the new department and the appointment of Mr. Chatterton to the charge of it, with the title of Director of Industrial and Technical Enquiries. Thus the Department of Industries came into existence in August 1906, though not under that name, and in the following year, it was strengthened by the appointment of an Assistant Director, in the person of a junior Engineer of the Public Works Department. The work consisted largely of chrome tanning and investigations into the hand-loom weaving industry, but experiments in other directions were also carried on. Boring operations were begun, and it was shown that in certain districts of the Presidency considerable supplies, often artesian or semi-artesian in character, of subterranean water existed. And, by encouraging the installation of pumps driven by internal combustion engines, it was proved that these and other supplies of water could profitably be used for irrigation.

Industrial Conference.

4. In September 1908 an Industrial Conference was held at Ootacamund, the representatives of the leading industrial interests being invited to attend. The object of the Conference was to consider the best method of developing further the work which had been begun by the Director of Industrial and Technical Enquiries, and also to review the question of the improvement and extension of technical education. Sixty-eight resolutions were passed by the Conference under the heads (1) Industrial development, (2) Technical education, (3) Textiles and dyeing, (4) Sugar, chemicals and leather, and (5) other industries. The Conference defined the three functions of the Department of Industries as (1) the supply of advice in regard to new industries, and the introduction of new methods and processes, (2) the carrying out of investigations and

experiments, and (3) the development of selected industries, and added that the department should open a bureau of information and an industrial museum. And in regard to the vexed question of pioneer industries, the Conference passed the following resolution :—

> "The Government may undertake, as a pioneer, the introduction of new industries or industrial processes for the purpose of training students or apprentices or for demonstrating that such industries will be commercially successful
>
> "Provided—
>
> "(1) that no such undertakings be engaged in without prior consultation with an Advisory Board, upon which Indian interests and the leading commercial and trading interests in the Presidency should be represented;
>
> "(2) that no such undertaking, if used for demonstrating any process as commercially successful, should be engaged in, unless, after careful enquiry, the Government arrives at the conclusion that it is one in which the private capitalist does not already exist nor is willing to venture;
>
> "(3) that it should be a principle of such undertakings that the fullest possible publicity should be given by the periodical publication of reports and by a full statement of the accounts of the undertakings; and
>
> "(4) that, looking to the principle that such undertakings, if used for demonstrating that any process is commercially successful, should be directed to the assistance of private enterprise, it should be a rule that Government should withdraw from any such undertaking as soon as it is clear that it has sufficiently demonstrated the advantage of the improved methods of working in that particular industry."

5. These resolutions, however, were not passed without protest. The operations of the chrome-tanning department, the sales in which in the year 1907-08 had amounted to Rs. 85,520, had already begun to excite alarm in business circles, and three prominent representatives of European business interests in Madras recorded a minute of dissent from the resolutions relating to industrial development, holding that Government should confine assistance to commerce to matters of research, technical education, industrial instruction, and the dissemination of industrial information. On this point the Government accepted the resolution of the Conference. They recognised as a general principle that the exploitation of industries should be regarded not as a normal, but as an exceptional, function of Government, and on the general question of the limitations that should be set to the functions of the State in attempting to promote industrial development, they accepted the conclusions arrived at by the Conference. Accordingly, in March 1909, they made the following proposals to the Secretary of State :—

(1) that a permanent Department of Industries under the control of an officer to be styled the Director of Industries should be created;

(2) that industrial education, as opposed to technical education, should be placed under this department; and

(3) that the department should further be entrusted with the duty of encouraging trade by the introduction of new industries, that it should establish and maintain a bureau of industrial information, and that it should have the charge of the well-boring and pumping operations which were then in progress.

It was further proposed that an expert assistant should be attached to the Director of Industries, who should also have the assistance, as a temporary measure, of experts in dyeing, weaving and leather work.

6. Lord Morley, however, in a despatch, dated 29th July 1910, differed fundamentally from the views expressed by the Conference and approved by Government as the functions of a Department of Industries. As before, he condemned a policy of attempting to create new industries by State interven-

Lord Morley's Despatch.

tion, and he was sceptical as to the utility of State effort in this direction, unless it was strictly limited to industrial instruction and avoided the semblance of a commercial venture. The danger of a new State industry was either that it would be a petty and ineffective plaything, or that it would prove to be a costly and hazardous speculation. The policy that he sanctioned was that State funds might be expended upon familarising the people with such improvements in the methods of production as modern science and the practice of European countries could suggest. Further than this the State should not go, and it should be left to private enterprise to demonstrate that these improvements could be adopted with commercial advantage. He negatived the proposal to establish a Department of Industries, but he sanctioned the appointment of a Superintendent of Industrial Education working under the Director of Public Instruction, and he also agreed to the recruitment of dyeing, weaving, and leather experts on the condition that they should be employed for instructional purposes only. He stated further that his objections did not extend to the establishment of a bureau of industrial information or to the dissemination from such a centre of intelligence and advice regarding new industries, processes and appliances, provided that nothing was done to interfere with private enterprise.

Abolition of Department.

7. As the result of these orders the Department of Industries, which on the recommendation of the Conference had been created in anticipation of sanction in October 1908, was abolished, and Mr. Chatterton was placed under the control of the Education Department as Superintendent of Industrial Education. In that capacity he still retained control of pumping and boring operations, but the chrome tannery was sold, the hand-loom weaving factory at Salem disbanded, and all industrial institutions were transferred to the management of the Education Department. Steps were also taken to recruit the experts whose appointments had been sanctioned by the Secretary of State. The above arrangements, however, proved unworkable, and it was soon found necessary to relieve Mr Chatterton of his duties in connection with industrial education and to place him on special duty in connection with the pumping and boring operations. In July 1912, his services were lent to the Mysore Darbar, and since that date up to the present time he has not been employed in the Madras Presidency.

Its reconstitution.

8. Lord Morley's orders, however, aroused considerable opposition in India. The Sixth Indian Industrial Congress, which was held at Allahabad in December 1910, protested against the abolition of the Department of Industries and, in the following February, a resolution was passed in the Legislative Council of Madras inviting the Secretary of State to reconsider his decision. In pursuance of this resolution, the Government again addressed the Secretary of State in May 1911. They referred to the general disappointment which Lord Morley's orders had occasioned, and laid stress on the difference between the industrial conditions of India and those prevailing in Europe, pointing out how difficult it was in a country like Southern India, "to bridge the gulf which exists between mere scholastic instruction and the practical application of industrial teaching, unless factories under State management are founded." And they asked for authority, in special cases and subject to the safeguards suggested by the Industrial Conference, to undertake the experimental introduction of new industrial processes. Apart, however, from the question of State intervention on a commercial scale in industrial enterprises, they asked for a reconsideration of the decision regarding the creation of a separate Department of Industries independent of the Director of Public Instruction. They had no objection to the retention of the inspection of technical and industrial schools under the Director of Public Instruction, provided that a separate Inspector

was appointed, but they pointed out that such matters as the conduct of a bureau of industrial information and the supply of expert advice regarding the purchase of industrial and agricultural machinery were outside the province of the Educational Department. These proposals were supported by the Government of India, and Lord Crewe's reply was not altogether unfavourable. He reaffirmed Lord Morley's decision against the extension of the activities of a Department of Industries to trading on a commercial scale, but he had no objection to the creation of a separate Department of Industries, provided that its functions were confined within the limits which will be referred to later. He asked for further information regarding the proposed appointment of an Inspector of Industrial Schools, and it was not until the end of 1913 that final orders were passed on this point, the control and supervision of industrial, as opposed to technical, schools being transferred to the Director of Industries, for whose assistance an appointment of Inspector of Industrial Schools was sanctioned. Accordingly the Department of Industries in its present form came finally into existence on the 21st March 1914. The functions of the Director were thus defined:—

(1) to collect information as to existing industries, their needs and the possibility of improving them or of introducing new industries;
(2) to carry out and direct experiments connected with local enquiries;
(3) to keep in touch with local manufacturers, to bring the results of his experiments to their notice, and to obtain their co-operation in the conduct of experiments on a commercial scale;
(4) to supervise the training of students; and
(5) to advise Government with regard to technical matters involving legislation.

Subsequent changes.

9. Since these orders were passed, the only important change in the function of the department has been the transfer in 1916 to the Agricultural Department of all pumping and boring work. But the outbreak of the war in August 1914 seriously prejudiced the work of the department in some of its branches. Experimental and teaching work by the Dyeing Expert has been stopped owing to the lack of dye-stuffs. The Leather Expert joined the Indian Army Reserve of Officers in July 1915. The officiating Director (Mr. Tressler) followed suit last August, and a Civilian has been placed on special duty to submit proposals for the reorganisation of the department.

Present staff.

10. The superior staff of the department now consists of an officer on special duty, a Dyeing Expert, and a temporary engineer who acts as Assistant Director. The Leather Expert is at present on military duty, and his place has been filled temporarily by an assistant who, as a Government of India scholar, was trained in tanning at home. There is a sanctioned post of Weaving Expert which is at present vacant. Sub-Engineers of the Public Works Department are at present in charge of the Madura Technical Institute and of the Glass Factory, and there are three sanctioned posts of supervisors. The question of organising a district staff is now before Government. An Inspector of Industrial Schools has just been appointed.

11. Brief notes are appended on some of the activities of the department since its inception.

Aluminium.

12. The first reference to aluminium in Madras that appears in the records was in 1891, when Mr. Chatterton made proposals to the Government for the utilisation of water power in the manufacture of the metal. A committee of experts was appointed by the Secretary of State to examine the proposals, and in due course a report was published, and the matter left to private enterprise. Nothing practical resulted therefrom till Mr. Chatterton went on furlough in

1896. He then consulted the officers of the British Aluminium Company, who informed him that there was no prospect of commercial success attending the manufacture of aluminium in India, unless there was a large local market for the metal. He then, with the sanction of the Director of Public Instruction, proposed to introduce the working up of aluminium into some of the industrial schools in the Presidency and, on his return from furlough at the end of 1897, he brought out a hundredweight of metal for the purpose. He was given permission to make experiments in the School of Arts and, early in 1898, he applied for funds to carry on the work. This application was refused; but a further application to carry on the work at his own expense was sanctioned. At the end of March, Government reversed their previous decision and sanctioned the expenditure of a sum of Rs. 3,800 on the purchase of metal and agreed to the experiments forming an integral part of the work of the School of Arts. No great difficulty was experienced in manipulating the metal, and, from the outset the work done was sold, though it was naturally rough and deficient in finish. Coppersmiths and bell-metal founders were employed, and, at first, indigenous methods of working were adopted. But gradually, as the workmen became more skilled, changes were made, and improved methods and modern tools were introduced, with the result that the cost of production was considerably reduced. Attention was also paid to the commercial side of the venture. From the outset there was a good demand from the military authorities and from Europeans for aluminium vessels, and by establishing agents and subsidiary workshops at various places, the Indian demand was also stimulated. The following figures give the annual receipts and charges of the aluminium department till it was sold in 1903 :—

Year.	Receipts.			Charges.		
	Rs.	A.	P.	Rs.	A.	P.
1897-98	...			3,800	0	0
1898-99	44,621	13	9	15,011	7	5
1899-1900	91,132	0	8	93,000	0	0
1900-01	1,37,452	2	9	1,91,936	14	0
1901-02	1,84,549	13	8	2,31,874	7	7
1902-03	1,69,711	15	8	2,21,001	0	8
1903-04	2,91,582	8	6	94,112	15	1

13. In 1900 the Indian Aluminium Company was formed by Mr. Eardley Norton, then practising as a barrister in Madras, with the view of following up and developing the pioneer work of the Department of Industries. For the time the company worked in conjunction with the department to open up a market in India, and in 1903 it was decided that the time had arrived when private enterprise could be left to carry on the business unaided. Accordingly in September 1903, the company took over the aluminium department of the School of Arts, purchasing all the tools, plant and stock after valuation. The results of the valuation showed that the department had made a nett profit of about Rs. 60,000 during the period it had been pioneering the industry. Of this surplus one half was surrendered to the Indian Aluminium Company as a free gift to enable it to finance the transfer. The Government of India also permitted Mr. Chatterton to act as Consulting Engineer to the company for a period of eighteen months from the date of transfer. The company is now firmly established in Madras. It has extended the use of machine processes as far as possible in its workshops, but in spite of this fact it employs on an average nearly 250 workmen. The nominal capital of the company is Rs. 10 lakhs. In the six years preceding 1914 it paid on an average a dividend of 12⅔ per cent. on a paid-up capital of Rs. 6,80,000, but since the war owing to army

contracts its dividends have been much larger. Since the prohibition of the import of aluminium into India - a war necessity—the company has taken up the manufacture of copper and brass ware. From plans prepared by Mr. Chatterton, it has furnished the equipment of the two large sandalwood-oil distilleries which have recently been started in Bangalore and Mysore. The manufacture of aluminium vessels is also carried on in seven factories in the city of Bombay and in three factories in Ratnagiri It has also become a bazaar industry in the Godavari district of this Presidency. Before the war 60 or 70 workshops were engaged in the industry in Rajahmundry alone, and 3,000 men were employed, the men skilled among them earning from Rs. 30 to Rs. 40 a month. The vessels manufactured were sent all over India as far as Benares in the north and Madura in the south. But, as the figures given below indicate, the bazaar industry has been hard-hit by the war. The export of aluminium from England has been prohibited, and it is now unprocurable except at fancy prices.

14. Aluminium is not made in India, and the existing industry, which is entirely an offspring of the company's work at the School of Arts, extends only to the manufacture of aluminium vessels. But such as it is, and though the war has materially affected it, it is an industry of some dimensions as the appended table of imports of aluminium into India shows :—

Table of imports.

Year.	Bombay.		Madras.		Cocanada.		Total.	
	CWT.	LAKHS Rs.	CWT	LAKHS. Rs.	CWT.	LAKHS. Rs	CWT.	LAKHS. Rs.
1904-05 . . .		...	890	1·05			890	1·05
1905-06 . . .	188	0·25	1,615	1·81	...	.	1,803	2·06
1906-07 . . .	429	0·71	1,535	2·18	.	...	1,964	2·89
1907-08 . . .	1,126	1·73	1,570	1·89	...	..	2,696	3·62
1908-09 . . .	1,158	1·01	2,275	1·91	301	0·27	3,734	3·21
1909-10 . . .	5,373	4·04	4,477	3·46	1,898	1·52	11,740	9·02
1910-11 . . .	7,875	6·38	2,336	1·78	1,573	1·08	11,784	9·24
1911-12 . .	12,258	8·91	6,267	4·39	3,086	1·90	21,611	15·20
1912-13 . . .	26 118	19·16	4,089	2·82	4,847	3·90	35 054	25·18
1913-14 . . .	17,714	14·90	5,056	3·81	3,362	2·48	26,132	21·19
1914-15 . . .	7,673	6·46	3,681	3·10	3.212	2·32	14,596	11·88
1915-16 . . .	10,407	9·75	3,141	2·90	1,301	0·95	14,849	13·60

15. The question of the intervention by Government in the Madras tanning industry was first taken up in January 1903, when the Chamber of Commerce was consulted as to the causes which had led to the temporary decline of the industry in Madras, and as to whether Government could do anything to assist the industry. The Chamber's reply was in the negative. It ascribed the falling off in the industry to a natural reaction following the over-production of the previous years, and thought that the industry would revive in the natural course without interference by Government. Chrome tanning was not feasible in Madras owing to climatic difficulties, the process having already been tried by an experienced tanner brought out from **Chrome tanning.**

home and found impracticable. The whole question was reviewed by Mr. Chatterton in a report, which was later expanded into a monograph on the Madras Leather Trade, and in March 1903 Government decided that no reason existed for State intervention. Later on, however, in the same year this decision was reconsidered with reference to the economic waste involved in the use of country leather for *kavalais* or the buckets used by the ryots for well irrigation. Large numbers of these buckets were required annually by the ryots, for owing to inferior methods of tanning the leather perished after a comparatively short period of use, and Mr. Chatterton suggested that experiments should be made with the object of introducing and popularising the more enduring chrome leather. In September 1903, therefore, Government sanctioned the expenditure of a sum of Rs. 2,000 on experiments in the School of Arts to determine whether chrome tanning could be successfully carried on in the Presidency, the object in view being not to manufacture a leather which would compete with the products of Europe and America, but merely to turn out something superior to the locally made article. The field of chrome tanning was at that time clear. It is true that in 1910, when the operations of the department had led to the whole question of State interference with private enterprise arising in an acute form, the Chamber of Commerce explained that its letter of 1903 had been written solely with reference to chrome tanning by the two-bath process, and stated that the one-bath process had been found practicable before the department had undertaken its further development. Nevertheless, it does not appear that at the time when the department began work, any one else was engaged in chrome tanning, though Mr. Chambers, of Messrs. Chambers & Co., began work on an experimental scale some months later, instigated by Mr. Brand, the Assistant in the School of Arts in immediate charge of the experimental work.

16. The experiments at first were conducted on a small scale, the establishment consisting merely of a tanning *maistry*, a flesher and three coolies, but, even in the first year, the sales amounted to Rs. 4,779, and enquiries from all parts of India indicated that the venture had aroused considerable interest. The demand for water buckets, however, was not great at first, and it was soon found necessary to embark on the manufacture of boots, shoes and sandals, partly in order to popularise the use of chrome leather and partly in consequence of the difficulty of disposing of the leather cuttings not utilisable in the making of water buckets. Chrome-leather water buckets gradually became more popular, and, in the year 1908-09 Rs. 9,000 worth of leather was sold for this one purpose in two districts of the Presidency, but the main business of the department always consisted in supplying the demand for foot-wear, especially sandals. A boot shop was opened in the Mount Road by private enterprise, and large orders for sandals were obtained from some Government departments. In 1907-08 alone, nearly 20,000 pairs of sandals were sold. The scale of these operations necessitated the removal of the department from the School of Arts, and, in March 1908, the department moved over to a tannery of its own at Sembiam near Madras. Another consequence was that the commercial side of the venture now began to attract attention. At the end of 1908, Messrs. Chambers & Co. entered a protest against the department's interference with private trade, and, in the following year, further protests were made by the Upper India Chamber of Commerce and by the Madras Chamber. In reply to these protests Government expressed their willingness to withdraw from the venture, and, in July 1910, they accepted an offer from the Rewah Darbar to purchase the plant of the tannery for the sum Rs. 50,000, the whole stock also being taken over at a valuation. The transfer was finally effected in the beginning of 1911.

17. The appended statement shows the receipts and charges of the department from the inception of the operation till the tannery was finally closed down :—

Total cost of the chrome-tanning department from the beginning to the end.

Expenditure.	Details.	Total.	Receipts.	Details	Total	Net cost
	Rs. A. P.	Rs. A P.		Rs A. P	Rs A P.	Rs. A. P.
Capital outlay.			*Receipts.*			
Land and buildings .	13,100 0 0					
Machinery . .	35,518 0 0		Sale of the tannery with machinery.	50,000 0 0	50,000 0 0	
Improvements to buildings.	20 978 0 0	69,596 0 0				
			Sales—			
Charges.			1903-04 .	41 0 0		
			1904 05 .	1,470 0 0		
			1905 06 .	25,629 8 9		
1903-04 . . .	2,200 0 0		1906-07 . .	51,467 2 1		
1904-05 . . .	5,495 0 0		1907 08 . .	85,357 5 9		
1905-06 . . .	49,435 6 4		1908 09 .	1,07 798 0 0		
1906-07 . . .	72,922 3 0		1909-10 .	84,971 4 1		
1907-08 . . .	88.727 12 7		1910-11 . .	92,585 6 2	4 51,317 9 7	
1908-09 . . .	1,35,867 10 0					
1909-10 . . .	99,704 13 9					
1910-11 . . .	33,626 15 11	4,86,975 13 7				
		5,56,571 13 7			5,01,317 9 7	55,254 4 0

Note.—Figures are taken from the draft final report after the closing of the chrome tanning business

It will be seen that the nett cost to Government was Rs. 55,000 odd spread over a period of seven years. The chrome-leather industry is now firmly established in India, at any rate as regards certain classes of leather, and there is no doubt but that the Government of Madras helped materially to contribute towards this result. Messrs. Chambers & Co.'s tannery at Pallavaram now employs about 1,100 men, partly on bark and partly on chrome tanning.

18. The superintendent of the Mysore Tannery, Limited, and managing agent of the Berhampur Leather Manufacturing Company, Limited, (which two tanneries turn out, it is reported, Rs. 1.50,000 worth of chrome upper leather every month) was trained by Mr. Chatterton, and in addition there are the following tanneries in India engaged to a greater or less extent in the manufacture of chrome leather :—

The National Tannery, Calcutta.
The Utkal Tannery, Cuttack.
The Thazgunj Tannery, Agra.
The Allahabad Tannery, Allahabad.
The Rewah State Tannery, Umaria.
The Calcutta Tannery Syndicate, Calcutta.

At least two of these tanneries were started by students originally trained by Mr. Chatterton.

19. Experiments in improved methods of weaving were commenced in the beginning of 1901-02, and a few fly-shuttle looms were set up in the School of Arts with the object of obtaining experience as to their working capacity and data regarding their possibilities. At the same time certain improved methods of sizing, chiefly hank sizing, were tried. About the beginning of next year, the looms were removed to the Anjuman Buildings and the experiments continued there. Hank sizing was soon given up, as the results of the experiments were found unsatisfactory. The looms were of the type of those already in use in the Basel Mission weaving establishments in the Madras Presidency on the west coast, but, so far as **Weaving.**

was known, no attempt had ever been made to turn out purely indigenous cloths on fly-shuttle looms, and it was to achieve this object that investigations were begun. At first the manufacture of Madras handkerchiefs was taken up, and, though it was not much of a success at the beginning, gradual improvements were effected. Experiments with the Madras handkerchiefs and subsequently with other classes of indigenous goods, such as *saris* and *dhotis*, yielded results which left no doubt as to the practicability of turning out a much larger percentage of cloth on a fly-shuttle loom than on the ordinary country loom. In 1905 it was decided to continue the experimental work in a properly organised hand-loom weaving factory. Accordingly, in February 1906, a weaving factory was opened at Salem, where there was a large weaver population, the objects in view being, in the words of Mr. Chatterton, to ascertain by experiment whether it was possible to improve the conditions of the hand weavers in Southern India:—

(1) by substituting for the country hand-loom an improved hand-loom which would enable the weaver to produce a greater length of cloth in a given time, without in any way sacrificing the essential characteristics of the country hand-woven goods;

(2) by introducing the factory system among weavers, so that they might work under the management of men with commercial and manufacturing experience and so that capital and organisation might be introduced into the industry; and

(3) by introducing, if possible, improved preparatory processes to diminish the cost of the preliminary warping and sizing.

20. Much difficulty was experienced in getting together a sufficient number of capable hand weavers adequately to test the possibilities of a hand-loom factory. Good wages and regular continuous employment were offered, but the weavers much preferred working in their own houses assisted by their women and children, and evinced great dislike to the discipline and regular hours incidental to factory life. Few of them moreover were free agents. Most of them were in the hands of the cloth merchants, who viewed the factory with suspicion and directed their influence against it. By dint of patience, however, improvement was effected, and though, even in the last year of the factory's existence, complaints were made that practical weavers of the right class would not work in the factory, the financial results of each year showed a progressive improvement and indicated that, if properly managed, a hand-loom factory might be a success. Thus the factory aroused considerable interest, and was the direct cause of numerous small private factories being started. Subsequent investigations showed that most of these factories failed sooner or later, the causes of the failure being, it was reported, (1) lack of technical knowledge on the part of the management, (2) inability of the directors to work harmoniously together, and (3) the dislike of the weavers themselves of discipline and control; but, as will be shown later, they helped to popularise the fly-shuttle loom.

21. Not much progress was made in the improvement of the preparatory processes in order to diminish the cost of the preliminary warping and sizing. A complete plant of warping and sizing machinery was obtained from England in 1907, but only negative results were obtained, and little further work on the problem was attempted at Salem. One of the facts, however, brought out by the weaving competition held at Madras in 1908 was that the sizing methods of the Presidency were much in advance of those in use in other parts of India.

22. Undoubtedly the most useful work done at the factory was in connection with the first of the problems which Mr. Chatterton set out to solve. From the time when weaving had first been started by Government, experiments had

been made with the fly-shuttle loom and various small improvements had been effected, and the type of loom ultimately adopted at the Salem Factory was practically the old English fly-shuttle loom, modified as far as possible in the direction of simplicity and so as to suit it for the manufacture of indigenous cloths. But numerous other types of improved looms were kept under observation and trial, and, in 1908, a weaving competition was arranged at Madras with the object of procuring definite data regarding the merits of the various types of loom which were then being offered to the Indian weaver. The result of the competition was to confirm the conclusions of the Salem Factory, the looms which did the best all round work being those manufactured at Madras on the lines of the old English hand-loom. The advantages of this type of loom over the country loom have been described as follows :—

(1) The fly-shuttle slay is cheaper than the ordinary slay;

(2) the fly-shuttle gives a greater outturn; the increase varies not only with the experience and skill of the weaver, but also with the different counts of yarn used, the outturn relative to that of the country loom being nearly double in the case of coarse counts, more than 50 per cent. greater with medium counts and rather less than 25 per cent. greater with finer counts ranging from 80's to 150's.

Efforts accordingly were made to spread the use of the fly-shuttle loom, but the results were not at first apparent, and pessimistic remarks about the prospects of success appear more than once in the earlier reports. As a matter of fact, the use of the fly-shuttle spread with considerable rapidity, partly owing to demonstration work done by the private factories alluded to above, and a census of fly-shuttle looms in ordinary use, taken in 1911, revealed the existence in the 89 towns and villages visited of not less than 6,528 looms fitted with fly-shuttle slays. Practically all these villages were in the coast districts north of Madras, and it was estimated that in these districts roughly 40 per cent. of the weavers had adopted the new method of plying the shuttle.

23. The factory was worked on a commercial scale, so far as an experimental factory could be run on commercial lines. Besides cotton goods, silk cloths and worsted shawls were manufactured, and the sale receipts in some years amounted to nearly Rs. 12,000. But this fact proved the factory's undoing. The Chamber of Commerce entered a protest; Lord Morley's ultimatum followed shortly afterwards; and the factory was closed in September 1910.

24. In the meantime, on the recommendation of the Industrial Conference, it had been decided to appoint a weaving expert and to open a weaving institute at Madura. A Government of India scholar was appointed to the expert's post, but he was not much of a success, and his services were dispensed with after a few months' trial. The project of a weaving institute at Madura also took a long time to mature, and after the closure of the Salem Factory, some rather desultory work followed, mainly in the demonstration of jacquard looms. At the end of 1911, however, as already noted, a census of fly-shuttle looms was made. It was found that the loom had already become very popular and that the use of it was steadily increasing, and the enquiry also indicated that further demonstration work was necessary in the direction of introducing (1) some sort of warping mill in places where the fly-shuttle had been adopted, (2) dobbies for weaving simple designs, (3) the jacquard machine for complicated patterns, and (4) the frame loom, wherever it might be profitable. Previous experience pointed to the conclusion that the best way to convince the weavers of the efficiency of any new appliance was by demonstrating it at their very doors,

and though it was recognised that the introduction of improved appliances would not by itself solve all the problems connected with the improvement of the material condition of the weavers, it was decided to organise a peripatetic weaving party for the purpose of demonstrating to the weavers the advantages of improved methods of work and appliances.

25. The first party accordingly was organised in March 1913 for work in the southern districts of the Presidency. The party consisted of a superintendent and five weavers, and was equipped with the following plant; warping mill, beaming frame, frame loom with automatic take-up motion, spare slays, dobbies, jacquard machine, and card-cutting machines. A small stock of machinery for sale was added. A second party for the Northern Circars was organised in 1914. In the southern districts the chief work done has been in pushing the introduction of fly-shuttle slays and dobbies, but in the northern districts, where weaving is more advanced, warping mills and dobbies have been popularised to some extent.

26. The cost of the weaving operations of the department in each year since the operations were begun is exhibited in the following table:—

Weaving experiments.

Year.	Receipts.	Expenditure.
	Rs.	Rs.
1901-02	177	2,281
1902-03	4,174	12,779
1903-04	3,592	10,210
1904-05	3,427	7,037
1905-06	2,512	10,935
1906-07	6,623	17,535
1907-08	10,537	15,023
1908-09	11,775	15,768
1909-10	8,601	14,341
1910-11	9,147	11,390
1911-12	1,430	5,476
1912-13	1,054	4,229
1913-14	3,156	9,521
1914-15	2,347	8,921
1915-16	1,417	9,501
Total	69,969	1,54,947

27. The nett expenditure was thus Rs. 84,978 spread over fifteen years. In return for this expenditure the department can claim to have attained a considerable measure of success in the introduction of the fly-shuttle loom and other improved appliances. Ten years after the first experiments were begun, as the result of the census taken, 6,500 looms out of 15,500 counted were found to be fitted with fly-shuttle slays, and it was estimated that in the coast districts north of Madras 40 per cent. of the weavers had adopted the fly-shuttle. In 1915, the proportion in the Kistna district had risen to two-thirds, and, at a conservative estimate, the number of fly-shuttle looms in use in the Presidency may be put at something like 15,000. Mr. Chatterton has estimated that the adoption of the fly-shuttle increases the wages of a weaver by Rs. 2-8-0 per mensem, and, on the basis of this figure, the monthly increase in wages resulting from the adoption of the fly-shuttle may be put at Rs. 37,500 per mensem, or Rs. 4½ lakhs per annum.

Pumping and boring.

28. The records of the pumping and boring branch of the department are very voluminous, and it is not possible here to give more than a very brief sketch of the development of the operations. In September 1903, the aluminium

industry was made over to the Indian Aluminium Company, and, as part of his programme of work in connection with the development of Indian industries, Mr. Chatterton proposed that a number of pumping installations should be set up with the object of demonstrating the advantages of modern machinery in agricultural operations. Some work had already been done in this direction, and Mr. Chatterton himself and the Public Works Department had both experimented with pumping by machinery. But these experiments had furnished evidence merely as to the value of lift irrigation on a comparatively large scale, and much scepticism still prevailed as to whether comparatively small areas of land could be profitably irrigated by small engines and pumps. One small installation had already been put up at Melrosapuram in the Chingleput district, and, in 1904, permission was obtained to open four other pumping stations, where experiments were begun with engines varying in horse power from 3½ to 6½, and with three and four-inch pumps. From the first, the progress made was encouraging, and by March 1905 so many applications for assistance had been received that Government agreed to advances being made under the Land Improvement Loans Act for the purchase of oil engines and pumps, and provided Mr. Chatterton with the nucleus of a staff to assist those wishing to put up installations with advice and supervision. A class for training oil-engine drivers was also opened at the School of Arts. It soon became evident, however, that very few of the wells in the Presidency could furnish enough water to make it worth while to put in an engine and pump, and that, in order to bring pumping installations into more extended use, it would be necessary to deepen existing wells or to sink new ones so as to tap the subterranean reservoirs, which were suspected to exist at no very great depth in certain districts of the Presidency. These results had been anticipated from the very beginning, and, in 1904, a set of boring tools was purchased, with which experimental borings were put down in various places. This led to the discovery of sub-artesian water both in the Chingleput and South Arcot districts, and it became evident that it was desirable greatly to extend the scale of operations. Accordingly, in 1906, the boring branch of the department was inaugurated by the deputation of a special party to the Chingleput district, partly to develope well irrigation by the expeditious disposal of applications for loans, and partly to prevent waste of money by preliminary borings before wells were sunk. Later on, the operations of the party were extended to the improvement of existing wells, and from this time forward progress was rapid, until the outbreak of the war operated as a check. By March 1916, operations were in progress over nearly the whole of the Presidency, and 3,333 borings had been put down. Rather more than half of these borings were made for the purpose of improving existing supplies, the remainder being fresh explorations. The percentage of success is reported to have exceeded 60, sub-soil water being met with at depths ranging from 35 to 200 feet. In the same period, 818 local investigations were made in connection with projected pumping installations, more than 400 installations were set up, and a sum of Rs. 2,99,800 was advanced under the Land Improvement Loans Act to 117 persons for the purchase of oil engines and pumps. Many other installations were put up independently of the department, the machines being mostly obtained from engineering firms on the hire-purchase system, and an admittedly incomplete census taken in 1915 disclosed the existence of nearly 900 installations irrigating an estimated area of nearly 50,000 acres. In addition, a number of oil engines were installed under the advice and with the aid of the department, in rice mills and other industrial concerns.

29. The rapid increase, however, in the popularity of oil engines and pumps entailed correspondingly heavy work in the department. In the cir-

cumstances of South India, it was necessary to provide for the supervision and periodical inspection of the pumps. A system of compounding fees was accordingly instituted, and, by 1915, 236 plants were on the inspection list. For inspection and boring purposes the pumping and boring staff was augmented from time to time, till, in 1915, it consisted of 12 supervisors, 21 mechanics and 38 boring *maistries*. Much of the Director's time was taken up in the supervision of his supervising staff and in what was practically consulting engineering work. Most of this work, moreover, was work which really appertained to the Agricultural Department, and eventually that department was strengthened by the appointment of an Agricultural Engineer who has relieved the Director of Industries of all work connected with pumping and boring.

The following statement exhibits the cost of the pumping and boring department from 1904-05 to 1915-16:—

Pumping and Boring Operations.

Year.	Receipts. Rs.	Expenditure. Rs.
1905-06	.....	*65,033
1906-07	.....	14,105
1907-08	53	21,444
1908-09	2,692	39,177
1909-10	4,370	46,908
1910-11	5,987	66,299
1911-12	14,461	63,060
1912-13	26,407	98,757
1913-14	31,237	1,54,076
1914-15	38,654	1,58,017
1915-16	40,429	1,17,920
Total	1,64,290	8,44,796

Industrial installations.

30. The oil engines first used by the department were worked with kerosene oil; but at the request of the Shell Transport and Trading Company, which then supplied Madras with kerosene oil, experiments were taken up with a view to utilising the very large stock of liquid fuel which had been brought out to Madras, in the hope that it would be found suitable for generating steam in the mills and factories. The scheme proved a failure and the company were left with a large tank containing about 4,000 tons of liquid fuel on their hands. It was found that the Hornsby-Ackroyd oil engine was equally well adapted for use with either liquid fuel or kerosene oil and, on this fact being made known by Mr. Chatterton in a letter to the "Madras Mail," the numerous users of Hornsby-Ackroyd oil engines in the Madras Presidency naturally at once displaced kerosene oil, which cost from 7 annas to 8 annas a gallon, by liquid fuel, which could then be obtained at 2 annas a gallon in Madras. The great reduction in the cost of generating power, consequent upon this discovery, gave a considerable impetus to the development of small power installations. These were principally applied to the preparation of agricultural produce for the market and, in the course of a few years, numerous paddy hullers, oil mills and a few saw mills and sugarcane-crushing mills were installed.

31. In 1911, Mr. Chatterton urged on the Government the necessity for experimental work in connection with the manufacture of jaggery and, a sum

* Includes Rs. 15,081 spent when the experiments were in charge of the Public Works Department. The figures are taken from the Annual Administration Report.

of Rs. 10,000 being placed at his disposal, a jaggery-boiling plant on improved lines was set up in the village of Singanallur near Coimbatore. Very little progress had been made when he left Madras for Mysore, and, on the establishment of a Department of Industries in that State, a number of similar plants were set up by him. Arrangements were made for the two departments to work in co-operation, with the ultimate result that very considerable improvements were effected, and a large number of installations have been set up both in Mysore and the Madras Presidency. A full account of the work done in this connection will be found in Bulletin No. 55 of the Agricultural Research Institute, Pusa, which is entitled, "The Manufacture of Jaggery in South India."

Experimental.

32. Allusion has already been made in paragraph 12 to the proposals submitted by Mr. Chatterton in 1891 for the utilisation of water power in Southern India, and, although these have not been carried out, they drew attention to the value of water power, and undoubtedly first suggested to the Mysore Government the idea of utilising the Cauvery Falls at Sivasamudram. Later on, in 1902, extensive studies were made regarding the cost of generating power in Southern India, the results of which were published in the "Indian Review" of that year. This paper was communicated to the agents of the Kolar gold mines and resulted ultimately in the central generating station, which was erected at the mines to supplement the supply of power from the hydraulic installation at Sivasamudram.

Recognising that cheap power was essential to the development of the country and that the south of India was greatly handicapped by the dearness of fuel, experiments were also started in 1902 to determine the value of wind mills as a source of power for lifting water for irrigation. Messrs. Parry & Co., the Madras agents of the Chicago Aer-Motor Company, provided a 16-foot aer-motor mounted on a 70-foot tower, and this was erected in the compound of the School of Arts, and its performances were kept under observation for more than a year. The results of the investigation were published in June 1903 in a bulletin issued by the department, entitled, "The Value of Wind Mills in India."

In 1906, a similar report was published on experiments in pumping with oil engines and centrifugal pumps. Attention was drawn to the defects of the existing pumps on the market, and, falling into the hands of an engineer in England, it resulted in this gentleman setting himself the task of producing a new pump free from these defects. This led to the invention of the Rees Roturbo pump, which is now extensively used all over the world and has been adopted as the most suitable type of pump for the majority of the installations in this Presidency.

In 1906-07, the flow of water in spring channels in the South Indian rivers was investigated, and it was found that when the hydraulic gradient was less than one in about 250, the water is unable to move through the sand. This disposed of the idea that there was a subterranean flow of water in the beds of our rivers and explained the partial failure of water-supply schemes for towns like Madura, Trichinopoly and Conjeeveram. A full account of the investigations is given in the report of the experimental pumping department for the year 1906-07.

The development of irrigation by pumping with oil engines and centrifugal pumps gave rise to a considerable number of investigations regarding the duty of water in the South of India and the results have been published from time to time in the bulletins and annual reports which have been issued.

Enquiries.

33. It would unduly extend the scope of this memorandum to furnish any detailed account of the industrial enquiries which have been made but have

yielded no practical results. Only two matters are of sufficient importance to be referred to.

Utilisation of the Periyar water power.

34. Reference has already been made in paragraph 12 to Mr. Chatterton's original proposals. A revised scheme was submitted by him to Government in 1908, the principal feature of which was the regulation of the Periyar lake so as to provide a perennial supply of water sufficient to yield 20,000 h. p. for 12 hours every day throughout the year. It was proposed to transmit this power to Madura, and the owners of the mills there signified their willingness to use it. The scheme fell through when referred to the Government of India, owing to objections raised by the Inspector-General of Irrigation. The importance of industrial development was not then so keenly appreciated as it is now, and it is possible that in the future the Irrigation Department may be prepared to waive their objections.

Wood distillation.

35. In January 1907, Mr. Chatterton invited the attention of the Board of Revenue to the question of the manufacture of charcoal from timber grown in the neighbourhood of the Buckingham Canal. He proposed the establishment of a wood-distillation plant to manufacture charcoal, for which a market was anticipated in Madras and elsewhere as fuel for suction gas producer plants as well as for the ordinary requirements of the city. Of the by-products, the most important was acetate of lime which was needed by the Cordite Factory at Wellington for conversion into acetone. Government sanctioned the preliminary proposal to send a sample consignment of ten tons of casuarina wood to England, to ascertain what percentage of charcoal it would yield and what would be the value of the by-products. The tests were eminently satisfactory, and a very extensive correspondence developed, which was ultimately referred to the Industrial Conference which was held at Ootacamund in September 1908. Finally, the proposals were submitted to a committee, chiefly consisting of non-official gentlemen, who were asked to state whether the industry was to be left to private enterprise or to be taken up by Government. "The Committee were of opinion that Government could not undertake the establishment of a factory for wood distillation on a large scale without undue interference with private enterprise, though, upon the information at present available and in view of the uncertainty of a market for some of the most important by-products, it was highly improbable that private enterprise would embark upon an undertaking of so much importance and difficulty." The Government accepted the opinion of the committee and decided to take no further action in the matter. Had wood distillation then been started as was proposed, there is not the least doubt that it would, by now, have been an industry of great national importance in India as some of the by-products are of great military value.

Pencil factory.

36. In 1908, two pencil factories were started in the Vizagapatam district, one at Bimlipatam and the other at Anakapalle. The Bimlipatam Company imported machinery from Germany, but, after spending about Rs. 28,000, failed to make pencils and sold the plant to a group of merchants at Cocanada. The factory was then started at Cocanada under the management of an Indian who claimed to have studied the processes of pencil manufacture in Japan. But, after spending some Rs. 14,000, he failed to make saleable pencils, and operations came to a standstill. The Anakapalle Company began life with a paid-up capital of Rs. 5,000 and a loan of Rs. 6,000. But this capital was exhausted in procuring machinery from Germany, and further sums were borrowed in order to enable the company to work. No expert appears to have been employed, and all attempts to make pencils failed. The machinery was made over to the creditor in payment of the money owing to him, and

eventually passed into the possession of the superintendent of an industrial school at Waltair.

37. In 1914, the attention of the Department of Industries was drawn to the industry which was then defunct, and terms were arranged on which the department obtained the use of the machinery. An expert was obtained and some pencils were made. But it soon appeared that the expert was expert only as regards the wood part of the process, and that he was unable to assist in the production of a satisfactory lead. His services were accordingly dispensed with in March 1915, and a Supervisor of the department was sent to Bangalore to study the composition of the lead in imported pencils with the help of the chemists of the Tata Institute. The refinement of the crude graphite also gave some trouble, but eventually, with the help of Professor Erlam Smith of the Presidency College, an effective method was discovered. Many other samples of Madras graphite were also tested, but none of the deposits in the Presidency are regularly worked, and since the graphite usually occurs in pockets, it is doubtful whether it will ever pay to work them. Eventually, therefore, it was decided to make use of Ceylon graphite, which can be bought on the basis of a guaranteed carbon content. The question of wood gave far more trouble. Nearly 80 Indian woods have been tested, but so far no really satisfactory Indian wood has been discovered, and the efforts made to place on the market a cheap white wood pencil made of Indian timbers have not been successful. The experiments with Indian woods are still going on, but the experience gained points clearly to the conclusion that pencil factories in India, as in European countries, will have to rely mainly on imported cedar. Fortunately there is a source of supply comparatively close at hand in British East Africa. Besides black lead pencils of different kinds (including carpenters' pencils and diary pencils), satisfactory copying pencils have been made, though the outturn of this class of pencil is limited by the scarcity of methyl violet of the right quality. Experiments have also been made with coloured pencils. The factory is now being run on commercial lines, and it is hoped that before long it will be possible to make it over to private enterprise.

38. The original experiments in glass making in this Presidency were carried out at Ennore near Madras by the late Mr. James Short and Mr. August Scholl, of Messrs. Volkart Brothers. Satisfied with the results of their preliminary enquiries regarding the supply of the requisite raw materials and with the success obtained by the experiments, they floated a company in 1909 with a capital of Rs. 2,00,000. A German expert and four Austrian blowers were brought out. An intermittent furnace and gas producer were constructed and work was started in 1910. In March 1910, a free grant of half the wood used in the company's furnace for the first two years of its working, up to a maximum of 7,200 tons for the whole period, was granted by Government. Mouth-blown soda-water bottles were produced which stood a pressure of 260 lb. per square inch, and were used in large quantities by Messrs. Spencer & Co., and found perfectly satisfactory. **Glass manufacture.**

39. After working for some time it was found that the available local labour could not turn out mouth-blown bottles in sufficiently large quantities to make the business profitable, and it was decided to get automatic machines. In 1911, therefore, six bottle-making machines, an air compressor and mechanical gear were obtained from Messrs. Forsters of St Helens. The factory worked till November 1911 and turned out a considerable number of soda-water bottles, the maximum output in any one month being upwards of 26,000. The company, however, experienced many difficulties. The furnace had been

constructed on a faulty design. It was an intermittent one, and work had to be stopped every time the furnace was charged. The concession of Government in regard to wood fuel did not prove of much value, and ultimately coal was used at a heavy cost, and the losses in the annealing chamber were excessive. In the month referred to above, for instance, though 44,000 bottles were put into the chamber, only 26,000 sound bottles were taken out. In 1913 therefore an attempt was made to raise further capital in order to construct a new continuous furnace. But the shareholders declined to invest any further money in the enterprise, and the company went into liquidation. Nearly Rs. 3,00,000 had been dropped in the venture.

40. The property then passed into the hands of a private gentleman, and in October 1914, the factory and plant were placed at the disposal of Mr. Tressler, then Director of Industries, for experimental purposes. Efforts, however, to obtain a glass expert were not successful, and the experiments were closed down in January 1917. They led to one valuable result, namely, the appointment of a committee which surveyed the prospects of a glass-making industry in the Madras Presidency. Conditions clearly are not favourable in a locality where fuel is particularly dear, and the committee were not in favour of the experiments being continued.

Lime-sand bricks.

41. Another experiment which must be written down as a failure is that of lime-sand bricks. Proposals for the inception of these experiments were submitted in May 1914. At that time the Chetput brick fields were approaching exhaustion, and it had been decided to open a new brick field further afield. Mr. Tressler suggested that, before Government committed themselves to the expenditure involved in this scheme, the question of making lime-sand bricks should be considered. The materials, lime and sand, were available in large quantities in Madras; if properly made, these bricks had a crushing strength of between 200 to 300 tons to the square foot; and Mr. Tressler anticipated that they could be made at about the same cost as the clay brick. The experiments were accordingly sanctioned in G.O. No. 1472, Educational, dated 23rd June 1914, and an indent for machinery sufficient for an output of 8,000 bricks a day was sent home to an English firm. Part of the machinery, delivered in June 1915, was set up in accommodation kindly provided by the South Indian Industrials, but, owing to the war and the fact that one consignment was sunk by a submarine, the delivery was not completed till September 1916. Unfortunately provision had not been made for an adequate power plant. An engine of an antiquated type was lent by a local firm, and two worn-out boilers were borrowed from Government House, but with this plant it was not possible to work the grinding mill and press simultaneously. Accordingly, in September 1916, an estimate was submitted for working the plant in 1917-18 with a 50 b.h.p. electric motor. In the meantime, after all efforts to procure an engine of the horse power required had failed, a supplementary steam engine was obtained from the glass factory, and work was begun towards the end of October. A number of bricks were made. They were massive, firm, and clean in shape, and to all outward appearances were excellent bricks, but, possibly owing to the fact that sufficient pressure could not be maintained in the hardening chamber, they were not satisfactory in point of crushing strength. Not only did they vary excessively from brick to brick, but on the average they were inferior in crushing strength to the best quality Madras stock bricks. Further, though, owing to the fact that two engines and two boilers were employed for purposes of power, accurate figures of the cost of production had not been obtained, sufficient information had been gathered to make it practically certain that the bricks could not be made in Madras for the price of the best clay bricks, *viz.*, Rs. 16—18 per 1,000. An officer was then deputed to Colombo

to study the conditions in which the manufacture of lime-sand bricks was successfully carried on in Ceylon and the processes of manufacture, and his enquiries showed that, given a satisfactory power plant and provided that our processes were somewhat elaborated, we could possibly turn out a really high-class brick at a price which at a minimum, in his opinion, would not be less than Rs. 21 per 1,000. Enquiries were therefore made of the Port Trust, the Madras and Southern Mahratta Railway, the South Indian Railway, and the Madras Corporation as to whether there was likely to be any demand in Madras for a superior but more expensive brick than the best quality Madras clay brick. The answers were all in the negative. All Superintending Engineers in the Presidency were also consulted whether, owing to the absence of clay and building stone, the conditions were favourable for lime-sand bricks in any part of the Presidency but here again answers were unfavourable. Accordingly it was decided that the experiments, which had been temporarily closed down in December 1916 should be abandoned.

Technical and Industrial Education.

42. The history of the development of technical education in Madras is described in full detail in a note presented by the Hon'ble Mr. (now Sir A. G.) Cardew to the Industrial Conference of 1908. The Conference divided the subject into two parts, industrial instruction and technical education, the object of the former being "instruction in the performance of definite operations, such instruction not necessarily involving the teaching of general principles but only their application," while the object of the latter is to train a student to apply theoretical principles to practical purposes, and it then proceeded to pass a number of resolutions on the subject. Among other things it recommended that the control both of industrial instruction and technical education should rest with the Department of Industries and that a whole-time Inspector of Industrial Schools should be appointed. Government accepted this recommendation in respect of industrial instruction, but decided that technical education should remain under the Director of Public Instruction. The School of Arts and the Reformatory School at Chingleput, as well as all purely commercial schools, were also retained under the Director of Public Instruction, and eventually, in 1909, 35 industrial schools were transferred to the Department of Industries. Most of these schools were carefully inspected by the acting Director of Industries (Mr. C. W. E. Cotton), and on his report the Government proposed in 1910 the appointment of a full-time Inspector of Schools. But very shortly afterwards the Department of Industries was abolished under the orders of the Secretary of State, and the control of industrial schools was resumed by the Director of Public Instruction, Mr. Chatterton being appointed Superintendent of Industrial Education under that officer. As already noted, however, in May 1911 Mr. Chatterton was placed on special duty in connection with the pumping and boring department, and Mr. Tressler succeeded him as Superintendent of Industrial Education.

Madras Trades School.

43. In the meantime, however, Mr. Chatterton had submitted a scheme to Government for the industrial education of workmen such as smiths, moulders, pattern-makers, turners, fitters and general machine men. The main feature of the scheme was a system of State apprenticeships by which each boy would be apprenticed to a particular trade for a period of years, and it was also proposed to establish a school in an industrial centre like Perambur, where the apprentices would receive such elementary technical instruction as their educational attainments would permit them to assimilate. The scheme was referred to a committee which was composed largely of gentlemen connected with the various engineering firms and workshops in Madras, and this committee passed a number of resolutions, the most important being that a

system of State apprenticeships should be established among the engineering shops north of Madras, and that some provision should be made for technical training in a school outside the workshops. The Government accepted generally the recommendations made, and called, in August 1912, for definite proposals for the establishment of State apprenticeships and the opening of a technical school on the lines advised by the committee. Tentative proposals were submitted shortly afterwards, but the consideration of them was delayed pending the receipt of the orders of the Secretary of State on the constitution of the Department of Industries, and the question also arose whether in addition to mechanical engineering, the facilities for technical education in the proposed school should not be extended to other branches of work such as motor engineering. Another committee was appointed to consider this question in 1914 and also to work out detailed proposals both for the school and for the system of apprenticeships. This committee, which was composed largely of men of practical experience, considered that such technological education as was necessary in the Presidency might, for the present, be conveniently arranged for by means of scholarships to the Victoria Jubilee Technical Institute at Bombay, and three scholarships of the value of Rs. 30 per mensem each for four years are now awarded to natives of the Madras Presidency for the study at the above institute either of mechanical engineering, electrical engineering, textile manufactures or technical chemistry, as well as three scholarships of the same value for the study of mechanical and electrical engineering at the Madras College of Engineering. The committee also proposed that extension classes should be provided in the proposed Trades School for subjects such as fitting and turning, blacksmith's work, foundry work, carpentry and joinery, plumbing and sanitary work, brickwork and masonry, electric wiring and fitting, motor-car work and motor-car driving, weaving and dyeing, metal work and metal spinning. Government decided to begin work experimentally in a rented building, and much difficulty was experienced in obtaining a building in a suitable locality. Eventually, however, a building was secured in Georgetown and a beginning made with classes in mechanical engineering and plumbing. The school has now overflowed into another building, and classes are now held in mechanical engineering (first and second year), plumbing (first and second year), electric wiring (two classes), and machine drawing, while a class has also been opened for apprentices from the Perambur railway workshops. So far the experiment has been successful, and it is hoped to make the school permanent.

Madura Technical Institute.

44. Among the industrial schools transferred to the control of the Department of Industries in 1909 in pursuance of the recommendation of the Industrial Conference were the two technical institutes maintained by the District Boards of Madura and Tinnevelly. Subsequently, both institutes were taken over by Government, and, while the Tinnevelly institute was abolished, it was decided to rebuild and remodel the Madura one on a more ambitious scale. The institute will comprise weaving, dyeing, and mechanical departments, the central idea being that the technical and industrial education provided should be connected with the industries of the town. In the mechanical department a small workshop will be established, well equipped with different kinds of machinery, and ten apprentices will be admitted yearly for a three years' course which may be extended to five in the case of promising lads. The workshop will undertake repairs for private oil engines and pumps as well as for the pumping and boring department, and will also undertake demonstration of up-to-date agricultural and industrial machinery. The apprentices will thus be provided with practical experience, and three afternoons a week will be devoted to lectures on materials and simple forms of mechanism and to mechanical drawing. The

idea is not to turn out engineer subordinates or draftsmen, but an intelligent class of mechanics somewhat resembling the old English millwrights. Industrial classes will also be opened for carpentry and blacksmith's work. Five students a year will be admitted to each class, admission being confined to caste workmen, and the period of instruction will cover a period of five years. In the weaving department, for the present, industrial classes only will be opened. Twenty boys will be admitted each year, they will be apprenticed for five years, and will be housed in a hostel. Details of the course of instruction have not yet been worked out, but roughly three hours a day will be devoted to general education and five hours a day to practical work. The practical work will be done in a weaving factory, the object being to train workmen capable of dealing with every stage of the processes of hand weaving for every kind of cloth manufactured in Southern India. It was also proposed to tackle in earnest at the institute the question of the improvement of indigenous methods of sizing, and with this object in view to obtain "drum-winding, beam-warping and dresser-sizing" machinery from England, as well as to import an expert European sizer. But it was decided that the restrictions placed by Lord Morley upon departmental work made it impossible to test the value of this machinery on commercial lines, and this part of the scheme (which included the higher technical training of students) has been held in abeyance for the present. In the dyeing class no industrial training will be undertaken, and it has been decided that "all that is required is higher education for prospective "works owners and managers, to place them in a position to understand the nature "of the processes carried on in the works and to keep in touch with and "appreciate the value of developments in methods and dyestuffs." Instruction, for the present, will be limited to the sons of dyers and of those engaged in business connected with dyeing, and the course which, as at present arranged will last for one year, will include instruction in elementary science and chemistry of dyeing materials, technology of textile fibres and dyeing processes.

45. Various causes have conspired to delay the opening of the institute. The negotiations with the District Board of Madura as to the terms on which the old institute should be taken over were not concluded till 31st March 1910, and a new site for the institute was not finally selected till the end of 1911. The site originally selected for the quarters of the Principal and lecturers was subsequently commandeered for the headquarters of the Ramnad district, and the acquisition of the new site has only just been sanctioned. The preparation of plans and estimates was also delayed in the Public Works Department, but final estimates for the institute and hostel, amounting to Rs. 3,24,700, have now been sanctioned, and work is proceeding steadily. In the meantime the work of the old Technical School has been carried on in temporary buildings.

46. Apart from the Madura Technical Institute, there are 35 aided industrial schools under the control of the Director. They may be roughly classified as below:— **Industrial schools.**

Schools where carpentry is the principal subject taught	15
Schools where lace making and needle-work are the principal subjects taught	15
Printing schools	2
Agricultural school	1
Weaving schools	2
Total	35

These schools at present follow the curriculum prescribed for the Government technical examinations, and prepare students for the examinations in the elementry, intermediate and advanced grades. The majority of these are managed by different missions, and aided by grants awarded under the Grant-in-Aid Code. One hundred and ninety-nine scholarships are at the disposal of the Director and are awarded to deserving pupils. The whole question of the policy to be followed in regard to these schools has been reviewed by Mr. Tressler, and his ideas have been embodied in a draft Grant-in-Aid Code which is now under the consideration of Government.

47. The following statement exhibits the grants paid to the industrial schools in the last four years:—

Year.	Teaching grant.	Building grant.	Furniture and special grant.	Scholarships.
	Rs.	Rs.	Rs.	Rs.
1912-13 . .	28,780	549	15,952	6,138
1913-14 . . .	29,760	24,819	17,315	6,150
1914-15 . . .	29,610	7,140	8,033	5,243
1915-16 . . .	33,273	9,639	6,104	5,259

Leather Trades School.

48. Resolution No. 50 of the Industrial Conference ran as follows:—

"The Conference considers that the leather trade in the Madras Presidency is of "sufficient importance to justify the establishment of a Leather Trades School, which should "be associated with a small tannery in which efficient practical instruction can be given, "that provision should be made for technical education in tanning, and that in the Leather "Trades School experiments may be fitly undertaken to determine whether or not the status "of the Madras tanning trade can be improved."

Government accepted the resolution, and the Secretary of State sanctioned the school on condition that it should be a technical school pure and simple. In it workmen should be instructed in methods of chrome tanning and other processes of leather manufacture, the idea being that, if the school were properly managed, it would supply "a private capitalist with instructed workmen and with all the information he requires for a commercial venture." But no attempt was to be made to convert the school into a factory in order to demonstrate that articles can be manufactured and sold at a profit. On this understanding Lord Morley sanctioned the establishment of the school and the recruitment of a European expert in tanning for industrial purposes. Mr. Allan Guthrie of Messrs. Cooper, Allen & Co., Cawnpore, was appointed Leather Expert, and joined his appointment on 1st September 1911. In the following year, he submitted his proposals in regard to the establishment of a school. He reported that, except in the type of tools used and the methods of using them and the treatment of water, there was very little that could be taught to the expert tanners, and that it would be better to aim at the improvement of leather tanned and dressed for use in this country. He proposed, therefore, that a school should be established and worked as a small tannery, lectures being cut down to a minimum, and the greater part of the two years' course being devoted to practical work in tanning, currying and dressing, and to chemical checks in the laboratory on the practical work done. Admission should be confined as far as possible to sons of tanners and of those connected with the leather trade, and, at the outset, it was suggested that the school should be devoted mainly to the training of operatives. These proposals were approved, and a model tannery has been constructed in Washermanpet. Space has also been reserved on the same site for a Government Trades School in which

lectures will be given. Unfortunately, just as the school was opened, Mr. Guthrie went off on military service, and temporary arrangements have been made to carry on the school in the tannery under the charge of an Assistant Leather Expert. Twelve students are now attending the school, which is run partly as a model tannery and school and partly as a research institute. Experiments are being conducted with wattle as a tanning agent and with various mixtures.

49. The following statement exhibits the receipts from and expenditure on the department since Mr. Chatterton first began work on aluminium in the School of Arts:—

Year.	Receipts.	Expenditure.	Nett cost.
	Rs.	Rs.	Rs.
1897-98 . . .	...	3,800	3,800
1898-99 . . .	44,622	45,014	392
1899-1900 . . .	91,432	93,000	1,568
1900-01 . . .	1,37,452	1,94,937	57,485
1901-02 . . .	1,84,727	2,37,155	52,428
1902-03 . . .	1,73,886	2,36,780	62,894
1903-04 . . .	2,95,216	1,30,199	*—1,65,017
1904-05 . . .	7,897	26,930	19,033
1905-06 . . .	28,142	1,11,660	83,518
1906-07 . . .	58,088	1,27,934	69,846
1907-08 . . .	95,948	1,97,511	1,01,563
1908-09 . . .	1,22,265	2,35,800	1,13,535
1909-10 . . .	96,942	2,09,813	1,12,871
1910-11 . . .	1,07,526	1,33,195	25,669
1911-12 . . .	81,923	1,54,526	72,603
1912-13 . . .	35,890	2,21,002	1,85,112
1913-14 . . .	43,536	3,20,221	2,76,685
1914-15 . . .	50,142	4,20,246	3,70,104
1915-16 . . .	57,762	3,52,814	2,95,052
Total .	17,13,396	34,52,537	17,39,141

*Nett profits.

APPENDIX K.

NOTE ON THE EXPANSION OF THE ENTOMOLOGICAL AND PATHOLOGICAL ENTOMOLOGICAL WORK AT PUSA AND IN THE PROVINCES.

By Mr T. Bainbrigge Fletcher, Imperial Entomologist.

(To be read with the evidence of Mr. C. M. HUTCHINSON, B.A., M.A.E.B., Imperial Agricultural Bacteriologist, Pusa, at pages 401—416 of the Minutes of Evidence, Volume I.)

Historical.

The study of Indian entomology may be said to date from 1758, the year in which was published the tenth edition of Linnæus' "Systema Naturæ" which is accepted as the starting point of modern zoology. A few Indian insects were described in this publication, but in the three succeeding decades large collections of insects, mainly collected by the missionaries in Southern India especially at Tranquebar, were sent to Europe, so that by the close of the eighteenth century over one thousand species of Indian insects were included by Fabricius in his "Entomologia Systematica" (1792-98). From this date onwards the progress of the study of Indian insects, if not rapid, was at least continuous, as is shown by an inspection of the numerous entomological publications issued in the nineteenth century, and which contain a vast amount of scattered descriptions of, and information regarding, Indian insects, mostly based on collections made in India by enthusiastic amateurs and sent to Europe. Towards the end of the nineteenth century a considerable volume of work began to be produced in India itself, and such pieces of work as Atkinson's papers on Rhynchota and his Catalogues of Indian Carabidae and other groups of Coleoptera, published in the *Journal of the Asiatic Society of Bengal*, together with Cotes' and Swinhoe's "Catalogue of the Moths of India," may by taken as representative of this period. A special series of volumes descriptive of the fauna of India was also undertaken under the direct sanction of the Secretary of State for India and is still in progress, and includes numerous volumes on insects, of which the first issued were on moths (four volumes 1892-96).

In 1881 Blanford published, in the *Journal of the Asiatic Society of Bengal*, a numerical enumeration of the known fauna of India and estimate the insects at about 12,000. In 1909 Lefroy attempted a similar census in *Indian Insect Life* and enumerated 29,700 species, but the figures for many groups were certainly under-estimated. It is safe to say that up to the present year (1917) not less than 35,000 different described species of insects are known to occur within the limits of the Indian Empire, and every year sees several hundreds of additions to the list, whilst in addition our knowledge of previously described species is yearly augmented. The foregoing figures, of course, refer only to definitely described species, but no groups are yet known completely, and many have scarcely been collected and are practically altogether unknown. The progress made during the last two or three decades has been rapid, and a few examples may indicate this. Twenty-five years ago only four species of mosquitoes were known from India; to-day, due to the interest taken on this group on medical grounds, upwards of two hundred species are known. Cotes' and Swinhoe's "Catalogue of the Moths of India" in 1889 enumerated 225 species of Microlepidoptera; in 1917 we know well over 2,000, and hundreds

of novelties are turned up every year. It is scarcely possible even to estimate how many forms of insects actually exist in India, but a very moderate computation would place the number at not less than 70,000 as under:—

Lepidoptera	20,000
Coleoptera	25,000
Orthoptera	3,000
Neuroptera	1,000
Hymenoptera	10,000
Diptera	6,000
Rhynchota	5,000
	70,000

I quote these figures because they may possibly assist to make a non-entomologist realise, if only slightly, the magnitude of the work before us as students of entomology in India. There is, unfortunately, a common but erroneous idea, presumably due to the fact that insects are small animals, that entomology is a small subject of minor importance, and it is not at all unusual for comparatively well-informed people to assume that any entomologist must necessarily be able to name off-hand any insect and generally to know everything about every different species; whilst the fact is that as yet we cannot claim to know everything about even the commonest insects, and no one worker can pretend really to know anything more than one small section of the science as a whole. A man who has spent years on the study, for example, of Indian birds, which total not more than 2,000 species, is not usually expected to be proficient in several dozen other sciences of equal magnitude; yet this is usually taken as a matter of course in the case of a student of any branch of entomology.

We may now consider briefly the progress made in entomology by Government employés in India.

Work in India.

Indian Museum.

2. Entomology, principally the formation of a collection of insects and their systematic classification, has always formed part of the general zoological work carried on by the Indian Museum. In 1884 and 1885, Mr. Wood-Mason, at that time Superintendent of the Museum, published reports on "The Tea-Bug and Tea-Mite of Assam" and on the "*Paraponyx oryzalis*, an insect pest of the rice plant in Burma," and from time to time furnished to inquirers such information as was then available on injurious insects. In 1888, Mr. E. C. Cotes took up an investigation of the wheat weevil, and the Trustees of the Indian Museum then decided that the work of identification of the crop-pests of India should be taken up as a part of the work of the Museum staff; Mr. Cotes, then Deputy Superintendent of the Museum, carried on this work, the results being published in *Indian Museum Notes* on Economic Entomology, of which five complete volumes were published between 1888 and 1901. By the latter year the entomological work had grown to an extent which necessitated a change of policy, and in 1901 the post of Entomologist to the Government of India was instituted and filled by the appointment of Mr. L. de Niceville. Up to 1900 the work of the Museum had been confined to receiving and to reporting on specimens sent in, but Mr. de Niceville was appointed to carry his investigations into the field and to study crop-pests, not only in the Museum but in the actual areas of their occurrence. Unfortunately, in December 1901, Mr. de Niceville died of fever contracted in the Darjeeling Terai, which he had visited to study mosquito-blight of tea. An additional part (Volume VI, part 1) of *Indian Museum Notes* was issued in 1903 by Mr. E. P. Stebbing, when officiating as

Superintendent of the Indian Museum, but no further parts were issued, as the post of Entomologist to the Government of India was subsequently transferred from the Museum to the Agricultural Department. The entomological work at the Museum remained practically in abeyance until 1909, when a new post of Assistant Superintendent in Entomology was created and filled by the appointment of Mr. F. H. Gravely, who still holds it, and who has done valuable work on the systematics of certain groups of Coleoptera and Arachnida. The Museum staff for entomology, however, only comprises one Assistant Superintendent and a small staff of subordinates, and is quite insufficient in itself to deal with the study of even the systematics of Indian insects.

A few insects are exhibited in most of the Government and local museums throughout India, but few of these institutions have any member of their staffs with any entomological knowledge.

3. After the death of Mr. de Niceville in 1901 it was decided to transfer the post of Entomologist to the Government of India to the Agricultural Department, and Mr. H. Maxwell-Lefroy was appointed in 1903 and stationed at first at Surat, specially for the study of cotton pests. About two years later, on the reorganisation of the Agricultural Department, Mr. Lefroy was transferred to Pusa, and the title of the post changed to that of Imperial Entomologist to the Government of India. The expansion of the work soon led to a necessary expansion of staff, leading to the creation of two new posts, those of Second Imperial Entomologist (to deal specially with biting insects) and of Supernumerary Entomologist, which were filled by Messrs. F. M. Howlett and C. W. Mason, respectively. There has been no further increase in the superior staff at Pusa, although the work is constantly expanding, but in 1912 Mr. Howlett's title was altered to that of Imperial Pathological Entomologist, a change which indicated more precisely the line of his work (*i.e.*, the study of insects carrying disease to man and animals). Subsequently, the Medical Department appointed its own entomological staff for the study of insects carrying human diseases, leaving the study of insects carrying animal diseases to the Imperial Pathological Entomologist. **Agricultural Department.**

The provincial Agricultural Departments also have found it necessary to take up the study and control of insect pests and to have their own entomological staffs for this end. The proposals put forward in 1905 (see paragraph 11 of Mr. Sly's note of 16th January 1905) provided for a qualified entomologist in each province, but this was negatived by the Secretary of State. All the provinces, however, have one or more entomological assistants, whilst Madras has had a Government entomologist since 1912, and an entomologist has also now been sanctioned for the Punjab.

The original idea underlying the creation of provincial entomological staffs was that they were appointed to assist the Imperial Entomologist in the collection in their provinces of information respecting insects, and that their work was to be in direct touch with, and under the control of, the Imperial Entomologist. This is borne out by the following extract from the *Proceedings of the Board of Agriculture* for 1905 (page 15) :—

"The training of provincial assistants to assist the imperial experts in special branches of work such as entomology is recognised by the Board as being of great practical utility."

The fact of their isolation and in some cases the jealousy of the provincial departments, combined with the instructions contained in Government letter No. 188—12-16 of 26th January 1906 that "each imperial expert must bear in mind that he has no authority over the provincial experts, and that his functions in relation to them are purely advisory," have however, in many cases, led to unfortunate results in the quality and outturn of the work of these provincial entomological staffs. I consider that the policy of isolated

provincial Entomological Assistants has been a failure, and that the failure has been due directly to the policy of decentralisation.

The present entomological staff of the Agricultural Departments is as follows:—

At Pusa.

Entomological Section.		*Pathological Entomological Section.*	
Imperial Entomologist .	One.	Imperial Pathological Entomologist.	One.
Supernumerary Entomologist	One (vacant since 1915).	Assistants	Three.
Assistants	Four.	Fieldmen, Clerks, etc. .	
Sericulture Assistant . .	One (tempy.)		
Fieldmen, Clerks, etc.			

In the Provinces.

Madras.—One Government Entomologist, 3 Assistants, Fieldmen, etc.

Bombay.—Two Assistants.

Central Provinces.—Two Assistants.

Bihar and Orissa.—Two Assistants.

Bengal.—One Entomological Collector.

Assam.—One Assistant.

Burma.—One Assistant.

United Provinces.—One Assistant.

Punjab.—One Government Entomologist (post sanctioned; not yet filled); two Assistants.

Besides the above, Mysore has two Entomological Assistants and Baroda and Travancore one each.

At Pusa have been brought together large collections of insects of all orders from various parts of the Indian Empire (especially of crop-pests from the plains of India) and of records of occurrence, damage, etc., of crop-pests. The life-histories of many hundreds of Indian insects have also been investigated and published in over 200 coloured plates, in Lefroy's "Indian Insect Pests" and "Indian Insect Life" and Fletcher's "South Indian Insects," and in departmental memoirs and bulletins and in other publications. Special branches, such as insecticides, sericulture, apiculture and lac culture, have also been taken up and publications issued on each subject. There is also at Pusa a large (though by no means complete) library of entomological literature.

Each of the provincial Agricultural Departments has also formed collections of insects, records of occurrence of crop-pests, etc., and most have issued short bulletins or leaflets on pests of local importance. Except in Madras (where the library at Coimbatore, though small, contains a few entomological books mainly selected as supplementary to those in the Pusa library), there are at present no entomological libraries in the provinces.

Veterinary Department.

4. In spite of the importance of the study in India of the various insects (including ticks, etc.) carrying diseases of animals, there has hitherto been no special entomological staff appointed for this work except the pathological entomological section at Pusa, which for the last three or four years (since the separation of the medical side of the work) has been nominally more or less restricted to veterinary work. In 1914 the services of an Entomological Assistant were placed at the disposal of the Imperial Bacteriologist for an investigation of the insects playing a part in the transmission of *surra*, and a report of the results was sent to Muktesar, but has not yet been published. Considerable collections of cattle flies and of flies causing *myiasis* in domesti-

cated animals have been accumulated at Pusa, but have not yet been worked out. Considerable information has also been brought together on the life-histories and habits of biting insects, and there is also the nucleus of a library on this subject.

Medical Entomology.

5. The great importance of insects as carriers of disease has only been realised within comparatively recent years, but a good deal of work on this subject has been done in India by scattered workers, especially in connection with mosquitoes, ticks and blood-sucking flies, and much of this work is necessarily purely entomological, being concerned solely with the life-histories, anatomy and systematic discrimination of insects. As examples, it is only necessary to mention here the general work on mosquitoes (including numerous Indian species) by Giles and by Theobald, with the later revisions and additions by Edwards, and numerous papers on biting flies by Austen, Ricardo, etc. In India itself the study of biting insects (especially mosquitoes) has been taken up by numerous medical officers, as is witnessed by such publications as James' and Liston's Monograph on the Anopheline Mosquitoes of India, by several scientific memoirs of the Medical and Sanitary Departments, by Christopher's papers on mosquitoes, and by Patton and Cragg's "Text-book of Medical Entomology." The work, however, has suffered to some extent from want of precision owing to the want of expert entomological knowledge on the part of some of the workers—I do not mean to say that their results have been inaccurate, but that in some cases there has been apparent a want of familiarity with ordinary entomological usage regarding such matters as definitions, descriptions and nomenclature—and to a far greater extent by a want of continuity, whereby the few men capable of doing entomological work have not always been retained in posts where they could apply their talents to the best advantage.

Three or four years ago a medical entomologist (Mr. Awati) was appointed, but this post is, I believe, held under the Medical Research Fund, and is not, strictly speaking, a Government appointment.

In view of the extensive incidence of insect-borne diseases in India, it seems clearly necessary that the study of medical entomology should be placed on a proper footing, and that medical officers in India should be afforded adequate and competent assistance in the investigation of such insects. As Sir Pardey Lukis has recently written (*Indian Journal of Medical Research, IV, 386; January 1917*):—

"The flies of India, both blood-sucking and non-blood-sucking, the parasitic ticks, ... the larvae-destroying fish and other enemies of the mosquitoes ..... offer ample scope for research to the entomologist."

With the help of a strong entomological staff working in close touch and collaboration with the Medical Department, it may be said with confidence that a very great advance in the control of insect-borne diseases in India may be expected.

Forest Entomology.

6. The pages of *Indian Museum Notes* (already referred to) contain numerous references to insects attacking forest trees, but it was not until 1900 that a post of Imperial Forest Entomologist was sanctioned for the study of Indian forest insects. In 1906, after the creation of the Forest Research Institute at Dehra Dun, the title of the post was altered to that of Forest Zoologist. The appointment has been held by the following officers:—

1900-1909	Mr. E. P. Stebbing.
1910	Mr. V. S. Iyer (*pro tem.*)
1911	Mr. R. S. Hole (*pro tem.*)
1911-1913	Dr. A. D. Imms.
1913	Mr. C. F. C. Beeson.

The staff comprises also two assistants, two collectors, one setter, one artist, three clerks and four peons.

I am indebted to Mr. Beeson for the following notes:—

"Buildings.—In the Forest Research Institute, completed in 1914, are the offices (clerks' room, record room, and Zoologist's office room), and the museum. In two detached buildings in the Research Institute grounds are the insectary and laboratories, etc.

"The museum is a well-lighted room, 92′ × 32′, containing a collection as yet in its early stages. It is mainly entomological and exhibits a good series of forest insect pests with examples of their work, there is a small but growing collection of birds and of reptiles, and of shikar trophies.

"The laboratory building consists of four rooms, two of which are laboratories 26′ × 15″ and 18′ × 15′, while the other rooms, 18′ × 32′, are used respectively as library and insect-collection room. In the latter the systematic collection and spirit material is stored; teak wood store boxes with bases of cork or naphthaline in paraffin wax are in use, contained in dustproof teak almirahs. Collections and library are card-indexed.

"The insectary is a one-roomed building, built on the Pusa pattern after designs by Dr. Imms. The main room is 41′ × 28′, to which are attached on three sides a series of out-door cages with raised soil pits in which saplings of forest trees can be grown. The east and west cages measure 12′ × 7′ and are enclosed on three sides and above with 1/22″ mesh galvanised wire-gauze in an iron frame-work. The six cages on the south side measure 7′ × 6′, and two central cages are roofed with plate glass and have cement-plastered walls. Access is gained to them by double doors from the interior. Gas and water are laid down and the building is isolated by means of an ant-gutter.

"The indoor breeding cages are mostly adapted for the breeding of woodborers over long periods, and are light-tight with emergence-traps on American patterns. Evaporators of coarse pottery are used to maintain even humidity and postpone shrinkage of the logs. Defoliators are usually reared in open Fiske trays, and root-feeders in gauze cylinders in the soil pits.

"Times of investigation.—A three-year programme of research is drawn up at the triennial meeting of the Board of Forestry, based on suggestions brought forward by the Forest Departments of the several provinces. The present investigations deal chiefly with the insect pests of three principal forest trees, *sal* (*Shorea robusta*), teak (*Tectona grandis*), and the Himalayan conifers (*Pinus longifolia*, *Pinus excelsa*, *Cedrus deodara*). The enquiries are carried out by the research officers in prolonged tours extending over about eight months of the year. There are no field stations, but in a few cases observation areas in the forest have been started for pests which cannot be established in the insectary. The limited staff, however, prevents very extensive enquiries being carried out.

Special problems.—The enquiries with regard to the majority of pest species have not yet passed the initial stages, but, where life-histories are well-known, effective control measures have been devised in a few cases only. The absence of intensive management, the disproportionate value of the crop, and impossibility of early recognition and location of insect attack prevent the adoption of many of the control measures in force in European forests. An exception can be made in the case of nurseries, young plantations, where intensive cultivation and supervision occurs, and in the case of bark beetles in the coniferous forests of the Himalayas, which are successfully controlled by measures based on European methods. The chief problems lie (*a*) in the discovery of methods of checking damage by heart-wood borers, especially those species which are sporadic in habit and attack isolated trees here and there and (*b*) in the prevention of widespread defoliation which occurs annually in many types of deciduous forests."

A considerable volume of work on forest insects has been published during the last fifteen years, but a large proportion of the earlier work was very incomplete and in many cases inaccurate, thus requiring revision. Forest entomology in India has also been handicapped considerably by the dislocation necessarily produced by the numerous changes of staff which have taken place. Generally speaking, it may be said that the work of the Forest Zoologist is purely entomological and deals with insects in many cases identical with, and in nearly all cases closely allied to, those dealt with by the entomological staff of the Agricultural Department, so that there seems to be no necessity for the seperation of this work between two departments.

7. Besides entomological work carried on under the Government of India and the Local Governments, there is a certain amount of work done by Native States and un-official workers. Baroda, Mysore and Travancore, for example, maintain entomological assistants attached to their Agricultural Departments, whilst the Bombay Natural History Society has a small collection of insects and helps to bring together amateurs and others by means of entomological papers published in its journal. **Other entomological work in India.**

The Indian Tea Association also maintains an Entomologist (Mr. E. A. Andrews), with a small staff, to work solely on insects affecting tea estates in north-eastern India, but, whilst the study of tea insects is rather specialised as regards some of the worst pests, it may be pointed out that many pests of tea attack other crops (and *vice versâ*), and also that lately, owing to the extension of the practice of growing leguminous crops as green manure and to prevent erosion on tea estates, the work of the Entomologist to the Indian Tea Association has necessarily been extended to comprise the pests of such crops, which are also necessarily studied by the entomological staff of the Agricultural Department in other (non-tea) areas. In southern India also, where there is a considerable acreage under tea, it is part of the duty of the Deputy Director of Agriculture in the planting districts (Mr. R. D. Anstead) to advise the planters on the subject of insect pests of tea, coffee, rubber, etc., and this is done mainly in co-operation with the Imperial Entomologist, with whom Mr. Anstead keeps in touch. Thus, even as regards only tea-pests in India, there is no one individual or body to study them as a whole.

Numerous residents and visitors also take an active interest in entomology although their energies are mostly confined to the more conspicuous and popular groups of insects, such as butterflies. However, it is largely owing to the enthusiasm of such amateurs in the past that the study of entomology in India has attained its present proportions, and hence it is necessary to include their activities in any general résumé of the subject.

8. The horizon of the ordinary Government servant in India is usually limited to his own district or province, but insects have no respect for political boundaries. Many of our worst pests, indeed, are practically world-wide in their range, and the entomological worker must, therefore, if his information is to be adequately complete, study the habits and control of such pests throughout their whole area of distribution and keep himself abreast with al information published concerning them; incidentally, it may be pointed out that this requires ability to read all the principal European languages. The insect pests of Ceylon, for example, are practically identical with those of southern India, and the same may be said to a less extent of those of the Malay Peninsula, Java, Queensland and Formosa, all of which maintain expert entomological staffs, whilst the habits and control-methods of insects in other parts of the world often afford most valuable hints regarding these points in India, even in cases where the insects are not exactly identical. The extra-Indian breadth of view required of an entomological worker in India is a point which is usually little realised by the non-entomologist and, therefore, requires to be emphasised here. It may also be pointed out that much of our most important work on Indian insects, including the preparation of most of the volumes in the *Fauna of British India* series, has been done outside of India. **Necessity for considering work outside of India.**

9. The above statement shows in very brief outline in what various directions entomology is being carried on in India, and it will at once be apparent that the official work is distributed over at least four services (Forests, Medical, Museums, Agricultural and Veterinary), all independent of one another and **Summary of foregoing.**

not even under one department of Government. Many insects and groups of insects are pests common to both forest trees and agricultural crops, many others are carriers of disease both to man and animals, whilst the systematic side of the work, which is nominally confined to the Museums branch, must form the very foundation of all advance by economic workers in each of the other branches. There is thus a great amount of unnecessary overlapping, expense and waste of work, as each worker must maintain his own collection, library, records, etc., many of the items of which must also be set up and maintained by other workers in each different service, and indeed (as things are at present) by each worker in each appointment. Each worker in the Agricultural, Forest and Museums Services, for example, has to maintain a series of insects in all orders, which means that he has to waste a large amount of time in identification of groups with which he is not personally familiar, although they may be represented and named up in other collections in India, and to obtain such identification requires a large amount of time, trouble and correspondence with specialists in each of such groups, whilst conversely each such specialist suffers from the disadvantage of seeing scattered small lots of specimens instead of being able to examine a large mass of material, which is usually (it may be pointed out) far more satisfactory to work out. There is also the further disadvantage that the same species may be sent by different workers in India to different specialists at the same time, thus leading to unnecessary synonymy and trouble for future workers.

Conclusions.

10. It will be seen from the above summarised statement that, although considerable progress has been made towards the study of entomology in India, this science has hitherto suffered from the scattered and haphazard way in which such studies have been prosecuted, at first by (*a*) professed (though not in many cases professional) entomologists outside of India, each working primarily on a special group of insects, and (*b*) in India itself mostly by enthusiastic amateurs who have provided the material for the workers noted in (*a*), and who have also contributed by their observations to a knowledge of the habits and life-histories of those insects which they met with in India. Even later on, in recent years, when the study of Indian insects has been taken up by whole-time employés of Government, it will be seen how scattered and inco-ordinated such work has been, the various workers in the Agricultural, Forest and Medical Departments and the Indian Museum each confining his attention and devoting his energies to work in his own particular line, with little regard to what has been done by other workers in India. It may be said, indeed, and with considerable accuracy in my opinion, that such is the logical outcome of the present policy of isolation of the different entomological workers who are, so to speak, shut off from one another by the water-tight compartments artificially set up by the separation of the various departments under which they are working. This is, I know, a matter of general policy and perhaps rather outside of the present case, but it is necessary to consider it now, because, in my opinion, the time has come when Government should definitely make up its mind regarding the continuation and expansion of the present work in entomology and the most efficient means of securing such. It is not a question of one or two men or a few thousand rupees in this or next year's budget. It is our duty *now* to lay a firm foundation which will endure permanently, so far as we can foresee, and which will not require to be scrapped or changed in any essential particulars during the present century; otherwise we are wasting our own time and failing in our duty to our successors. The question is, how can we best provide now for the requirements, not only of our own time, but of the future? And to this question there are, it seems to me, only two possible answers, which may be

summed up in the words (*a*) centralisation, and (*b*) decentralisation. We have now to consider the respective merits and demerits of these two propositions.

(*a*) Centralisation.—A centralised scheme will provide for one main institute and a body of workers all belonging to one service. All the workers will be working on one subject, though not necessarily on the same branch. Each worker will be able to devote his time and energy to his particular object knowing that other workers, with whom he will be in touch as belonging to the same service, are also working at other similar problems, and that their information is freely at his service as his is at theirs. Government officials and the general public equally will know exactly where to apply for information regarding any matter concerning insects, and the best information available can be supplied either from the central institution's records or from the entomological worker best able to reply from his special knowledge. As regards the entomological workers, also, a centralised scheme will allow for recruitment of suitable candidates for the employment of entomologists on work for which each is best suited, both as regards aptitude for particular kinds of work and for employment in the field or at the central institution with some regard to personal fitness, for problems connected with leave and various cognate matters. As regards such questions as legislative restrictions regarding insect pests, it is obviously desirable that such should be handled by a central institute. As regards the central institute itself, a centralised scheme will secure economy in buildings and in all expenses necessarily entailed in the acquisition, accommodation and upkeep of collections, library and records, while there will be, further, the inestimable advantage of having one general collection of insects and entomological literature and records for the whole of India, under which conditions it will be possible for the first time to aim at a tolerable degree of completeness in each. A strong plea must also be entered for the centralisation of publications (at least of entomological ones as such), especially as regards other workers on cognate problems outside of India.

All the above may be, and in my opinion are to be, described as merits of a centralised scheme.

As regards the demerits of such a scheme, the following have occurred to me:—

(1) The difficulty at present of providing a sufficient staff of entomological workers: this, however, is a difficulty which will apply to any scheme for expansion and one, moreover, which will solve itself in course of time, and it may only be noted here that the larger the staff and the higher their reputation, the less difficulty is there likely to be in attracting sufficient candidates of the right stamp.

(2) The practical difficulty of attending to purely local inquiries (such as small outbreaks of crop-pests) or local problems (such as education in provincial Agricultural or Forest Colleges) without having such an overwhelmingly large staff that centralised control would become inefficient: I fully recognise this difficulty and propose to overcome it by restricting the proposed centralised scheme to a high-grade service of entomological workers, engaged mainly (if not solely) in research work, as explained in detail later on.

(*b*) Decentralisation.—I fail to see any particular merits in a decentralised scheme, whereby each department has its own separate entomological staff as at present, so far at least as this remark applies to the higher-grade research workers. There may be a certain amount of *amour propre* on the part of such departments or their heads, in the idea that they are self-contained, but we are concerned with efficiency and not with sentiment. There may also be red-tape

objections to a centralised scheme on the ground of budget allotments to particular Governments or provinces or departments, but very little readjustment is really required.

The demerits of decentralisation are numerous and cogent and include :—

(1) Waste of time by the necessity of each separate worker having (*i*) to spread his energies over a wide field instead of settling down to one piece of research, (*ii*) to go over an enormous volume of current literature merely to see whether there is anything affecting his own work.

(2) Overlapping of work due to the fact that there is no real dividing line between, for example, insects affecting many forest trees and agricultural crops, so that both the Forest and Agricultural Entomologists must study the same insects. This, of course, is more pronounced still in the case of, say, half-a-dozen Agricultural Entomologists in as many provinces, in all of which the same insects may occur on the same crops. Of course, there is the advantage that different workers may proceed on different lines and one succeeds where another fails, but the waste of labour due to overlapping more than compensates for this. In this question especially it is necessary to look ahead.

(3) Waste of public money by the absolutely necessary provision of accommodation (laboratories, insectaries, collections, staff, etc.), libraries and other expenses for each worker.

(4) The publication of results in a mass of scattered literature, which makes it much more difficult for present and future worker to know where to find information on any particular subject.

Entomological progress outside of India.

11. Having briefly considered the merits and demerits of centralised and decentralised schemes as applied to the present and future requirements of entomological work in India, we may briefly review the experience gained in some other countries in which entomology has progressed in recent years. In this connection I shall omit consideration of European countries because, comparatively speaking, their entomological problems and staffs are alike of small importance.

The United States of America.

12. The United States of America have justly attained a world-wide reputation through the organisation and efficiency of their Agricultural Department, and their entomological problems are dealt with by the Bureau of Entomology under the able leadership of Dr. L. O. Howard.

The Bureau of Entomology (as described in the United States Department of Agriculture Year Book for 1908, page 495) "obtains and disseminates information regarding injurious insects affecting field crops, fruits, small fruits, truck crops, forest and forest products, and stored products ; studies insects in relation to diseases of man and other animals and as animal parasites; experiments with the introduction of beneficial insects and with the fungus and other diseases of insects ; and conducts experiments and tests with insecticides and insecticide machinery. It is further charged with investigations in apiculture. The information gained is disseminated in the form of general reports, bulletins and circulars. Museum work is done in connection with the Division of Insects of the National Museum, and insects are identified for experiment stations and other public institutions and for private individuals."

The Bureau of Entomology is divided into at least ten sections, of which eight are concerned with researches on plant pests. Their budget for the year 1913 (the latest year of which I have particulars) was Rs. 20,64,750* and

* I have reckoned three rupees to the dollar.

Later Note.—The budget for the year ending 30th June 1918 is Rs. 27,94,440.

their staff comprised 207 members. The sections dealing with plant pests are :—

1. Researches on pests of deciduous fruit trees, with a staff of 16 experts and a budget of Rs. 1,39,800.
2. Researches on pests of cereals and fodder crops, with a staff of 42 experts and a budget of Rs. 2,76,600.
3. Researches on insect pests of the southern crop districts, with a staff of 24 experts and a budget of Rs. 1,54,800.
4. Researches on forest insects, with a staff of 36 experts and a budget of Rs. 1,67,850.
5. Researches on pests of truck crops and stored products, with a staff of 20 experts and a budget of Rs. 1,12,200.
6. Researches on tropical and sub-tropical fruits, with a staff of 7 experts and a budget of Rs. 64,500.
7. Researches on Mediterranean fruitfly, with a staff of 2 experts and a budget of Rs. 10,500.
8. Researches on gipsy and brown-tail moths, with a staff of 36 experts and a budget of Rs. 9,09,000.

Other sections deal with :—

9. Insects carrying diseases of man and animals, and
10. Bee keeping,

but I have no definite information regarding their staffs or budgets.

In addition to the Bureau of Entomology many of the States maintain their own entomological staffs, and of course all the principal Universities have their professors of Entomology (several in some cases, as at Cornell University), but it may be said without hesitation or fear of contradiction that it is mostly owing to the centralised activities of the Bureau of Entomology that the United States have come to occupy a position in the very forefront of entomological progress.

13. In Canada, the first Dominion Entomologist was appointed in 1884 by the Minister of Agriculture on the recommendation of a Select Committee and in accordance with recommendations from various parts of the Dominion, and the late Dr. James Fletcher was appointed, the position being an honorary one for the first year. In 1886, when the Dominion experimental farms were established, Dr. Fletcher was attached to the scientific staff of that branch as Entomologist and Botanist, in which dual capacity he served until his death in 1908. The increase of all lines of work necessitated the separation of these two offices, and in 1909 Dr. C. Gordon Hewitt was appointed Dominion Entomologist and, with one assistant, was entrusted with the work of organising the new Division of Entomology. In April 1914 the entomological work of the Dominion Department of Agriculture was separated from the Experimental Farms Branch and was constituted as a separate branch of the department. The work of the Entomological Branch includes : **Canada.**

(*a*) the working of fumigation stations and of various legislative enactments to prevent the introduction of dangerous pests from abroad and to control those already imported,

(*b*) the fumigation of nursery stock,

(*c*) the suppression of brown-tail moth, San José scale and other serious pests,

(*d*) the working of field laboratories for the local investigation of various destructive pests. In 1916 these laboratories totalled nine, in addition to two sub-stations, and provided for both agricultural and forest pests,

(*e*) the deputation of trained men from these laboratories to cope with outbreaks of pests when these are reported,

(*f*) special investigations on forest insects, fruit insects and pests affecting field, garden and cereal crops,

(*g*) special investigations of insects carrying diseases of man and animals,

(*h*) the building up of a national collection of Canadian insects,

(*i*) the dissemination of information regarding insects by publications, exhibitions and addresses,

(*j*) apicultural work (for the present this remains under the Experimental Farms Branch).

The aims of the Entomological Service are briefly defined by Dr. Gordon Hewitt as:—

"first, the prevention of the introduction and spread of injurious insects, second, the investigation of insect pests affecting agriculture, horticulture, forestry and the health of domestic animals and man; and third, the imparting of the information so obtained to those interested and concerned by means of bulletins, circulars, press notices, addresses, letters, and personal visits. For these purposes there exists at Ottawa and at the various field laboratories throughout the country a staff of men of such scientific training and ability as will enable them to make the service of the greatest benefit to the people of Canada.

It may particularly be noted that all the work of the Canadian Entomological Service is directed from Ottawa by the Dominion Entomologist.

In addition to the foregoing, Ontario, Nova Scotia and Quebec have also provincial Entomologists. "In the other provinces of Canada, no provincial entomologists have been appointed, and where entomological investigations are being conducted they are in connection with one or other of the Dominion field laboratories. Where Dominion and provincial officers are carrying on investigations in the same province, the heartiest co-operation is enjoyed, and arrangements are made with a view to preventing duplication of the work and consequent loss of energy. In certain cases investigations are being conducted conjointly, and this spirit of co-operation is most valuable, especially in its relation to the attitude of the public towards the work." (*Annals Entom. Soc. America*, IX, pages 24-25, 1916.)

South Africa. 14. In South Africa, prior to the formation of the Union of South Africa, the four colonies (Cape Colony, Natal, Transvaal and Orange River Colony) carried on their entomological work independently. Cape Colony was the most advanced and in 1895 had created a Division of Entomology with Mr. C. P. Lounsbury as Chief. Following on the Union, Mr. Lounsbury was made Chief of the new Division of Entomology of the Union Department of Agriculture, with headquarters at Pretoria. The work of this division comprises, in addition to the dissemination of advice on insect problems and the carrying on of investigations, the administration of Government regulations concerning (1) the suppression of locusts, (2) the inspection of nurseries, (3) plant and fruit imports, and (4) restrictions on the conveyance of plants and fruit. Mr. Claude Fuller, formerly Entomologist in Natal, is also stationed at Pretoria as Assistant Chief, together with a staff of other workers. There are also branch laboratories at Cape Town, Bloemfontein, and New Hanover (Natal), and in addition to the staffs at these laboratories, plant inspectors are stationed at the following ports of entry for plants and fruit, *viz.*, Capetown, Johannesburg, Durban, East London and Port Elizabeth.

Australia. 15. In Australia the Commonwealth Government did not, on its formation about sixteen years ago, assume any jurisdiction over agricultural matters, but left the individual States in full control. There is, therefore, no entomological work undertaken by the Commonwealth Government beyond the administration of the Federal Quarantine Act, which regulates the importation, etc., of

plants into the country; this Act, I understand, is administered by the Customs Department.

A result of the absence of any central control over entomological work in Australia is seen in the scattered and inco-ordinated work which is being done there. New South Wales has a Government Entomologist (Mr. W. W. Frogatt), but considerable work on the investigation of disease-carrying insects is also carried out by the Government Bureau of Microbiology, whilst a large staff of inspectors, employed in different districts to see that spraying regulations, etc., are carried out apparently work under the Agricultural Department directly. In Victoria the Entomologist (Mr. C. French) apparently devotes most of his time to the administration of the Fruit and Nursery Inspection ordinances, and little work of an investigatory character seems to be carried on. In South Australia the entomological work is carried on by the Horticultural Division of the State Department of Agriculture, at Adelaide; nursery inspectors are employed to carry on a campaign against fruit pests (codling moth and scale insects), but there appears to be no definite Entomological Division. In Queensland there has been a Government Entomologist (Mr. H. Tryon) since 1897, with headquarters at Brisbane, but little original work seems to have been done in the last ten or fifteen years; there is a special field station at Gordonvale, near Cairns, for the investigation of sugarcane insects, but I am not aware that any entomologist has yet been appointed or any work actually done. At the Tropical School of Medicine at Townsville also, Mr. F. Taylor has carried on some excellent work on blood-sucking Diptera, especially *Calicidæ* and *Tabanidæ*. Western Australia has since 1898 maintained an entomologist (the present officer being Mr. J. L. Norman) with headquarters at Perth, but little work seems to have been done beyond supervision of imported vegetation and of the nurseries in this State. The Northern territory has an entomologist (Mr. G. F. Hill), stationed at Darwin, who has done some work on termites and on the relation of blood-sucking flies to the transmission of parasitic nematode worms. In Tasmania there seems to be no regular entomological service, but advice on the control of insect pests is given by the Fruit Expert.

Other countries and British Possessions (such as Rhodesia, Uganda, British East Africa, Egypt, Sudan, British West Africa, Ceylon, Fiji, New Zealand and the West Indies) have also their own entomological staffs, but it is unnecessary to refer to these here. Those I have already described have been selected because they are representative of countries (equally with India) (*a*) comprising large areas under very diverse climatic conditions, and (*b*) with a Supreme Government combined with local Administrations. The United States, Canada, and South Africa unite in the possession of a centralised entomological staff working in conjunction with provincial staffs, whilst in Australia the entomological staffs are purely provincial and decentralised. It seems to me a significant fact that, whilst in the United States, Canada and South Africa the entomological work accomplished is universally acknowledged as of excellent quality, that being done in Australia can only be described (with a few exceptions) as indifferent.

From a consideration, therefore, both of our own requirements in India at the present time and to admit of expansion in the future, and from a comparative study of the methods found most efficient under somewhat parallel conditions in other parts of the world, I am strongly of opinion that all the higher-grade entomological work in the Indian Empire should be carried out by a staff of entomological specialists, included in one Entomological Service, and attached to one Central Entomological Institute.

Proposals for an Indian Entomological Service.

16. It now remains to consider the means by which the above suggestion may be carried out, and these may be considered under the headings of (*a*) Staff and (*b*) Buildings, etc.

(*a*) Staff.

Entomological Service.

As indicated above, the present workers on entomology in India are scattered amongst the Agricultural, Forest, Medical and Museum Services in India, whilst there are also entomologists working under the Indian Tea Association and Medical Research Fund. These latter are not Government servants, strictly speaking, but practically are so, because their employers are receiving Government subsidies, without which they would be unable to maintain their staffs. The present system leads to want of co-operation between these various workers, and it appears clearly desirable that all workers in this one subject should be in one service. At the same time, I do not consider that it would be practicable to unite these men in any of the existing services, as such a course would inevitably lead to a feeling of inter-departmental jealousy and possibly friction, as the workers would necessarily tend to get out of touch with departments other than the one to which they were attached. I recommend, therefore, that all the workers be placed in one service, to be called the Indian Entomological Service, separate from any of the existing services to which the Entomological Service would be co-ordinate but not subordinate. As regards the department of Government under which the Service would come, pending the creation of a special Scientific Department of the Government of India—a department which, I venture to predict, will come into existence within the next fifty years—it seems a matter of indifference whether the service should be placed under the Department of Revenue and Agriculture (already represented by the Agricultural and Forest Entomological Sections) or under the Department of Education, which controls the Medical and Museum Departments, but on the whole, as matters are at present, it would perhaps be better to place it under the Revenue and Agriculture Department in the same way as the Agricultural and Forest Services. I do not anticipate any large increase of secretariat work as the result of this proposal, and it must also be remembered that the cadre of the Entomological Service will not represent any great increase in actual number of Government servants, but only a centralisation of the total numbers instead of scattered items, *e.g.*, of budgets, etc.

The Indian Entomological Service should comprise two classes of entomological workers, together with the subordinate staff usual to every service.

Class I to consist wholly of entomological experts, that is to say, of qualified entomological workers, each an expert in his own line, to devote their time purely to research work either in the laboratory or the field. The pay would depend largely on the special qualifications of each man, but should conform roughly to a scale of Rs. 500—50—1,500. As each expert should be a specialist in his own particular line, it is very important to be able to select only the very best men obtainable, and to do this and retain such men in the Entomological Service, good terms must be offered. The Entomological Service will have no use for second-rate men except for subordinate posts.

Class II to consist of :—

(1) Assistants. These men to be of much the same grade as those at present employed, *i.e.*, graduates of Indian Universities. They would be

employed in minor investigations under the direction of the experts. Pay to depend primarily on capabilities and work of each man, but to conform generally to a scale of Rs. 50—20—150, Rs. 150—10—300, thereafter rising higher in special cases.

(2) Collectors and setters. Men of less educational acquirements than assistants, their work requiring rather manual dexterity. Their duties would comprise the collection in the field of material required, and its preservation and preparation for the collection and the upkeep of the same under the superintendence of the assistants and experts. Pay about Rs. 20—3—50, with a few higher posts.

(3) Clerical establishment on the usual rates of pay.

(4) Artists. These are absolutely necessary for keeping a proper record of life-histories in the field and for preparation of results for publication. The work is specialised and technical, and only really good men are of any use. Pay about Rs. 30—5—75, with a few higher posts.

17. As regards numbers, the following scheme is intended as a nucleus to commence with and represents the bare minimum with which really efficient entomological work can be carried out in India. At the same time it is capable of expansion in any direction found necessary.

Class I.

Available for definite problems in Agricultural work	6
Available for definite problems in Forest work :—	
One for Himalayan Forests One for South Indian Forests One for Burma Forests	3
Available for definite problems in Medical work	2
Available for definite problems in Veterinary work	1
Stationed at the Central Institute and employed on systematic and life-history work there and available as a reserve for leave and field workers	7
Imperial Entomologist and Director of Central Entomological Institute	1
	20

The numbers shown against each item above must be regarded as approximate only and represent what would probably be the most efficient distribution of workers on a basis of twenty men, which I regard as the minimum number necessary. The allotment of workers to each subject must be based on (*a*) the work to be done in each direction, and (*b*) the men available, but it must be borne in mind that there is no intention of tying down any particular number of men to work on any one line, and also that the work on which any expert is employed must be selected with special regard to his capabilities; one man, for example, may be best employed on administrative work (*e. g.*, pest-control experiments), another on working out life-histories, and another on purely systematic work. The actual allocation of workers to particular duties must be vested in the Director of the Central Institute, and it will be his duty to employ his staff to the best advantage, with due regard to the requirements of the various departments of Government, who will of course be free to indicate any special problems which they consider require special investigation by the Entomological Service. With these remarks, we may now consider briefly the foregoing lines of work.

Problems in agricultural works.

18. It is usually conceded, by those who have studied the subject and are, therefore, in the best position to form an exact opinion, that on an average the outturn of all crops is reduced about ten per cent. by the attacks of insect pests; that is to say, the farmer who obtains what he considers a normal full crop

really only gets ninety per cent. of what he would have got, had there been no diminution due to insect pests. I leave to the Statistical Department the task of working out the value of the annual crop production of the Indian Empire, and will here only estimate roughly that the annual damage thereto by crop-pests cannot be placed at less than five hundred millions (five thousand lakhs) of rupees, and that a reduction of this damage by even one per cent. of the damage now done would more than justify the cost of the most expensive and the best Entomological Service obtainable. I consider that, at least in the case of the more important crop-pests, which do most damage because they attack crops which are grown over very extensive areas in India, the reduction of such damage is most likely to be attained by a thorough investigation of each such pest. It is only when we have a really thorough knowledge of such a pest that we are in a satisfactory position to check it. We must know everything about it, its range of occurrence, its normal and possible food-plants, its exact life-history under every condition, its enemies (and their enemies), and in short all the conditions favourable or unfavourable to its increase. It is only after this thorough investigation of each insect concerned that we are really in a position to evolve a sound scheme of control built up on a firm foundation of adequate knowledge, and to attain such a foundation it is necessary to put whole-time workers on to each problem and to leave them to solve it, unfettered by any other demands on their time, and with the whole help and co-operation of the Central Institute to assist them. Each of these workers on agricultural problems would, therefore, be given a definite piece of work to do, and left to carry it out throughout the whole area of occurrence of the insect concerned, without being tied down to provincial limits; for, as noted above, nearly all the important pests occur over wide areas, and their investigation is therefore not a matter concerning one or two provinces, but all or nearly all. It seems obvious that a body of, say, half-a-dozen workers, attached to a Central Institute, and each free to give his whole undivided attention to one piece of work, would accomplish far more than an equal number of workers, each confined, to all intents and purposes, within the narrow limits of his own province and each relying on his own resources and probably duplicating to a large extent the work already accomplished elsewhere. I do not refer here so much to the practical application of results as to the preliminary investigation of pests which is necessary for the devising of successful means of control, but it may be added that the application of practical means of control of insect pests of crops may usually be left to the staff of the Agricultural Service and, once such control measures are established as a practical routine measure, will not generally require the continuous supervision of an entomological expert, whose services can then be transferred to the investigation of the next problem awaiting solution. The numbers provided for are intended to allow for the taking up of work in applied entomology as regards apiculture and lac culture, so far as the entomological aspects of these subjects are concerned, although as the work expands, it is probable that these subjects may require each a special section. This, however, will work out with the development of the service. I have not provided for sericulture, as I understand that proposals on this subject are now before Government; this also is primarily of importance from the commercial point of view. So far as the Entomological Institute is concerned, however, any information or assistance on the entomological side would of course be given as far as possible.

The present work of the Entomologist to the Indian Tea Association on tea pests would fall under the ordinary scheme of work of the entomological experts employed especially on agricultural work.

19. I have provided, in the above nucleus scheme, for three entomological experts, one each to work respectively in the Himalayan, South Indian and Burmese forest areas, as the predominant trees (and hence their pests) are considerably different in these three areas. It must, however, be understood that this scheme is only a nucleus one to provide for preliminary research on such insect pests. The Forest Research Institute at Dehra Dun already possesses an insectary and laboratory accommodation, and these could doubtless be utilised as a central out-station of the entomological expert attached to the Himalayan Division. The need of an entomologist for the South Indian Forests has certainly made itself felt, and I think that the same may be said of Burma; at least three experts are required, therefore, as a minimum. **Problems in forest work.**

20. The importance of insects as carriers of human diseases has forced itself on the attention of all civilised nations during the last two decades, and the necessity for the investigation of such insects in India requires little emphasis here. In this section again it should be realised that the two experts, provided for in the foregoing scheme, are intended as a nucleus only. I would suggest that one of these two experts should be exclusively a mosquito specialist, whilst the other should be primarily a pathologist, able to work on insect-borne diseases from a medical view-point, leaving the more systematic side to his colleagues at the Central Institute. **Problems in medical work.**

The mosquito expert would be attached permanently to the Central Entomological Institute, where all systematic work would be done, but would be available for touring to study the life-histories, and occurrence of mosquitoes throughout the Indian Empire and to advise, where required, on problems of mosquito control. The pathologist would keep in close touch with Schools of Tropical Medicine in Calcutta, Bombay and Madras. The work of both men would be arranged by the Director of the Entomological Institute in consultation with the Medical Department.

21. Seven-tenths of the population of the Indian Empire are directly dependent on agriculture for their livelihood, and the whole basis of Indian agriculture rests on the cattle of the country; yet in spite of the fact that so many serious diseases of domesticated animals are known to be transmitted by insects (including ticks, etc.), there seems hitherto to have been no definite policy of entomological work in this direction, and very little has been done. At least one whole-time entomological expert is required for this work alone. His work would be arranged by the Director of the Entomological Institute in consultation with the Veterinary Department. **Problems in veterinary work**

22. The scheme provides for seven men under this heading, and there would be more than ample work for this number merely in working out the collection of insects received from the staff of the Institute working at their several problems in the field and from correspondents in and outside India, in investigation at headquarters of life-histories, etc., of insects, testing of insecticides and general routine work. But the scheme provides for more than this, because, even if the staff is at full strength, there will necessarily be leave vacancies at times, and also an expert who has been working in the field for a year or more on one insect will require to return to headquarters to write up his results and perhaps to have a change of work, and the field work can then be continued (so far as can be done) by sending out one or more of the men from the Central Institute. It will also be necessary to provide (*a*) for purely systematic workers, as some of the recruits available will inevitably turn out to be excellent systematists but indifferent field workers, and (*b*) for men who have reached a time of life when they are not fit for strenuous field work, but when their previous extensive experience will be more valuable at headquarters. In any case, it will be essential to have a strong staff at headquarters, as it is intended **Entomological experts at Central Entomological Institute.**

that the field workers should be relieved, as far as possible, of all systematic work, care of collections, correspondence, etc., so that they may give their undivided attention to the problems in hand.

Director of Entomological Institute.

23. As this officer will have to keep in close touch with the various activities of his whole staff and to arrange their work in consultation with all other departments, to keep in touch with all other entomological work throughout the world, and to advise Government on all entomological questions, he must necessarily be an entomologist. He should draw the ordinary pay of his grade as an expert and be given an additional allowance of Rs. 500 per month, in recognition of his increased responsibility and the onerous nature of his duties.

Class II.

24. Generally speaking, each entomological expert working in the field will require the services of assistants, collectors, setters, and artists, but the amount of assistance required by each expert would depend so largely on the conditions of each case that I have thought it unnecessary to draw up any rigid scheme of establishment for each section, as such assistance would be allocated as requisite by the Director of the Entomological Institute. It seems better, therefore, to show these men in one group of figures for each grade.

Assistants.

Available for field work	12
Upkeep of entomological show-cases in museums	1
At headquarters:—	
Records	1
Library	1
Insectary	2
Collections	6
Total	23

Setters and Collectors.

Available for field work under experts	12
Available for field work to be sent out to procure special material	4
At headquarters:—	
For upkeep of collections	6
Insectary setter	1
Printer (for labels)	1
Total	24

Clerical Establishment.

Superintendent of Director's office	1
Head clerk	1
Cashier	1
Clerks and typists	8
Storekeeper	1
Total	12

Artists.

Head artist	1
Artists (available for work under experts in field and at head-quarters)	11
Total	12

Menial Establishment.

Peons (for touring officers and at Central Institute)	24
Estate chowkidars	4
Malis (for estate and insectary compound)	6
Sweepers for Central Institute	4
Total	38

(*Note.*—The above figures do not provide for water supply, electrical current, workshops, etc., as such will necessarily depend on the actual situation of the Institute. It would, for example, probably make for economy to maintain a small workshop for making and repair of cabinets, show-cases for museums, etc.)

(*b*) Buildings.

25. The Central Entomological Research Institute, forming the head-quarters of the Indian Entomological Service, must be situated in an accessible locality with:—

(1) an equable climate making it (*a*) habitable for the staff, and (*b*) suitable for breeding insects at all seasons of the year, and

(2) an equable and not excessive humidity in order to ensure the proper preservation of insect specimens. In a very dry atmosphere, insect specimens become so brittle as to break at the least touch, whilst an excess of humidity induces growth of mould which completely ruins all delicate specimens. In this connection it must be pointed out that proper preservation of a collection is essential, not merely on account of the money value of a collection as such, but because the actual individual specimens themselves often form an exact record (as in the case of crop-pests or in the case of types of various categories in systematic work) which cannot be duplicated if the specimens perish.

None of the present main entomological stations fulfils the above conditions. Pusa, for example, is quite unsuitable climatically, as practically all insect activities cease during the cold weather (November to February) and again during the hot, dry weather of April and May, whilst in the wet season (June to October) the humidity is excessive. Dehra Dun has a more extended cold weather than at Pusa, and I think that the humidity is too high for proper preservation of collections. Calcutta is more equable but much too humid, so that the Indian Museum has found it necessary during the monsoon to close up its insect collection, which is not available for study then; the expense of providing a suitable large area of land for the Entomological Institute in Calcutta must also be considered. Much the same remarks apply to any coast town.

Coimbatore would seem to fulfil the necessary conditions better than any other place that I know of. It is sufficiently accessible. The temperature whilst rather high, is fairly equable, and it is possible to carry on breeding work throughout the year, whilst the adjacent hills would provide accessible localities for small laboratories for the study of insects requiring a cooler

climate. The humidity is low, but excessive dryness is prevented by the proximity of hills and of the sea, and practical experience during the last ten years has shown that it is possible to keep insect collections in good order there with very little risk of mould. Coimbatore has the further unique advantage of possessing already at once an Agricultural College and a Forest College, so that the Entomological Service would be able to (1) keep in close touch with the requirements of these two services, (2) have available for consultation the views of Agricultural and Forest Officers on technical questions; and (3) utilise their libraries on these subjects, thus reducing expense in the case of numerous publications only required for very occasional reference.

Coimbatore is not ideal altogether, but it approaches the ideal locality for a Central Entomological Research Institute more closely than any other locality which I know of in the Indian Empire, and therefore, pending the suggestion of any more suitable place, I recommend Coimbatore.

As noted, there are already Agricultural and Forest Colleges at Coimbatore. Both are situated in close proximity to one another, about 3 miles west of the town. It would probably be possible to secure an appropriate site for the Entomological Institute somewhere near (probably to the north of) these two Colleges. An estate of about 150 acres would probably be required to allow of the proper disposition of the Institute, accommodation for the staff, insectaries, out-buildings, experimental areas, etc. By placing the Institute here, there would also be a saving in provision of post-office, dispensary and medical staff, electric supply, water supply, etc., as a scheme for any of these could be made to serve the Entomological Institute as well as the two present Colleges.

The Institute itself would require to be a large building, well-lighted, with large rooms for collections, records, library, etc. It seems unnecessary to draw out detailed plans at present, but the cost of building may be estimated at Rs. 6,00,000. This estimate provides for a suitable building and is not intended to include architectural fancy work.

In addition there would also be required the provision of house accommodation for the staff. This may be estimated at Rs. 6,00,000, of which only about half would be required to start with, the other half being utilised as necessitated by expansion of staff, for it would probably take ten years to get together a body of twenty really suitable men as entomological experts and the staff of men in Class II could only be increased *pari passu* with those in Class I.

In addition to the Institute, it would be necessary to provide insectaries and other out-buildings and for the fitting up of the Institute. These items, together with the purchase of the necessary land, initial laying out of roads, planting of trees, etc., may be estimated at Rs. 2,00,000.

Cost of scheme.

26. The following is a rough estimate of the foregoing scheme :—

Non-recurring charges.

	Rs.
Entomological Institute (main building)	6,00,000
Accommodation for staff	6,00,000
Purchase of land, fitting and out-buildings . . .	2,00,000
Removal of present staff, collections and records from Pusa, Dehra Dun, Calcutta, etc., to Coimbatore . . .	10,000
	14,10,000

Recurring charges (pay).

	Rs.
Pay of Entomological Experts (20 men at Rs. 12,000 each) .	2,40,000
Allowance (beyond ordinary Expert pay) to Director (Rs. 500 per mensem)	6,000
Pay of Entomological Assistants :—	
20 men at Rs. 2,500)	
2 „ „ 3,000 } each	60,000
1 man „ 4,000)	
Pay of setters and collectors :—	
20 at Rs. 600)	
} each	15,600
4 „ 900)	
Pay of clerical establishment	11,300
Pay of artists	10,000
Pay of menial establishment	4,000
Total . .	3,46,900

Recurring charges (allowances and upkeep).

	Rs.
Travelling allowance for Experts	30,000
Do. do. for staff	10,000
Camp charges (hire of temporary laboratories, transport of apparatus and specimens, etc.).	5,000
Laboratory apparatus	20,000
Insecticides and experimental apparatus	10,000
Books	5,000
Postage	2,000
Furniture	1,000
Miscellaneous	5,000
Publications	5,000
Estate charges	2,000
Total .	95,000
Total recurring average annual charges .	4,41,900

The cost would therefore be roughly fourteen lakhs non-recurring and four and a half lakhs recurring when the scheme was in full working order.

But from the above figures must of course be deducted the value of (1) accommodation to be given up, and (2) pay and expenses of the present entomological staffs. The value of the laboratory and house accommodation of the entomological staff at Pusa alone, for example, based on original cost of buildings, must be at least three lakhs, and this would be rendered available for much-needed expansion of other sections at Pusa without extra charge to Government, whilst the Pusa budget would similarly be reduced by over half a lakh; this reduction is on present rates, whereas the estimate for the proposed Entomological Service is for a full service which would take at least ten years to work up to.

Relations of the Entomological Service with other Government departments and with the general public in India.

27. Having considered briefly the constitution of the proposed Entomological Service, I will now endeavour to indicate the directions in which such a service would work in with other services and the general public in India. In

the first place, however, it should be noted that I am strongly of opinion that the Entomological Service should be a separate service, distinct from any now in existence. The subject of entomology is so vast and its boundaries in most directions are so clearly defined, that I consider that it should be treated as a separate entity and not tacked on as a minor appanage of the Agricultural, Forest or similar department, or the Zoological Survey or any Phyto-pathological Institute.

Relations with Agricultural Department.

28. As the Agricultural Department in India has by far the largest and best organised Entomological Section at present, I will deal with the Agricultural Department first.

The Agricultural Department (exclusive of the Veterinary Department, to be considered later) is of course chiefly interested in (1) crop-pests, and (2) useful insects (silk worms, bees, lac). The word "crop-pest" indicates, roughly speaking, an insect which does appreciable damage to any cultivated plant; from a strictly entomological view-point, however, any exact definition becomes impossible, whilst the study of any crop-pest must include a study of its enemies, and its relatives, and may thus cover a very wide field. The Agricultural officer (farmer), however, is concerned little with the entomological side, but mainly with control; what he wants is a knowledge of the best means of preventing and checking damage to his crop, and it will be the business of the Entomological Service to give the required help in this direction.

Particular problems concerning specific crop-pests will be taken up by the Entomological Service in consultation with the Agricultural Departments, and one or more Entomological Experts (with any necessary staff of assistants, setters, artists) placed on special duty to work in each. The preliminary step in such investigations will be purely entomological and will comprise a thorough study of the insect concerned in all aspects, and usually in more than one area of its occurrence. In the case of crop-pests this work can usually be done at one of the numerous stations belonging to the Agricultural Department, and temporary accommodation for the entomological staff can doubtless be arranged for in most cases by the Agricultural Department. A thorough working knowledge of the insect having been attained, the Entomological Expert will then be in a position to collaborate with the local Agricultural officer in control measures, at first on an experimental, and later on a field scale, and, a satisfactory control method once having been worked out, this can then be carried on in future by the Agricultural Department as a routine measure in connection with that crop, in the case of most methods of control by cultural or mechanical methods. This is, of course, what is done already by the entomological staff of the Agricultural Department, but the Expert of the Entomological Service will be in a better position to deal with each problem because he will have the whole help of the Entomological Institute behind him, instead of being compelled to waste time in doing every detail for himself, as under the present conditions; if, for example, in working at the crop-pest under investigation, he finds that it is controlled by an efficient parasite, he will be able to send specimens of that parasite to the Entomological Institute where it will be examined by the section dealing with that group, and the expert in the field can then be informed promptly what the parasite is and from what other pests or areas it is known and any other details available in the centralised records of the Institute. This is a very great advantage over the present system, where every entomological worker has to gather his information for himself as best he can, with the result that years of work may be wasted in control of a pest, and each separate worker (whether in different provincial Agricultural Departments or in other spheres of work) has often a few scrappy facts which are useless in themselves, but which, if co-ordinated into one whole at a

Central Institute, would often throw a flood of light on to obscure problems. In the case of effective parasites also, the Central Institute could be of great use to the Field Expert, either by rearing them in quantity at the Central Institute and sending them out as required to control crop-pests, or by sending out extra help to breed them on the spot. This has already been done to some extent from Pusa, in the case of parasites of the cotton bollworm in the Punjab, but it will only become a practicable proposition on a large scale if there is a sufficiently large entomological staff to carry out such work.

The Entomological Service would therefore help the Agricultural Service by a thorough investigation of crop-pests and by recommendations for dealing with such on a field scale, leaving to the Agricultural Service the carrying on of such control measures as a regular routine, once their efficiency had been thoroughly demonstrated. To use an Entomological Expert for routine work of this sort seems to me a waste, as his services will be much better employed in investigation of another problem requiring them.

In some cases the Agricultural Departments may require the permanent services of entomological workers to carry out routine measures, in the case of sporadic outbreaks of pests, for demonstration of approved means of control, or for other similar purposes. One very useful function would be the prompt reporting to the Entomological Institute of all outbreaks of crop-pests. In such cases the services of a highly trained expert would not be required, and the present grade of Entomological Assistants in the Agricultural Departments should be competent to do such work. They will, in fact, require to be retained and their numbers expanded as the Agricultural Departments develope, and I should be inclined to recommend that one Entomological Assistant should be placed under each Deputy Director of Agriculture for the work noted above. These Entomological Assistants* should belong to the Agricultural Departments, as at present, and work under the orders of, and correspond with, the Entomological Institute through the Deputy Directors of Agriculture. At the same time, they will be able to obtain help and advice as required from the Entomological Research Institute and will have the whole advantages of centralised collections, records and publications on entomology. It would probably be practicable, and undoubtedly it would be advantageous, to send these Agricultural Entomological Assistants to the Entomological Institute occasionally, for a short course in agricultural entomology, to rub up their knowledge.

The Agricultural Departments have also at each of their Agricultural Colleges an Entomological Assistant who gives a course in Agricultural Entomology to the College students. These men should similarly be retained in their present positions in the cadre of the Agricultural Service. At the same time they would have the advantage of the help and advice, when required (through the Agricultural Department officers), and publications of the Entomological Institute. The course of training in agricultural entomology at the Agricultural Colleges is necessarily elementary, and the present grade of Entomological Assistants should be quite competent to give it. To employ an Entomological Expert on elementary work of this nature is a waste of his time, which could be better employed at research work. At the same time, if there was any desire to this effect on the part of the Agricultural Colleges concerned, it would be practicable to arrange to send an entomological lecturer from the Entomological Institute to give a short course of lectures annually at each college and, if necessary, to inspect the entomological

* NOTE.—For the sake of convenience I have retained the present title of Entomological Assistant, but these men could equally well be included in the ordinary cadre of the agricultural branch of the Agricultural Service (under the name of Inspectors or any suitable title).

courses at the colleges and keep them up to the mark. There are now Agricultural Colleges at Coimbatore, Poona, Nagpur, Sabour, Cawnpore and Lyallpur, besides Pusa, and there will presumably be Agricultural Colleges in the future at Dacca, Mandalay and Peshawar, so that a course of lectures at each of these places would make a year's work for one man. This work could be done by a senior Entomological Assistant, and it need hardly be added that such a type of lecture-course would ensure efficiency (by using the services of a specially picked man equipped with the latest facts) and economy in the preparation of specimens, models, diagrams, lantern slides, etc. Such a course of lectures would be supplementary to the ordinary College course.

The changes in the present entomological staff of the Agricultural Departments consequent on the foundation of an Entomological Service would be as under :—

Pusa.

The Entomological and Pathological Sections would be transferred *en bloc* to the Entomological Research Institute, only one entomological lecturer being retained at Pusa to give a course in agricultural entomology to the Agricultural students.

Madras.

The whole of the Entomological Section (with the exception of one Assistant as entomological lecturer at the Agricultural Colleges) to be transferred to the Entomological Research Institute.

One Agricultural Entomological Assistant to be provided to work under each Deputy Director of Agriculture.

Bombay, Central Provinces, Bihar, Bengal, Assam, Burma, United Provinces and North-West Frontier Province.

No change except that one Entomological Assistant to be provided to work under each Deputy Director of Agriculture.

Punjab.

The recently sanctioned post of Entomologist to be absorbed in the staff of the Entomological Institute. No other change except that one Entomological Assistant to be provided to work under each Deputy Director of Agriculture.

At present, therefore, there would be comparatively little change in most of the provinces but, allowing for future expansion of the Agricultural Departments in the provinces into suitable circles, each under an Agricultural officer and each provided with an Entomological Assistant, the numbers required would be approximately as under* :—

Province.	For fieldwork in Agricultural circles.	For teaching at Agricultural Colleges.
Baluchistan	1	..
North-West Frontier Province	3	1
Punjab	5	1
United Provinces	5	1

* NOTE.—I have made no provision for Mesopotamia as it is at present uncertain how much will be included in the Indian Empire.

Province.	For fieldwork in Agricultural circles.	For teaching at Agricultural Colleges.
Bihar	5	1
Bengal	5	1
Assam	4	...
Burma	6	1
Madras (including Coorg)	7	1
Bombay	6	1
Central Provinces and Berar	5	1
Pusa	...	1
TOTAL	52	10

The cost of the foregoing alterations would show a saving to the Agricultural Department on the present figures, but would increase gradually as the country becomes subdivided into circles until the full numbers were attained. On a basis of full numbers, the cost for each Agricultural Entomological Assistant would be roughly :—

	Rs.	Rs.
Pay	2,500	
Travelling allowance	1,500	5,000
Apparatus, insecticides, and general office charges	1,000	

In some provinces the rates of pay are lower than in others, but probably a figure of Rs. 5,000 per annum represents a fair average for India as a whole. In the case of the College lecturers there would be a saving on travelling allowance and insecticides, but, on the other hand, these posts would be generally held by the more senior and experienced and intelligent men whose pay would run higher, so that in their case also the annual budget estimate of Rs. 5,000 may be taken as a fair average.

On these figures the cost would approximately be :—

	Rs
Baluchistan	5,000
North-West Frontier Province. Four new men at Rs. 5,000 =20,000, less approximately Rs. 1 000 now spent	19,000
Punjab. Six men at Rs. 5,000=Rs. 30,000, less approximately Rs. 25,000 for Government Entomologist (already sanctioned), staff, and office expenses	5,000
United Provinces. Six men at Rs. 5,000=Rs. 30,000, less approximately Rs. 2,000 now spent	28,000
Bihar. Six men at Rs. 5,000=Rs. 30,000, less approximately Rs. 7,000 now spent	23,000
Bengal. Six men at Rs. 5,000=Rs. 30,000. less approximately Rs. 1,000 now spent	29,000
Assam. Four men at Rs. 5,000=Rs. 20,000, less approximately Rs. 2,000 now spent	18,000
Burma. Seven men at Rs. 5,000=Rs. 35,000, less approximately Rs. 5,000 now spent	30,000
Madras. Eight men at Rs. 5,000=Rs. 40,000, less approximately Rs. 20,000 now spent	20,000
Bombay. Seven men at Rs. 5,000=Rs. 35,000, less approximately Rs. 6,000 now spent	29,000

	Rs.
Central Provinces and Berar. Six men at Rs. 5,000= Rs. 30,000, less approximately Rs. 4,000 now spent .	26,000
	+2,32,000
Pusa. (As post-graduate teaching will be given here the man selected will require higher pay.) One Lecturer + Rs. 8,000, less present cost of two Entomological Sections—Rs. 75,000	—67,000
	+1,65,000

But it should be remembered that, in the absence of a centralised Entomological Service, the entomological staff of the Agricultural Department in nearly all the provinces would normally expand to include at least one Entomologist and a staff, besides expenses for laboratories, house-accommodation, library, etc., so that the totals for all major provinces (except Madras and Punjab) require a relative reduction of roughly Rs. 20,000 each.

Relations with Forest Department.

29. The relations of the Entomological Service with the Forest Department would roughly follow those of the Entomological Service with the Agricultural Department.

There would be firstly the Entomological Experts, with their assistants and collectors, employed on investigation of forest pests. This work would necessarily be done in close touch with the local Forest officers, who would carry out control methods for each pest after these had been worked out. The Experts' work would be primarily research on the insects concerned, their life-histories and occurrence, followed by experimental work on control in close collaboration with the Forest officers, at first on a small scale and later (if successful on a small scale) on a larger scale, measures found successful on a large scale being thereafter carried out by the Forest officers as routine methods in checking particular pests. It should be noted that such measures would usually become purely silvicultural operations.

The Forest Department would probably also require on its own staff the services of a small number of subordinates (1) to collect information regarding the occurrence of insect pests, and (2) to apply approved control measures under the Forest officers. I have no exact information regarding the number of forest areas in which such men could be usefully employed, but, if there were twenty such men in the department, this would allow roughly for one such man under each Forest Conservator. Their duties would be to tour in such areas as were indicated by the Conservator under whose orders they were acting, and to enquire into and collect specimens of all insects found damaging forest trees, such specimens and information being forwarded through the Forest Department to the Entomological Institute, which would then possess an exact record of the occurrence of forest pests in each area. These records would, in the course of time, prove an invaluable asset in allocating the investigations to be undertaken by the Entomological Experts, both on the part of the Forest Department and of the Entomological Service. The amount of pay, expenses and travelling allowance for each of these men would undoubtedly vary considerably in different districts, but probably a sum of Rs. 5,000 for each annually would cover all expenses on a general average for the Indian Empire.

The Forest Department would also require to provide for instruction in forest entomology at their Research Institutes at Dehra Dun, Coimbatore, and hereafter in Burma. Very advanced instruction is not required, but the instructor should be attached to the Forest Research Institute permanently in order that he may be able to accompany the Forest students on instructional

tours. Such a post of instructor could probably be filled in course of time by selection from the Forest Entomological Assistants described above, and would form a higher appointment for the best of such men, being graded roughly on a scale of pay of about Rs. 250-600. It should be practicable to get together the Forest Entomological Assistants and Forest Entomological Instructors at regular intervals (annually or biennially), either at the Entomological Institute or at the Forest Research Institutes, to discuss their work and to go over it with the Entomological Experts employed on forest work, so as to get the fullest benefit out of the work of these men.

The following is the estimated cost of the scheme:—

	Rs.
Twenty Forest Entomological Assistants* at Rs. 5,000 each .	1,00,000
Three Entomological Instructors (one each for Dehra Dun, Coimbatore and Burma) on pay of Rs. 5,000 with travelling and other expenses of Rs. 3,000. 3 (Rs. 5,000+3,000) .	24,000
Total .	1,24,000
Deduct cost of three Forest Zoologists (one each for Dehra Dun, Coimbatore and Burma) with pay, allowances, and staff transferred to Entomological Service. Say Rs. 25,000 each .	—75,000
Total .	+49,000

The total extra cost to the Forest Department would, therefore, come to roughly half a lakh annually, which is a comparatively small sum to pay for a comprehensive system of investigation of forest pests throughout the Indian Empire, whilst half of this sum represents cost of instruction of Forest students.

Relations with the Medical Department.

30. This subject has already been dealt with to some extent under "Problems in Medical Work." I think that the whole work, from the entomological side, could be carried out by the staff of the Entomological Institute, and that it would not be necessary for the Medical Department to maintain any special entomological staff of its own.

Estimated cost of the scheme would be:—

	Rs.
Medical Entomologist, staff and allowances, at present paid from Medical Research Fund—to be transferred to the Entomological Institute	10,000 (approximately).

Relations with Veterinary Department.

31. It is proposed to employ one Entomological Expert, with necessary staff, exclusively on investigations of insects carrying disease to domesticated animals in the Indian Empire. His work would be arranged by the Director of the Entomological Institute in consultation with the Imperial Bacteriologist and the principal Veterinary officers in each province. The Expert would tour as required and work at his problems in close collaboration with the local Veterinary officers. The Veterinary Department would also have the benefit of the use of the Entomological Institute for identification of insects found in association with domestic animals.

The scheme would imply no increased or decreased cost so far as the Veterinary Department is concerned.

Relations with the Indian Museum.

32. In the term "Indian Museum" I propose to include the Zoological Survey because, although nominally separate, the work of the Zoological Survey is centred in the Indian Museum at Calcutta.

* The title is immaterial. They could be called Entomological Rangers or any other title.

The present staff of the Indian Museum, so far as entomology is concerned, comprises one Assistant Superintendent and a small number of assistants and setters (about two assistants and three setters). The collections, as in most large museums, comprise (*a*) a small collection, open to the public, of representative examples of insects, and (*b*) a larger collection, or series of collections, not open to the public but only intended for special entomological students. The collections contain some good material, but are comparatively small, nor does there seem to be much room in the Museum building for sufficient expansion to provide for a really representative collection of Indian insects. If any serious attempt is to be made in the future to provide for a large collection of Indian insects, the Museum (including Zoological Survey) would have to provide at least a dozen specialist workers to work on nothing but the systematic side of entomology, and even a dozen men could not attempt to tackle the whole insect fauna of India, whilst, if they did, their work would (1) necessarily overlap that done by other entomological workers (under present conditions) in the Agricultural, Forest, and other Government departments, (2) be comparatively worthless to the Indian Empire; if nomenclature as such were to be the final aim of these Museum workers. The climate of Calcutta, also, is absolutely unfitted for the proper preservation of dried insect specimens, owing to the excessive damp during the rains.

I do not think that the Zoological Survey will ever be in a position to correlate the varied entomological work even now being done in India, largely because the area of entomology is too vast for inclusion in the Survey, without an unduly large expansion of its staff. It must be remembered that about 80 per cent. of the whole Indian fauna is composed of insects.

I recommend that the whole of the Entomological Section of the Indian Museum (including staff and study collections and library, so far as these are the property of Government,) be transferred to the Entomological Institute, leaving the Indian Museum a small collection of insects for exhibition to the public, this small collection (and other similar collections in other museums) to be maintained in future by the Entomological Service, which would depute a special Assistant to go around the various museums to see to the renewal, display and upkeep of such public collections. By this means the Zoological Survey would be able to specialise more completely on marine biology, in which direction the officers of the Museum have been doing good work (specially in connection with the R. I. M. S. "Investigator" and fresh-water fauna) for some time past. The Museum would also remain a centre for work on mammals, birds, reptiles, and other animals, except insects.

The cost of the scheme to the Museum would be :—

	Rs.
Cost of present Assistant Superintendent for entomology, staff and expenses, to be transferred to Entomological Institute	—12,000 (approximately).

Relations with other museums in India.

33. There are various other Government museums in India (at Madras, Nagpur, Lahore, Darjeeling, etc.), and many of these maintain a small exhibition collection of Indian or local insects. There are no regular entomological staffs at any of these museums (except the Indian Museum at Calcutta), and the exhibited series of insects are as a rule very poor. With the aid of the Entomological Institute, which would be yearly receiving large collections of insects from all parts of the Indian Empire, it would be quite practicable to put aside a proportion of identified and surplus duplicates of insect specimens for these museums, due regard being paid to local requirements, and to send around a specially selected Assistant to visit such museums periodically and arrange such duplicates for display, replace faded and damaged

specimens, and generally look after this section of each museum. By this means the museum staffs would be relieved of a piece of technical work with whose details they are not usually conversant, and the general public visiting the museums would gain by seeing the best available collection of insects. There would be no idea of setting up complete collections of insects in these museums, but only of exhibiting representative series, which is all that is required generally.

The cost of the scheme to the museums would be *nil*, and the gain in general efficiency would be considerable.

Relations with Educational Service.

34. The museums and Medical Services come under the general heading of "Education", but I refer here more particularly to the relations of the Entomological Service with the Educational Department as such.

The Entomological Research Institute would be intended purely as a Research Institute, and it is not intended that the energies of the staff should include regular training in entomology, although of course all real students would be welcomed and given every facility for work. There would thus be no direct relations or competition between the two services; but the experience and knowledge of the Entomological Service would be freely available to the Educational Service for such items as the preparation of nature-study manuals or any similar items which might deal with life-histories or bionomics of insects.

Relations with Geological Survey.

35. The Entomological Experts at the Entomological Research Institute could doubtless assist the Geological Survey by technical advice regarding fossil insects, which may at times throw some light on palæontological problems. Similarly, it is probable that in some cases the distribution of certain insects may depend on the geological nature of certain areas, and the Geological Survey could advise on this point; in this connection it may be noted that, as the Entomological Institute is intended to gather a general collection of insects from all parts of the Indian Empire, it will be in a far better position to study such problems as distribution, than any of the present scattered workers, each with an incomplete collection.

Relations with Customs.

36. The notification yet to be issued under Act II of 1914 for regulating the importation into India of insect pests must be considered in this connection. As experience is accumulated, it is inevitable that more stringent restrictions will be found necessary to regulate the importation of insect pests and to control by legislative means those which are already in the Empire, and it is obvious that a strong Central Entomological Institute will be in the best position to advise on any points which may arise and to carry out in a uniform manner any restrictions which it may be found necessary to impose. If there is one centralised Entomological Institute, the Customs Department will know exactly where to apply for any information required and, if it should be necessary (for example) to provide an entomological staff for inspection or fumigation of imports or to carry out the requirements of any Internal Pests Act, such staffs should be under the control of, or at least in touch with, the Entomological Institute.

Relations with other entomological stations and workers outside India.

37. As already pointed out, the entomological worker in India is concerned not only with problems of his own area, but with similar or cognate problems of areas outside of his own. The insect pests of Ceylon, Java, Malaya Formosa, Queensland, and to a less extent of other parts of the world, are not only of interest but of importance to the worker in India, and it is absolutely necessary to keep in close touch with work that is going on in these other localities, whilst of course our work in India is of equal interest to them. The advantages of a centralised Entomological Institute are perhaps nowhere more apparent than in dealing with this aspect of the subject. If, for example

there are numerous scattered workers in India in the Agricultural Forest, Medical and other departments, it is equally impossible for each of them to keep in proper touch with extra-Indian work and for extra-Indian workers to keep in touch with the work of each one of them. There are also grave difficulties, such as those concerned with the languages (French, German, Latin Dutch, Italian, Spanish, etc.), in which such extra-Indian publications are issued; no one entomological worker can be expected to be conversant with all even of the six languages named above (although he should know at least two), even if he should be able to get hold of all the various publications; but it would be a comparatively easy task to receive in one Entomological Institute all these scattered publications and to have them abstracted and, if necessary, translated for the use of the Institute. Similarly, it would be of the utmost advantage to all extra-Indian workers to have all publications on Indian insects issued and available from one centre, so that they could at once ascertain what work had been published on any particular insect, instead of having to consult numerous journals and publications of several departments, as at present.

Publications.

38. As pointed out in the preceding paragraph, the present system of publication of information on Indian insects is so diffused that it is becoming increasingly difficult to keep track of the literature. When the Entomological worker has to keep track of the information on Indian insects published in India in the *Bombay Natural History Society's Journal*, the *Indian Journal of Medical Research*, the *Agricultural Journal of India*, the *Memoirs* and *Bulletins* of the Agricultural and Forest Departments, the *Indian Forester*, the *Memoirs* and *Records* of the Indian Museum, besides innumerable provincial journals, leaflets and other publications on agriculture, etc., the work becomes more involved as the sets of these publications expand; but, when he enters on extra-Indian literature, he has to contend with an absolutely unwieldy mass of publications, past and present, many of which have to be gone over in detail to see whether they contain any information of interest or importance, as the mere titles of papers are frequently very misleading.

For the sake, therefore, of all interested in entomological publications, both in and outside of India, I recommend that all the present purely entomological publications issued by Government should be discontinued and amalgamated into one set of publications to be issued by the Entomological Research Institute.

The publications of the Entomological Research Institute would include (1) reports and results, scientific and applied, of the work of the staff of the Institute; (2) such other papers on Indian entomology as were deemed of sufficient value to merit publication; and (3) abstracts of all current literature on Indian insects or related problems.

In the case of other Government publications, such as the *Agricultural Journal of India*, they would not necessarily be deprived of all entomological contributions, although the tendency will be for such publications to become more specialised, but, if entomological papers were published in such, they would be abstracted by the Entomological Institute, and so brought to the notice of the entomological public.

Summary of foregoing.

39. In a short historical *résumé* of the rise and progress of entomology in India, I have indicated briefly the growth of this study until the present time, when it deals with roughly 35,000 different described forms of insects, this being, perhaps, roughly half of those actually existent within the Indian Empire. Subsequently I have reviewed the progress made in entomology by the Indian Museum, the Agricultural Department, the Veterinary Department, in medical entomology, in forest entomology, and in other entomological work in and outside of India, and have endeavoured to show

that the scattered efforts made in these various directions show a lack of the coherence necessary to the best efficiency, which can, in my opinion, be best secured by a centralised scheme of entomological research. I have also briefly reviewed the progress of applied entomological work in the United States, Canada, South Africa, and Australia, in which cases also the results actually attained seem to support the idea of the advantages to be derived from a centralised scheme in India. Finally, I have sketched out such a centralised scheme in some detail.

Supplementary Questions and Answers.*

Q. 1 (*a*) Is it not the case that for agricultural entomology, the life-history of an insect must be examined and remedial measures devised, in close and constant touch with agricultural, botanical and economic conditions, in order to avoid work on impracticable lines?

A. This is obviously the case with this qualification, that a close study of the bionomics of the insect in question must precede and form the foundation of any applied remedial measures. There is much less danger, as is shown by practical experience in the past, of any want of close touch with agricultural, botanical, or ecomonic conditions than there is of work on wrong lines owing to want of detailed work on the bionomics of the insect or insects concerned. As examples of this I would adduce the following instances which are only a few out of many :—

(1) Termites destroying wheat at Hoshangabad ; see pages 196-197 of "Report of the Second Entomological Meeting."

(2) Cane-borers ; see pages 142-143, *loc cit.*

(3) Further recent work has shown that the rice-stem borer (Chilo sp.) is distinct from borer (Chilo simplex) in *juar*, etc., with which it has hitherto been confused.

(4) Microbracon (Rhogas) spp. parasitic on cotton bollworm (Earias spp.) see page 107, *loc cit.*

In all these cases, and in numerous others, detailed work on purely entomological lines is necessary as a pre-requisite of any applied work. In such cases as control of pests by the use of natural parasites, work on purely entomological lines will be required, not only because such work requires special technique in breeding, etc., such parasites, but to ensure that only efficient parasites are utilised and that they are used under the best conditions, free from hyperparasites, etc. Work of this sort requires the very best type of entomological worker devoting his whole time and attention to one particular problem, and it is only after this preliminary and purely entomological investigation has been carried out that we shall really be in a position to begin to consider remedial measures in relation to the agricultural, botanical or economic aspects of each case. In the meantime, we can of course recommend rough and ready remedies in many cases (*e.g.*, bagging of grasshoppers, hand picking of caterpillars, spraying, etc.), but such remedies are merely temporary palliatives to minimise damage actually being done, whereas what is required is the prevention of damage. As regards collaboration with agricultural, botanical or other experts by members of the Entomological Service, this is fully provided for in my scheme (see remarks under "Relations with other Government Departments"), and I do not think that anything more requires to be said under this heading.

Q. 1 (*b*) Is not this likely to be the case with other lines of work?

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* These answers were given in reply to questions of the Commission based on the foregoing proposals.

A. I understand this question to refer to the devising of remedial measures for other than agricultural pests and the reply to the preceding question will apply equally, *mutatis mutandis*, to this one.

Q. 2. In view of the necessity so shown of keeping in touch with provincial departments and of the strong representations for autonomous department that provincial Governments will set up, will it not be sufficient :—

(1) to have an Entomological Service, in order to facilitate recruitment and promotion,

(2) to second a large proportion of its members to provincial or other departments for definite periods or problems,

(3) to maintain touch among workers by submitting their reports to the central authority of the Entomological Department, by periodical meetings, by the publication of records, and by tours of inspection by the head of the Entomological Department who would advise Local Governments and departments ?

Would not these measures obviate the danger of overlapping or unnecessary duplication of work in the case of a pest common to more than one province ? Might men so seconded be given special allowances for different classes of work as to which the head of the Entomological Department would be consulted ?

A. The benefits to be derived from a centralised scheme, as already outlined in my note, appear to me to outweigh any representations that may be set up by provincial Governments for autonomous departments. In my opinion, the question of expansion of entomological work, in all its aspects, in the provinces cannot be considered apart from the far larger question of the development of entomological work in the Indian Empire as a whole. We have now had sufficient experience during the last twelve years :—

(*a*) to indicate the lines on which expansion of entomological work in India is necessary and desirable,

(*b*) to foresee the effects in the future of development on the present decentralised lines, and

(*c*) to reorganise the work before such decentralised development has gone too far.

I am quite aware that any scheme for centralisation of work will be likely to be looked at askance from a purely political point of view, but India is a large country and also a relatively poor country, and furthermore a country in which the ravages of insects, as pests of crops and forests and as carriers of diseases to man and animals are of vast monetary value. Yet, as Indian revenues cannot provide for more than a limited amount of control of such injurious insects, it is the more necessary to see that the very best and most efficient use is made of the amount of money available, and this necessity should take precedence of any *amour propre* desire of provincial Governments to have their own autonomous departments. I am, as a matter of fact, doubtful whether there will be the amount of opposition implied in the Commission's question on the part of Local Governments to a centralised scheme of entomological work, at least as far as the Agricultural Departments are concerned. I have discussed my scheme informally with several Directors of Agriculture and other officers of the Agricultural Departments, and their opinion hitherto has been that such a scheme will meet the requirements of the provincial departments. Some weight might, perhaps, be attached in this connection to the feeling of agricultural officers (*i. e.*, agriculturists as opposed to specialists in other branches) that they themselves have not the special knowledge requisite for the control of such specialists' work (particularly in the future as this becomes more and more detailed and specialised), and they are therefore likely rather to welcome than to oppose the transfer of the control of such specialists' work, provided

that their own departments do not suffer. Furthermore, in the case of practically all our Indian insect pests, the preliminary entomological investigation will be applicable, not to one province also, but to all areas in which such pests occur, although it is possible in some cases that control methods will vary in accordance with varying agricultural practices, although any variation in these last does not necessarily coincide with provincial boundaries. So far, then, as concerns the research side of the work, which will be the main object of the Entomological Service, this will not be provincial in its aspects. I am very strongly of opinion that efficiency and economy can only be combined, so far as entomology in India is concerned, by a centralised scheme of research and work, at least somewhat on the lines I have endeavoured to describe in my note. It is, I think, our duty now to initiate a comprehensive policy, considered from the point of view of the Indian Empire as a whole and not from any provincial outlook, and which will be capable of expansion without overlapping of different branches of work or scrapping of previous work, and which will be of immediate benefit to the peoples of India in the present generation and of incalculable benefit to their successors.

As regards the seconding of a large proportion of the members of the Entomological Service to provincial or other departments for definite periods or problems, this is dealt with in the sections of my note under "Problems in agricultural work" and following paragraphs, read in conjunction with "Relations with other Government departments". I see no necessity for seconding the members of the Entomological Service to other departments, as such a procedure would cut at the very root of the whole idea of the Entomological Service as such, *viz.*, that the investigators working on particular problems should be unfettered by any local restrictions or other demands on their time. As already pointed out, the distribution of any pest will very rarely coincide with provincial boundaries, and its investigator must be free to work on it throughout its whole area of occurrence. Nor should his time be taken up with unnecessary correspondence, teaching, or the investigation of Local problems outside his specific objects of study; if seconded to a Local Government or other department, there would be sure to arise cases where dual sets of instructions to the investigator would lead to loss of efficiency in work. I am, therefore, against any idea of seconding. The investigators should be treated as touring officers from the Central Institute, although the tour in some cases might be a prolonged one. They would in fact be detailed for definite problems, but not for definite periods. If the entomological experts were to be seconded for definite (and presumably prolonged) periods, the Local Governments or departments would have to provide proper accommodation, laboratories, libraries, etc., which expenses are avoided by my scheme.

Proposals for maintaining touch between the Entomological Service and other workers under the provincial Governments or in other departments by periodical meetings, by publication of records and by touring have already been included in my note. The members of the Entomological Service out on tour would keep in close touch with the Entomological Institute by frequent correspondence (including reports) and by visits to headquarters as necessary; at the present stage it is unnecessary to elaborate rules for this.

As regards the prevention of overlapping of work by mere advice to Local Governments and departments, past experience has clearly shown that such a system is a failure in many cases because, if the technical experts are only empowered to advise without any control, in practice they cannot advise in cases where little or no interest is taken in the work or where the work is being done on wrong lines by local officers. In such cases, advice is only given when it is asked for and, if given unasked, is not followed, with the result that it is

not volunteered subsequently. If there is no control, there is no responsibility, and, without a sense of responsibility, there ensues a decided lack of interest, which results in a loss of efficiency in the work.

As regards the giving of special allowances to men employed on different classes of work, I think it is premature to lay down any rules regarding such cases. As noted in my scheme, "the pay would depend largely on the special qualifications of each man", and his qualifications and capacity would necessarily determine his line of work. If the men employed away from the Entomological Institute were regarded as on tour, they would presumably receive travelling allowances under the ordinary regulations to compensate for the extra expenses to which they would be put, and in some cases it might be necessary to give special extra allowances in special cases. For example, if the Pathological Expert were to give a course in medical entomology at one of the Tropical Medicine Institutes in Calcutta, Bombay or Madras, he might be given a special allowance whilst doing so, to compensate for the extra expense of a prolonged halt in an expensive locality. But, as already stated, I think it is premature to consider such cases, which could be dealt with as they arose.

APPENDIX L.

INDUSTRIAL DEVELOPMENT AND PUBLIC HEALTH.

By Major F. Norman White, C.I.E., M.D., I.M.S.,

Sanitary Commissioner with the Government of India.

Fundamental importance of 'public health' in industrial development.

In spite of the remarkable advance ever being made in the perfecting of labour-saving devices, the human being remains the most important machine in the production of wealth and in industrial development. Viewed thus, all measures designed to improve the efficiency of the human machine are matters of economic importance that modern industry cannot afford to overlook. It is ever becoming more clearly recognised that 'Public Health,' with its two main functions of preventing disease and increasing the welfare of the individual, is of fundamental importance in the industrial development of any country; that the question of man power is fundamentally a health question; and that health considerations must enter very largely into the relationship of capital and labour as well as into all other sociological problems of the present day. Such assertions are true of every country; but in India, where labour is less organised than in the more advanced countries of the west, where the prevalence of parasitic infections and serious epidemic disease is excessive, and where climatic conditions and environment generally are extremely unfavourable, the neglect of public health brings an immediate and striking punishment. In spite of this, the subject of industrial hygiene has received remarkably little attention in India until quite recent times, and to-day its importance is not fully recognised in any part of the country. The main cause of this neglect of so important a matter would appear to be due to the fact that labour in India has been in the past both plentiful and cheap; moreover, the introduction of public health reform in India has ever been attended with peculiar difficulties, difficulties which dictated a policy of *laissez-faire*, incompatible with progress.

Even in England, where health matters were in a relatively advanced state, special laws to safeguard the well-being of munition workers were considered necessary to secure a satisfactory output. It was realised that all new industries present special health problems which demand attention. How much more do such matters require attention in backward India?

Neglected health conditions in labour-recruiting centres and necessity for reform.

2. The recruiting centres of Indian labour forces are for the greater part rural areas, where public health conditions are no whit more advanced than they were when the etiology of all the important communicable diseases of the tropics was enshrouded in mystery. It has been possible to apply a few of the remarkable results of modern research to urban areas, but there are no considerable rural tracts in India that have benefited, for example, by the discovery of the part played by mosquitoes in the propagation of malaria. And yet, more than 90 per cent. of the population of India is a rural one and malaria is all but everywhere prevalent, playing a part of overwhelming importance in the morbidity of the country. This is not the place for a full discussion of all the causes underlying the neglect of public health in rural India; reference to the matter has been dictated by a desire to indicate the extent of the ground lost and the consequent necessity for making an immediate start, if India is to compete with any prospect of success in modern industrial enterprise.

In the complete absence of any rural health organisation, it is not possible

to cope with outbreaks of plague and other devastating diseases which are o annual occurrence, and which run their course almost uncontrolled. Such epidemics can and do interfere most seriously with recruitment of labour, quite apart from the so serious direct mortality they inflict. Moreover, labour recruited from such unhygienic surroundings is seriously handicapped from the first. Living an outdoor life, engaged in agricultural pursuits, the ryot is able to put up with the considerable degree of parasitic infestation so commonly seen; malaria and hook-worm infection, for example, is not incompatible with a fair output of agricultural work in such circumstances. Transference to large industrial centres, however, involves a change of environment which apart from other considerations connotes increased liability to disease. A more confined atmosphere, crowded insanitary dwellings, lack of outdoor recreation are certain to exercise a baneful influence and render the factory employé mor liable to fresh infections and to upset the compromise that his body has been able to effect with the parasites that it harbours. Had the large employer of labour a plentiful supply of really healthy material to start with he would still be under an obligation to secure for his operatives an environment above reproach; how much greater is the present need for hygienic environment, when in most cases cure has to precede the conservation of health?

From what has been said it will be clear that the progress of health administration in India as a whole and the control and eradication of communicable disease are matters of vast economic concern to the industries of India. The writer is firmly convinced that an improvement in general health conditions is a necessary preliminary to industrial as well as to all other forms of development.

It is frequently stated and commonly accepted that a community or a country can obtain as much health as it is willing to purchase, but it is not so commonly realised that large sums devoted to the purchase of health are certain to be remunerative financially. In this country it is generally assumed that early progress is impossible, and that education must precede any real progress in health matters. If all teachers in our primary schools had even a small acquaintance with the laws of health, and lived as if they believed in them; if they were never unmindful that children take their bodies to school, as well as their minds, something might be said in favour of the policy of making sanitation wait on education; progress though slow would be sure. As things are, the waste of educating children and then allowing them to die of preventible disease before they attain the age of productivity is sufficient to demonstrate the economic necessity at least of allowing the two activities to proceed *pari passu*. Moreover, a mind enclosed in a healthy body is infinitely more receptive than one enclosed in the parasite-infested body that is found so commonly in our schools. Sir Ronald Ross states in his book "The Prevention of Malaria":—'I have seen a large class of coloured children, almost all of whom were suffering at the time from fever or enlargement of the spleen, being taught the dates of accession of the Plantagenet kings.' If health development has to wait on education of such a kind, progress is impossible.

Inefficiency of Indian labour largely a health problem.

3. All are agreed that the organised labour of India is relatively inefficient and that the wage-earning capacity is low. It is difficult to assess the importance of disease as a contributory cause of this state of affairs. There is very little statistical data that can be relied on regarding the incidence of occupational disease or of the effects of industrial occupation on the prevalence of the common forms of communicable disease. This is a matter that urgently calls for thorough investigation. The difficulties of such an investigation are

considerable, not the least being due to the fact that industries are not supplied by a settled labour force. When disease makes further labour impossible, the unfortunate victim commonly departs to his village and is lost to observation.

In spite of the admitted paucity of reliable statistical data, it may be profitable to offer a few remarks as to the effects of three diseases on the efficiency of labour, *viz.*, malaria, hook-worm disease and tuberculosis. These three diseases have been selected for the following reasons. Malaria and hook-worm infection are almost certainly the two most potent causes of "inefficiency." Both are almost universally prevalent in India; both exercise their malign influence from earliest childhood and seriously interfere with bodily and mental growth and development; both, by undermining the constitution, render the body more prone to infection with other disease. Directly and indirectly they are responsible for an enormous mortality bill. Tuberculosis has been included because of the special risks, with regard to spread of infection, entailed by large aggregations of labour in any but the best hygienic surroundings. In India a low degree of prevalence of these three diseases indicates a satisfactory environment and a high level of personal hygiene. The three diseases together can in fact be used as a reliable gauge of the sanitary and health conditions of any Indian community.

Hook-worm disease and industrial efficiency.

4. The increased attention that has been devoted in recent years to the subject of hook-worm disease is largely the result of the initiative displayed by the International Health Commission of the Rockefeller Institute. For years past we have known hook-worm infection to be very common in most parts of India, but because ankylostomiasis, or serious symptoms *directly* attributable to the parasite, is comparatively rare, we in India fell into the rather natural error of assuming that the hook-worm is not a factor of any great moment in the morbidity of the country. Having realised this assumption to be unjustifiable, the matter has been made the subject of fresh investigation, with the result that in large areas of the country infection with this noxious parasite is found to be almost universal. In the Madras Presidency little short of 100 per cent. of the rural population are infected. Over 70 per cent. of the tea-garden labour forces of Darjeeling are infected, and a similar state of affairs is found to prevail in the plains of Bengal. Enquiries are being prosecuted elsewhere. In India most of the infections are light, *i.e.*, the number of hook-worms per case is not large. A casual inspection of the inhabitants of a village, all of whom harbour the worm, always raises the doubt as to the possibility of the worm being a potent source of harm. Apparent good health and the presence of, say, fifty hook-worms in the intestine are certainly not incompatible. 'Good health,' however, is but a relative term, and we have already had sufficient experience to learn that the phrase connotes a much higher standard of efficiency among a population that has been freed from hook-worms than among an infected one. There are instances in the gardens of Ceylon of the output of the Indian labouring forces having been increased as much as 25 per cent. as the result of treatment with vermifuges, and this surprising increase in efficiency has been accomplished with a lessened prevalence of disease of all kinds. A marked increase in efficiency has been noted, similarly, in the Darjeeling tea gardens, after general medication with thymol. In short, there is ample justification for the dogmatic assertion that eradication of hook-worm infection from Indian industrial forces is certain to be followed by an appreciable increase in general efficiency, consequent upon improved general health and the lessened incidence of other diseases, chiefly those of an intestinal nature.

It is not, however, the direct results of hook-worm campaigns that are

alone important. The collateral benefits that well-organised campaigns have secured have been even more striking than the direct results achieved. Most have led to a demand for sanitary reform, that has led to a further lessened prevalence of almost all diseases. Experience in the southern states of America is a striking illustration of this. The oft-quoted American experience in the Bilibid jail in Manila is another case in point. When America assumed charge, the death rate in that jail was reported to be 234 per mille. The introduction of all the ordinary sanitary improvements effected a rapid reduction to 75 per mille. Further improvement was not effected until the question of hook-worm was investigated; the administration of thymol was followed by a reduction of the mortality rate to 13·5. The recent marked improvement in the health conditions of Assam jails is almost certainly another case in point.

Instances could be multiplied, but enough has been said to emphasise the importance of the matter to all large employers of labour in India. A thorough hook-worm campaign offers perhaps the best opportunity of effecting a rapid improvement in the health conditions and consequently the efficiency of our labour forces.

Malaria and industry.

5. The still larger question of malaria can only be dealt with very briefly in this place. As has been indicated, the general incidence of this disease throughout the country is a matter of grave moment to all connected with industrial enterprise. The problem can only be approached when the country has realised the urgent need of a real health organisation in every district throughout the country. The incidence of the disease can be markedly diminished if we are prepared to pay the bill. Once we have embarked on the enterprise, there is little fear that the money will not be forthcoming; results will be patent and the value of health as an imperial asset will be recognised.

One aspect of the malaria problem calls for notice. Indian experience is full of examples of the serious, almost paralysing, effects of outbreaks of malaria among large labour forces engaged on the construction of canals, railways, docks and such like. It is doubtful, however, whether we have yet learnt the lessons taught by past experience. Such outbreaks are in almost every case preventible. Whenever such enterprises are undertaken, the special health problems that are likely to arise call for most careful consideration; the dangers can nearly always be anticipated. When a military force, however small, takes the field, the necessity of a sanitary organisation and precautions to safeguard the health are never overlooked. It is realised that their neglect is certain to lead to disaster. Quite as elaborate precautions are called for in many of our large constructional works, but, with few exceptions, the measures taken in the past have been most inadequate, or altogether wanting, a neglect that has involved both waste and sometimes disaster. Large projects of the nature alluded to are rarely referred to a health expert at any stage of their inception; their probable "financial" cost is estimated to a rupee; their probable cost in human life receives no consideration whatsoever. The Panama Canal was a triumph for the engineer; it was a still greater triumph for preventive medicine which made the engineer's work possible; for once the health official was not subordinated, but given plenary powers; and he made good. Is it not an irony that the most important research of which the results were applied with such profit in Panama was research work done in India, work which has done so little for India as yet?

Tuberculosis is an industrial disease.

6. As regards tuberculosis and its special prevalence in workshop and factory, we have very few statistical records to guide us. There is evidence, however, that the disease is more prevalent in the large industrial centres than elsewhere; that the disease is definitely on the increase in rural areas abutting

on such centres, from which labour is drawn and to which the victims of the disease go to die ; and that sufficient precautions are taken in few factories, to reduce the risk of such places affording facilities for the transmission of tuberculous infection from the sick to the healthy. The city factory and the crowded workshop are not the natural habitat of human beings, and every precaution must be taken to prevent the unnatural environment acting deleteriously on the employés.

Hygiene of factories.

7. This brings one to a consideration of the health conditions of the Indian factory and workshop and of the arrangements made for the housing of employés. The Indian Factories Act, 1911, is fairly comprehensive. There is however insufficient recorded evidence to justify the formation of an opinion as to how it works in practice from the point of view of preventive medicine. Nor do I know how many, if any, health experts have been appointed inspectors under the Act. This is a matter which it might be profitable to consider. The prohibition of the employment of persons suffering from communicable disease does not appear to have been considered in the framing of the Act; this matter also seems worth consideration. The provision of receptacles into which the employés could expectorate with safety is a small but important point, taking into count the habits of the Indian. Such matters cannot be supervised without efficient health inspection ; it is for this reason that reference has been made to them.

Housing of operatives : overcrowding of industrial centres, etc.

8. The housing of operatives is a matter that is fraught with much difficulty. From the public health standpoint, it is most desirable that industrial development be attended by the creation of fresh industrial centres, rather than by adding to the congestion of our already congested industrial towns. No new factory should be allowed to be built anywhere, unless there be sufficient space to house all the operatives without endangering their health or the health of the locality. Even where chawls and dwellings have been provided, they are frequently rendered dangerous by a degree of overcrowding that is inevitable in places where rents are high. However well built and designed the dwelling may have been, overcrowding produces slum conditions in which the preservation of health is impossible.

Another less obvious danger to our present large industrial centres would appear to lie in the great disturbance of the natural sex ratio. Thus, in Calcutta there are 365,000 males and only 131,000 females between the ages of 15 and 40. A certain disproportion is possibly unavoidable, but a disparity of the extent quoted would appear to be a direct health danger. It would be interesting to learn, among other things, what effect such a state of affairs has on the prevalence of venereal disease.

The question of the type of dwelling best suited to the housing of the operatives is too large a one to take up here. In certain places endeavours have been made to perpetuate the type of dwelling to which the ryot is accustomed in his village. Provided due attention be paid to the modifications demanded by health considerations, such a practice may be satisfactory; but it must not be forgotten that the sanitary régime practised in villages is the worst possible; and that the deposit of human excrement on the surface of the soil is not to be commended, and is, in fact, the direct cause of the wide prevalence of hook-worm and certain other parasitic infections. Finally, the village type of house generally signifies a high degree of rat infestation, the dangers of which require no emphasis in plague-infected India.

If the home environment of the operatives of our factories be satisfactory, the development of industries will have an educational value, from the health standpoint, of no mean order. It would, in fact, be a gain to the cause of

public health instead of being the menace which it is certain to be, unless it be more generally realised that efficient health administration is one of the most important functions of the modern state.

Other health problems.

9. In the above memorandum reference has been made to only a few of the many outstanding health problems that are intimately bound up with Indian industry. Such subjects as the effect of the expansion of communications which will accompany industrial development, on the spread of communicable disease; the facilities that the conveyance of natural products and raw materials offers for the spread of plague; and many cognate matters that will suggest themselves, have received no notice. All are of great importance. An exhaustive discussion of the whole subject was never intended, the chief object of the writer being to indicate that a large part of the relative inefficiency of Indian labour is due to removable pathological causes, and to emphasise that an efficient public health administration is essential to progress. The war has taught us that freedom from disease can be secured in spite of the most adverse environment, if the sanitarian be given a free hand. For economic and still more for philanthropic reasons "Public Health" must come into its own.

APPENDIX M.

RULES OF THE MYSORE STATE FOR THE GRANT OF LOANS GENERALLY TO FACILITATE AGRICULTURAL AND INDUSTRIAL OPERATIONS AND FOR THE PURCHASE AND ERECTION OF MACHINERY.

1. In order to facilitate agricultural and industrial operations, loans of money may be granted under these rules for any or all the purposes specified below :—

(1) for the purchase and erection of machinery for agricultural or industrial undertakings ;

(2) for the construction of wells or tanks, of mills, warehouses and other structures necessary for agricultural and industrial operations ;

(3) for the provision of raw material, working capital, or appliances other than those specified above required for the carrying on of industrial operations.

2. The Director of Industries and Commerce shall be competent to sanction loans not exceeding Rs. 1,000 ; loans of larger sums shall be granted with the sanction of Government. Loans granted for the objects specified in (1) and (3) of Rule 1 will ordinarily be subject to a limit of Rs. 10,000 and Rs. 5,000, respectively, in each case.

3. The rate of interest charged shall be 6¼ *per cent. per annum.*

4. Interest shall accrue from the date of the disbursement of the loan ; or, if it is expended by the Department of Industries and Commerce, from the date on which the machinery is put in working order by that department and the borrower put in possession of the same.

5. *Period allowed for repayment and mode of recovery of loans.*—Loans shall be repayable by fixed annual payments, discharging both principal and interest.

Simple interest shall be charged on the loan, or, if it is disbursed in instalments, on these instalments, up to a date one year previous to the date fixed for commencement of repayment ; and the total amount comprising the loan and such interest shall be recovered by annuities.

The time allowed for repayment of the loans and the amount of instalments shall be fixed by the Director of Industries and Commerce ; but such time shall not exceed five years in the case of loans for industrial purposes and seven years in the case of loans for agricultural purposes.

The time for repayment specified above shall count from the date on which interest becomes chargeable under Rule 4 above, provided that nothing in this rule shall be taken to preclude a borrower from discharging the loan at an earlier period or from paying a larger amount than the annual instalment. The excess so paid shall be credited in reduction of principal and the number of future payments shall, if necessary, be decreased, but no reduction in the amount of the instalments fixed under paragraph 2 of this rule shall on this account be allowed.

6. The date for repayment of each instalment shall be decided by the Director of Industries and Commerce in reference to the nature of the object for which the loan is granted. But the date of the repayment of the first instalment shall not be put off for more than fifteen months from the date on which interest becomes chargeable on the loan under Rule 4 above.

7. *Postponement of repayment and remissions.*—If from causes beyond the control of the borrower the payment of any instalment becomes unduly burdensome to him, the repayment of this and all the subsequent instalments may

notwithstanding anything contained in Rules 5 and 6, be suspended by the Director of Industries and Commerce for a period of one instalment. Simple interest at 6¼ per cent. shall be charged on all suspended instalments for the period of such suspension.

8. When the work for the carrying out of which the loan is contracted fails from causes beyond the borrower's control, and when the recovery of the loan in full would occasion serious hardship to the borrower, the circumstances of the case shall be reported to Government, and such orders as Government may be pleased to pass shall be binding on the borrower.

9. On every instalment which is not paid before the close of the revenue year in which payment falls due, interest at 6¼ per cent. will be charged from the date on which payment ought to have been made. In calculating interest under this rule, a broken period of a month shall count as half a month or one month, according as it is less or not less than 15 days, and a fraction of a rupee as half a rupee or one rupee according as it is less or not less than 8 annas.

10. Repayment should ordinarily be made at the treasury of the taluk in which the work has been carried out, but with the special permission of the Director repayment may be made at any district or taluk treasury in the State.

11. *Security.*—(*a*) No loan shall be granted unless the value of the security is at least equal to the amount of the loan applied for. The nature of the security to be required of the applicant or his surety shall be the saleable interest in lands or other immovable property held by the borrower or his surety, as the case may be, provided the value of the same is at least equal to the amount of the loan applied for; in addition to which, the object upon which the loan is expended shall be mortgaged to Government as additional security.

(*b*) When a loan is applied for by a group of persons on their joint personal security, an amount not exceeding 10 times the annual assessment of the lands held by the applicants may be sanctioned at the discretion of the sanctioning authority, provided that in addition to their personal security, the applicants mortgage to Government the whole plant, machinery and buildings on the purchase and erection of which the loan is expended.

12. *Hire-purchase.*—If an applicant so desires, he may, instead of offering security of immovable property for a loan to purchase machinery for agricultural or industrial purposes, obtain the requisite machinery from the Director of Industries on the hire-purchase system on the terms specified in the form of agreement appended hereto, provided the applicant deposits with his application one-fourth of the value of the machinery he requires.

13. *Recovery of loans.*—All loans granted under these rules and all other sums falling due to Government in connection therewith, or under a contract for hire-purchase, shall be recoverable as arrears of land revenue, and a stipulation to this effect shall be inserted in every agreement executed by a borrower.

14. If, at any time, the Director of Industries and Commerce is satisfied that any person or persons who have received a loan, have failed to perform any of the conditions on which it was made, he may, after recording in writing the grounds of his decision, pass an order directing the recovery forthwith of the loan, with any interest payable thereon and costs, as an arrear of land revenue. On receipt of a certified copy of such an order, the Deputy Commissioner to whom it is communicated will forthwith proceed to recover from such person or persons any sums which may remain due together with any interest payable thereon and costs, as an arrear of land revenue: provided that, with the sanction of the Director of Industries and Commerce, such officer may, at his discretion, so recover any sum less than the whole balance of the loan without prejudice to his right to recover the remainder of such balance at any subsequent time.

15. *Mode of application.*—An application for a loan must be made in writing to the Director of Industries and Commerce on Form No. I, hereto annexed, printed copies of which will be available free of cost at all taluk offices. Every application for a loan shall contain a declaration signed by

the applicant or his surety, as the case may be, that the statements made therein regarding the nature and extent of the encumbrances on the property offered as security are true, and that there are no other encumbrances on the property to the best of his information and belief. The applicant shall also show in the column of remarks in Form I:—

(1) Whether the applicant proposes to supplement the loan by any private capital and if so, to what extent;

(2) the estimated total cost of the proposed work and the probable period that will be occupied in its construction.

16. An application for machinery on the hire-purchase system shall be in Form II appended hereto, printed copies of which will be available free of cost at all Taluk Offices.

17. *Grant of loans.*—No loan shall be granted without a local enquiry, which shall be held by a Special Officer attached to the Department of Industries and Commerce for that purpose. The result of his enquiry will be reported to the Director of Industries and Commerce, whose subsequent action in dealing with the application will be determined by the nature of the report as to the value of the security rendered. In dealing with applications for loans connected with agricultural purposes, the Director will obtain and place on record the opinion of the Deputy Commissioner of the district where the loan is to be utilised.

18. Loans will ordinarily be granted for the purchase of machinery approved by the Director of Industries and Commerce or other competent professional adviser as suitable for the purpose to which it is to be applied. Intending applicants for loans may address the Director to obtain advice, previous to submitting their applications. For the present, no fees will be charged by the Department for advice and assistance.

19. All loans will be disbursed by the Director, and it will be the duty of the borrower to put the work in hand immediately after the receipt of the loan.

The Department of Industries and Commerce will, if requested to do so, undertake the erection and starting of machinery for private individuals or firms, and will hand over the same in good working order.

20. Machinery purchased with loans obtained under these rules must be maintained in good working order to the satisfaction of the Director of Industries and Commerce, who may order repairs or renewals to be made at the cost of the owner. Failure to comply with such orders will involve proceedings for the recovery of the loan under Rule 14 of these rules.

21. *Registers and accounts.*—The Director shall keep a register of loans and repayments under these rules, including cases of hire-purchase, in a form which he will settle in consultation with the Comptroller. This register should clearly show the stage in which each transaction stands at any particular time.

22. Every loan sanctioned under these rules should be reported by the sanctioning authority to the Comptroller with full particulars. The Comptroller will see that the loan is covered by rules and sanction of competent authority and will watch the repayment of the instalments. A special section in the Comptroller's annual report on loan transactions should be devoted to loans under these rules.

FORM I.

FORM OF APPLICATION FOR LOANS.

1. Name, father's name and residence of applicant.

2. Amount of loan required.

3. Object for which the loan is required.

Security offered.							Name of the person who agrees to offer land or other immovable property as security and the nature and extent of his right in it.	Rights of others in the land.		Nature and extent of encumbrances, if any, in the property, where land or other immovable property is offered as security.	Whether any arrears are due on land or other immovable property offered as security.	Proposed time of repayment.	Remarks.
If personal.	*If land.*				*Other immovable property.*								
Name, father's name and residence of the surety.	Survey No.	Extent.	Assessment.	In whose name registered.	Extent.	Description.		Name, occupation and address.	Nature and extent of right.				
4	5	6	7	8	9	10	11	12	13	14	15	16	17
		A. g.	Rs. a. p.		A. g.								

NOTE.

1. Application for a loan under these rules should be made to the Director of Industries and Commerce on Form No. 1, printed copies of which will be available free of cost in all taluk offices.

2. Loans of money may be granted under these rules for any or all the purposes specified below :—

(i) Purchase and erection of machinery for agricultural or industrial undertakings, ordinarily up to a limit of Rs. 10,000 in each case.

(ii) The construction of wells and tanks, of mills, warehouses and other structures necessary for agricultural or industrial operations.

(iii) The provision of raw material, working capital, or appliances other than those specified above, required for the carrying on of industrial operations, ordinarily up to a limit of Rs. 5,000 in each case.

3. All loans granted under these rules and all other sums falling due to Government in connection therewith shall be recoverable as an arrear of land revenue.

4. The applicant will show in the column of remarks in form No. 1 :—

(i) Whether the applicant proposes to supplement the loan by any private capital and if so, to what extent ;

(ii) the estimated total cost of the proposed work and the probable period that will be occupied in its construction.

5. The rate of interest charged on the loan shall be 6¼ *per cent. per annum.*

6. Loans shall be repayable by fixed annual payments, discharging both principal and interest.

7. The time allowed for repayment shall be fixed by the Director of Industries and Commerce, subject to the limitation of a period of 5 years in the case of loans for industrial purposes and 7 years in the case of loans for agricultural purposes.

8. If the grantee of a loan misapplies the whole or any portion of the loan or otherwise fails in any of the conditions of the grant, the whole unpaid balance of the loan with interest and costs will be liable to summary recovery as an arrear of land revenue.

9. Loans for the purchase of machinery will be sanctioned, only on the condition that the machinery is approved by the Director of Industries and Commerce or other competent professional adviser as suitable for the purpose to which they are to be applied.

10. If requested, the Department of Industries and Commerce will undertake to erect the work for which the loan is obtained at the cost of the borrower and hand it over to him in good working order and with proper accounts of the expenses incurred on his behalf.

11. The machinery purchased and the buildings, etc., erected with the loan referred to above shall be maintained in a suitable condition and working order, and repairs and renewals as directed by the Director from time to time shall be carried out without undue delay.

N.B.—This is a summary of the conditions under which the loans sanctioned in Government Order No. G. 2097-145—G. M. 55-12-239, dated 2nd September 1913 are granted. For further particulars the order itself should be consulted.

FORM 2.

APPLICATION FOR MACHINERY FOR AGRICULTURAL OR INDUSTRIAL PURPOSES ON THE HIRE-PURCHASE SYSTEM.

1. Name of applicant.
2. Father's name.
3. Caste.
4. Age.
5. Residence.
6. Village, hobli, taluk and district where applicant proposes to set up the machinery.
7. Nature and description of machinery required and its approximate value.
8. Object for which the machinery is required.
9. Amount which the applicant is prepared to deposit (being ¼ of the approximate value of the machinery required).
10. Whether the applicant wishes the Director of Industries and Commerce to set up the machinery for the applicant at applicant's cost and what other help he wants from the Department in connection with the installation.

FORM 3.

ORDER GRANTING A LOAN UNDER GOVERNMENT ORDER NO. G. 2097-145—G. M. 55-12-239, DATED 2ND SEPTEMBER 1913.

I. The sum of rupees_____is granted to_____caste _____ calling_____, son of_____, residing at_____ as a loan under Government Order No. G. 2097-145—G. M. 55-12-239, dated 2nd September 1913, for the purpose of_____

_____

subject to the following conditions :—

II. The conditions referred to are as follows :—

(i) That as requested by the borrower _____the amount of the loan shall be expended by the Department of Industries and Commerce on the execution of the necessary security bonds for the purpose of _____ _____ and the work handed over to the borrower_____ as soon after completion as possible in good working order with proper accounts of the expenses incurred on behalf of the borrower, or,

(ii) That the amount of the loan shall be paid to the aforesaid_____ in _____ instalments on the execution of the necessary security bonds, the first on the production of this order and the second and subsequent instalments on proof that the first and previous instalments have been properly utilised.

(iii) That if it shall appear to the satisfaction of the Director of Industries and Commerce that any portion of the first or subsequent instalments has been misapplied to any other purpose than that specified above, the portion of loan already paid to the aforesaid _____ shall be recoverable as an arrear of land revenue.

III. (i) That the loan with interest thereon at 6½ per cent. shall be repaid by equal annual instalments of Rs._____falling due with the_____ kist of the revenue year commencing with 19_____and ending with 19_____

(ii) Such annual payments shall be made at the Treasury of_____Taluk.

(iii) If default in payments of annual instalments on account of the loan occurs or if the aforesaid_____should contravene any of the conditions under which the loan is granted, the unpaid balance of the loan shall be recoverable as an arrear of land revenue.

IV. That the machinery purchased and buildings, etc., erected with the loan referred to above shall be maintained in a suitable condition and good working order and that repairs and renewals as directed by the Director of Industries and Commerce from time to time shall be carried out without undue delay.

V. That for the repayment of the loan with interest and costs, if any, due on the same, the immovable property specified below, in addition to the object upon which the loan is expended, is hypothecated as collateral security to Government.

Signature of the officer granting the loan.

I have understood and agreed to the aforesaid terms and conditions.

Signature of borrower.

FORM 4.

HIRE-PURCHASE AGREEMENT.

An agreement made this day of 19 between the Director of Industries and Commerce on behalf of the Government of His Highness the Maharaja of Mysore (hereinafter called " the Director ") of the one part and of (hereinafter called " the hirer ") of the other part.

Whereby it is agreed as follows :—

1. The Director agrees to let on hire to the hirer, and the hirer agrees to take from the Director the machinery in the Schedule hereunder written (hereinafter referred to as " the machinery ").

2 The Director hereby acknowledges the receipt of Rs. for the option of purchase hereinafter contained. If the hirer shall exercise such option, credit will be given to the hirer for such sum. If he does not, then such sum shall belong absolutely to the Director.

3. So long as the hirer thinks fit to continue the hiring, he shall pay for the hire of the said machinery to the Director at Bangalore, without demand, the sum of Rs. every six months with interest on the amount of hire for the time being unpaid at the rate of *per cent. per annum*. The first payment of Rs. together with the interest which shall have accrued and be payable as aforesaid to be made on the day of 19 , the second payment of Rs. and interest as aforesaid to be made on the day of 19 , and the third payment of Rs. and interest as aforesaid to be made on the day of 19 , and the fourth payment of Rs. and interest as aforesaid to be made on the day of 19 , (and so on).

4. It shall be lawful for the Director and all persons authorised by him, at all times to enter upon any premises in which the machinery may be for the time being, to examine the same.

5. The hirer agrees with the Director that during the hiring—

(*a*) the machinery shall be kept in good and serviceable order and condition (also without damage by fire) and that no alteration or addition thereto shall be made without the previous written consent of the Director;

(*b*) the machinery shall be kept in possession of the hirer and upon trust for the Director at the hirer's address given in the Schedule hereto, or at such other addresses as the Director may by writing authorise, free from distress, execution, or other legal processes, and shall not on any account be sold, assigned, or dealt with, or the possession thereof parted with;

(*c*) all rates, taxes and outgoings payable in respect of the premises wherein the machinery may for the time being be placed shall be duly and punctually paid and discharged by the hirer, and the current receipts therefor shall be produced to the Director on demand.

6. It is hereby declared that the Director has entered into this agreement upon the express declaration by the hirer, and the hirer hereby expressly warrants, that the premises upon which the machinery is to be placed are free from any mortgage incumbrance or charge given or created by the hirer, or any person through whom he claims.

7. If the hirer at any time during the hiring shall be desirous of executing or creating any charge, mortgage or other incumbrance of or upon the premises in or upon which the machinery shall for the time being be, he shall give to the Director one calendar month's previous notice in writing of his intention so to do, and upon the receipt of such notice it shall be lawful for the Director to put an end to the hiring in manner provided by the next succeeding clause.

8. If the hirer—

(*a*) shall make default in punctually paying any hire instalment or

(*b*) shall be adjudicated bankrupt or shall file a petition in insolvency or enter into any arrangement or composition with his creditors or

(*c*) shall execute or create any mortgage incumbrance or charge of or upon the premises in or upon which the machinery may for the time being be, or give notice of his intention so to do, as provided by the last preceding clause or

(*d*) shall fail to observe and perform any of the agreements and conditions contained in this Agreement and on his part to be observed and performed,

then, and in any such case, it shall be lawful for the Director to immediately put an end to the hiring, and for that purpose the hirer hereby authorises the Director or any one deputed by him to enter upon any premises in which the machinery may be for the time being, and to seize and take away the same.

9. Should the hirer hinder or prevent the Director or his Deputy seizing and taking away the machinery, then, and in every such case, the hirer shall pay to the Director the sum of Rs. 200 (two hundred rupees) as and by way of liquidated damage for breach of this provision and not by way of penalty.

10. If the Director shall seize and take possession of the said machinery under clause 8 hereof, the hirer shall have the option within one month after such seizure of purchasing the said machinery by the payment to the Director of Rs. together with the costs and expenses of and incidental to such seizure. In the event of the hirer making such payment within the time aforesaid he shall receive credit from the Director for all sums previously paid by him on account of hire and the amount paid on the signing of this agreement. If the hirer shall not exercise such option and make such payments within the time aforesaid, the option given to the hirer by this clause shall cease, and the hirer shall not be entitled to any credit, allowance or return for or on account of any payments made previously by him.

11. No allowance, return, credit or payment, shall be allowed or paid to the hirer in the event of the hiring being determined by the Director as provided by clause 8 hereof, but the

hirer shall pay to the Director at Bangalore all arrears of hire, interest and damages, for the breach of this agreement up to the date of such determination.

Such damages shall be in addition to and not in substitution of any damages mentioned in clause 9 hereof.

12. All sums falling due to the Director under this contract shall be recoverable from the hirer as an arrear of land revenue.

13. The Director hereby agrees that the hirer shall have the option of purchasing the machinery at any time during the hiring by paying the sum of Rs._____with interest thereon at____*per cent. per annum* from the date hereof, and also that if the hirer shall exercise such option he will give to the hirer credit against such purchase price for all payments which shall have been made by him for hire, with counter interest on such payments at the like rate and also for the sum paid on the signing of this agreement. But until such purchase price shall have been paid in full, the said machinery shall remain the absolute property of the Government of Mysore.

14. If the Director shall grant to the hirer any time or indulgence, the same shall not affect or prejudice the Director's rights under this agreement.

_____

Director's signature.

_____

Hirer's signature.

Witness to signature of the said

Signature_____

Address_____

Occupation_____

(Schedule above referred to)

Machinery.

Address for the purpose of clause 5 (*b*)

District Town Street Number of house.

FORM 5.

MORTGAGE DEED TO BE EXECUTED BY THE BORROWER.

THIS instrument made the_____day of_____191____between _____of_____(hereinafter called "the Mortgagor") of the one part and the Director of Industries and Commerce on behalf of the Government of His Highness the Maharaja of Mysore (hereinafter called "the Mortgagee") of the other part.

WHEREAS the Mortgagor $\frac{\text{has}}{\text{have}}$ received from the Director of Industries and Commerce _____an order under the Rules for the grant of Loans generally to facilitate Agricultural and Industrial Operations issued under Notification No. G. 2146—G. M. 55-12-240, dated 2nd September 1913 _____and dated the _____day of_____191____in virtue of which the Mortgagor $\frac{\text{is}}{\text{are}}$ entitled to receive the aggregate sum of Rs._____as a loan from the Mortgagee for the purpose of _____and WHEREAS security for the due application of the amount of the said loan and for the punctual repayment of the same according to the terms of the said order is demanded by or on behalf of the mortgagee and in order to furnish such security the Mortgagor has agreed to sign these presents.

NOW THESE PRESENTS WITNESS that in consideration of the said loan and in pursuance of the said agreement the Mortgagor doth hereby transfer to the Mortgagee, his successors and assigns the immovable property described in Schedule A hereunder written with the appurtenances thereto subject to redemption as hereinafter mentioned.

THESE PRESENTS ALSO WITNESS that in consideration of the said loan and in pursuance of the said agreement the Mortgagor doth hereby further transfer to the Mortgagee, his successors and assigns the property described in Schedule B hereunder written, being that on which the said loan is to be expended, subject to redemption as hereinafter mentioned.

AND it is hereby agreed that if the Mortgagor, $\frac{\text{his}}{\text{their}}$ legal representatives and assigns shall duly comply with the terms on which the said loan has been granted and shall apply the same and every part thereof in the manner provided in the said order and shall duly repay

the amount of the said loan together with any interest which may have become payable thereon or on any part thereof and all costs if any incurred by the Mortgagee, his successors or assigns in making the said loan or otherwise in connection therewith, the Mortgagee, his successors or assigns shall thereupon retransfer the said immovable property noted in Schedule A together with the property described in Schedule B to the Mortgagor, his legal representatives or assigns or as he or they shall direct.

PROVIDED always and it is hereby agreed that in case the Mortgagor, his legal representatives or assigns shall fail to comply with the terms on which the said loan has been granted it shall be lawful for the Mortgagee, his successors and assigns to sell the said immovable property noted in Schedule A and the property described in Schedule B or any parts thereof and out of the proceeds of such sale to make good to the Mortgagee, his successors or assigns the amount which in consequence of any such default shall be payable by the Mortgagor, his legal representatives or assigns.

In witness whereof the Mortgagor $\frac{\text{has}}{\text{have}}$ hereunto set $\frac{\text{his}}{\text{their}}$ hand the day and year first above written.

The schedule above referred to.

SCHEDULE A.

Registration District.	Registration Sub-District.	Village.	IF THE PROPERTY IS HOUSE PROPERTY.				IF CULTIVABLE LAND.				
			Boundaries of the property.	Description and value of buildings and how long likely to last.	Extent of building site and of vacant ground or compound.	Trees, wells, etc.	Survey number	Wet or dry.	Extent.	Assessment.	Trees, wells, etc
1	2	3	4	5	6	7	8	9	10	11	12

SCHEDULE B.

Registration district.	Registration Sub-District.	Village.	Description of objects upon which the loan is expended.

(Signature of borrower)

Witness.

(1) _____, son of _____, Village of _____.

(2) _____, son of _____, Village of _____.

Signed by the abovementioned
in the presence of

FORM 6.

SECURITY BOND TO BE EXECUTED BY A SURETY FOR A BORROWER.

THIS INSTRUMENT MADE the _____ day of _____ 19____ between _____ of _____ (hereinafter called "the Mort-

gagor") of the one part and the Director of Industries and Commerce on behalf of the Government of His Highness the Maharaja of Mysore (hereinafter called "the Mortgagee") of the other part.

WHEREAS _____ has/have received from the Director of Industries and Commerce _____ an order under the Rules for the grant of loans generally to facilitate agricultural and industrial operations issued under Notification No. G. 2146—G. M. 55-12-240, dated 2nd September 1913, and dated the _____ day of _____ 19____ in virtue of which the said _____ is/are entitled to receive the aggregate sum of Rs. _____ as a loan from the Mortgagee for the purpose of _____

AND WHEREAS security for the due application of the amount of the said loan and for the punctual repayment of the same according to the terms of the said order is demanded by or on behalf of the Mortgagee and in order to furnish such security the Mortgagor has agreed to sign these presents.

NOW THESE PRESENTS WITNESS that in consideration of the said loan and in pursuance of the said agreement the Mortgagor doth hereby transfer to the Mortgagee, his successors and assigns the immovable property described in the Schedule hereunder written with the appurtenances thereto subject to redemption as hereinafter-mentioned.

AND it is hereby agreed that if the said _____ his/their legal representatives and assigns shall duly comply with the terms on which the said loan has been granted and shall apply the same and every part thereof in the manner provided in the said order and the said _____ his/their legal representatives or assigns or the Mortgagor or his legal representatives shall duly repay the amount of the said loan together with any interest which may have become payable thereon or on any part thereof and all costs if any incurred by the Mortgagee, his successors or assigns in making the said loan or otherwise in connection therewith, the Mortgagee, his successors or assigns shall thereupon retransfer the said immovable property to the Mortgagor, his legal representatives or assigns or as he or they shall direct.

PROVIDED always and it is hereby agreed that in case the said _____ his/their legal representatives or assigns shall fail to comply with the terms on which the said loan has been granted, it shall be lawful for the Mortgagee, his successors and assigns to sell the said immovable property or any part thereof and out of the proceeds of such sale to make good to the Mortgagee, his successors or assigns the amount which in consequence of any such default shall be payable by the said _____ his/their legal representatives or assigns.

PROVIDED also and it is hereby agreed that although as between the said _____ and the Mortgagor, the Mortgagor is surety only for the said _____ yet, as between the Mortgagor and the Mortgagee, the Mortgagor is to be considered as principal debtor for the principal moneys, interest and costs intended to be hereby secured so that the Mortgagor or his legal representatives shall not be released or exonerated by time being given to the said _____ his/their legal representatives or by any other dealings act, matter or things whatsoever whereby the Mortgagor or his legal representatives as surety or sureties only for the said _____ and his/their legal representatives would be so released or exonerated.

In witness whereof the Mortgagor has hereunto set his hand the day and year first above written.

Signature of surety.

Witnesses.

APPENDIX N.

EAST INDIAN RAILWAY.

Proposed Technical School at Jamalpur.

I.—Present System of Training.

European and Anglo-Indian apprentices.

At Jamalpur, European and Anglo-Indian apprentices are engaged on a five years indenture as the result of an open competitive examination. During the five years they receive practical training as workmen in the workshops and attend a technical school for 4 hours per week at which they are taught a certain amount of elementary theory by masters, who are members of the Locomotive Department staff, and who receive allowances for this work. The apprentices live in a hostel where they pay for their board and lodging—the payments for this and for tuition in the school being rather more than covered by the stipend given to them by the railway.

The following shows their monthly salary and expenses:—

Jamalpur Locomotive Department.	First year.	Second year.	Third year.	Fourth year.	Fifth year.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs A. P.
Rate of pay	30 0 0	30 0 0	35 0 0	40 0 0	50 0 0
Deductions.					
Provident Fund . . .	...	...	...	3 5 0	4 3 0
Institute	0 4 0	0 4 0	0 4 0	0 4 0	0 8 0
Recreation Club . . .	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0
Technical School . . .	1 8 0	1 8 0	1 12 0	2 8 0	2 8 0
Total deductions .	2 12 0	2 12 0	3 0 0	7 1 0	8 3 0
	27 4 0	27 4 0	32 0 0	32 15 0	41 13 0
Board and lodging . .	36 0 0	36 0 0	36 0 0	36 0 0	36 0 0
Amount billed for against the apprentices.	8 12 0	8 12 0	4 0 0	3 1 0	...

On completion of their five years apprenticeship, these boys are appointed as fitters or boiler-makers, commencing on a salary of Rs. 110 to Rs. 130 per mensem and rising by the 6th year to Rs. 210 or Rs. 230. The initial salary may be increased at the discretion of the Locomotive Superintendent in accordance with the value he assigns to their work.

Indian apprentices.

2. Indian apprentices are also appointed in the workshops of two classes, the first class commencing at Rs. 10 and rising to Rs. 15 in the 5th year of apprenticeship, and the second class, usually consisting of sons of workmen in the shops, commencing on Rs. 4 per mensem and reaching Rs. 9 per mensem in the 6th year. In both classes the apprentices are bound by a stamped agreement; in the former to serve for five years and in the latter for six years.

Evening classes of instruction were formerly arranged for these Indian apprentices, but, mainly because of the difficulty of attendance, their homes being in outlying villages, this was found to be impracticable and they have been dropped.

II.—Reasons for Improvement.

Disadvantages of present system.

3. Under this system it is found that the European and Anglo-Indian lads who, in the absence of recruitment from England, must form the recruiting ground for the subordinate supervising staff of the workshops, do not get so complete and substantial a training as is the case in men of a similar class imported from England. This is ascribed to three causes:—

(1) Inadequate time for theoretical instruction of a thorough nature;

(2) Inadequate supervision of their practical work in the workshops;

(3) Disadvantages connected with the environment in which they are brought up as compared with the conditions of training in Britain, which conduce to self-reliance and development of character.

It is also to be noticed that the system makes no provision for the training of suitable Indians for recruitment as superior mechanics and the subordinate supervising staff of the workshops; nor for the training of apprentices in the Engineering Department, who at present receive little or no theoretical training.

Objects to be secured.

4. In view of the difficulties which will assuredly be experienced in recruiting mechanics and men for the subordinate supervising staff of the workshops in Britain, and also the desirability of making the best use of the material at hand, both European and Indian, it is considered essential that the facilities for training should be extended and improved.

Further it is desirable, in the interests of the country at large, that opportunity should be taken of the very valuable practical training which is available in large workshops such as those at Jamalpur to train up a class of men who will be able to take posts in other mechanical industries similar to those of the foremen and assistant foremen in the workshops, with a view in some cases to proceeding to further training and qualifying for supervising posts in such industries.

Lastly, it is desirable that more attention should be paid to the early education of Indian lads who wish to become workmen in the shops, and also to afford some means of elementary technical education to such of the younger workmen as are capable of assimilating it, so as to improve the general intelligence and, therefore, the value of this class.

III.—Proposed Improvements.

Outline of proposals.

5. The scheme now proposed is therefore designed:—

(1) To improve the training of Locomotive Department apprentices—

(*a*) by a better distribution of time between practical and theoretical training;

(*b*) by an improved theoretical course;

(*c*) by better supervision and arrangement of the practical course in the shops.

(2) To provide similar training for an additional number of Indian apprentices in the Locomotive Department.

(3) To provide training for apprentices in the Electrical Department and in the permanent-way works, signalling, block signalling and drawing office branches of the Engineering Department.

(4) To provide elementary theoretical technical training in the vernacular for some of the younger workmen out of workshops hours.

(5) To provide training, practical and theoretical (in the vernacular) for boys who will become workmen, and

(6) To arrange for suitable primary education for those who wish to benefit by proposal (5) (as a future extension of the scheme to provide for an even flow of recruits).

Apprentices.

6. For the first three portions of the scheme described above, it will be necessary to build a new school and provide a whole-time well-qualified staff. The apprentices would spend roughly half their time in the workshops and half their time in the school, the work in the school being co-ordinated with the practical work in the shops. During the time they are in the workshops, they would be under the supervision of a special instructor, and their work would be arranged in a progressive manner so as to cover all branches of workshop work.

The Engineering Department apprentices would have a simplified course of study and, in place of part of the workshop work in the second year, would do practical work relating to the particular branch for which they have been appointed.

For the Indian apprentices, a separate hostel would have to be provided, but in other respects the boys would all work together, and no distinction would be made in the training between Europeans and Indians.

Numbers.

7. The present number of Locomotive Department apprentices engaged annually varies from 20 to 25 according to the probable requirements of recruiting in the workshops at the end of the fifth year, the number of boys under training at any one time being approximately 90.

The school should in addition provide for an annual recruitment of 10 to 12 Indian Locomotive apprentices per annum, which, allowing for wastage, would mean an addition of perhaps 45 students by the fifth year.

For the Engineering Department it is proposed that all apprentices in the permanent-way works, drawing office, signalling and block signalling branches should put in a two years course of training at Jamalpur. The average annual rate of recruitment is estimated at 10 and this would mean an addition of 20 students to the school.

The Electrical Department would appoint, say, 2 to 3 apprentices per annum, meaning an addition of 5 to the numbers.

The total number of apprentices to be dealt with would accordingly be 115 in the first year after the opening of the school, rising until the full number of 160 was reached in the fifth year, after which the numbers would be about stationary at this figure.

If the time of the apprentices were divided between practical and theoretical work in the proportion of 60 per cent. to 40 per cent., it would be necessary to provide school accommodation for, say, 65 boys and to arrange for the training of 95 boys at a time in the workshops.

Workmen and boys.

8. For the elementary vernacular technical instruction, which it is intended to give to younger workmen and boys, it is necessary to provide an industrial school, as a branch of the technical school. Classes in mensuration,

drawing, arithmetic, etc., would be given by junior members of the staff of the school to selected workmen, the time being given out of workshop hours.

The industrial school would provide simple education in the vernacular in drawing, mensuration, etc., for about 3 or 4 hours a week in workshop hours to some of the boys who are commencing their career in the workshops as workmen. The education would be free, and successful passing of each year's examination would be recognised by a small rise of salary. The industrial school would thus provide an alternative to boys who at present pass from the Upper Primary Schools to the Middle English and High English Schools.

The numbers in the industrial school would eventually be large if the results were satisfactory, but it is proposed to commence with accommodation for 50 boys in the first instance.

IV.—Management and Finance.

Committee of Management.

9. The whole of the technical education scheme would be under the management of a Committee, of which the Locomotive Superintendent would be the Chairman and the Principal of the school the Secretary. The other members should be the Works Manager, the Electrical Engineer, the Chief Engineer, or his representative, one other Locomotive Department officer appointed by the Locomotive Superintendent, an Indian railway officer selected by the Agent, and a representative of the Bihar and Orissa Government (either Educational Department or Industrial Department, when constituted).

The initial expenditure and subsequent additions would be met from railway capital with the assistance of grants from the Bihar and Orissa Government, and the recurring expenditure would be met from railway revenue and annual grants from the Bihar and Orissa Government.

The building and equipment would be the property of the railway, and the staff would be railway servants. The income and expenditure would be dealt with under the orders of the Committee, but it would be preferable if they could form a part of the railway budget instead of being kept separate and vested in the Committee.

V.—Staff.

Cadre of Staff.

10. The following staff is suggested :—

	Monthly Salary. Rs.	Rs.
Principal	1,000 to 1,500	2,750 to 4,000
Assistant Master	600 „ 800	
Ditto	400 „ 600	
2 Junior Masters	150 „ 250	
Workshop Instructor	450 „ 600	
Demonstrators, etc.	300	650.
Clerical staff	250	
Menial staff	100	
Hostel Superintendent	200 to 300	300 to 450.
Indian Deputy Hostel Superintendent	100 „ 150	

The Principal and the two senior masters should be appointed by the Board of Directors and be officers of the railway. The appointment of all other members of the staff should be in the hands of the Committee.

Principal.

11. The Principal should be a man with an engineering degree from a British University or a recognised British engineering college. He should be an Associate Member of the Institution of Civil Engineers or Mechanical Engineers, and should have had some years of experience in teaching as well as workshop training. It would be an advantage if he had already been some years in India.

As the success of the scheme depends very much on its direction in its early stages, it is important that the Principal should be a man capable of building up and developing the constitution of the school, both as regards staff and equipment, and who could advise and suggest the details of the design of the building and organisation.

Assistant masters.

12. The two senior assistant masters should possess the same educational qualifications as the Principal, but need not have had so much experience in teaching, and it is not essential that they should have had workshop training. One of them should be specially qualified in mathematics, physics and allied subjects, and the other in drawing and applied mechanics. They might be obtainable in India, and be of the class generally recruited for the Educational Department.

13. The junior assistant masters should be qualified to teach the more elementary subjects, such as arithmetic, drawing in the early stages and elementary science. They would be of the type appointed to the Provincial Educational Service.

Workshop instructors.

14. The workshop instructor should be a man of the foreman class, and it is possible that a suitable man might be found amongst the foremen in the Locomotive workshops, who could be given an allowance over and above his salary, bringing his pay up to, say, Rs. 600. His duties would be to arrange and supervise the work of the apprentices in the workshops, under the direction of the Works Manager. The first year, apprentices would require to receive regular instruction under the instructor on an approved course, so as to become acquainted with the use of tools. Later they would be drafted into the various shops and work under the foremen of those shops. During the whole time, however, the instructor would require to watch their work and see that they were making the best use of their time. The workshop instructor would work under the orders of the Works Manager in all matters connected with the presence of the apprentices in the workshops.

Minor staff.

15. The school would require a small number of demonstrators, etc., to assist the teaching staff in the practical work and drawing, etc. It is estimated that they would cost Rs. 300 per mensem.

The Principal would have an office supervised by a head clerk and accountant on, say, Rs. 150, with one or two assistants, the whole costing Rs. 250 per mensem.

VI.—Hostels.

Europeans.

16. The present European hostel will accommodate 95 apprentices. Of the Engineering Department apprentices, it is estimated that half or 10 might be Europeans, and one or two of the Electrical apprentices will also be Europeans. It will be necessary, therefore, to provide accommodation for 10 additional European lads, which may be estimated to cost Rs. 10,000.

Indians.

17. The Indians for whom accommodation will be required will be 45 Locomotive Department, 10 Engineering Department and, say, 1 Electrical Department or 56 in all. The accommodation for the Indians should be arranged as in the present European hostel, *i.e.*, rooms containing 8 or 10

beds for the younger apprentices and rooms with 4 or 2 beds for the Seniors. Lavatories and bath rooms would be built in an outlying block with a covered way. To give facilities for separate messing of the different castes, it would be necessary to have at least four mess rooms each with its separate cook room. At a rough approximation, such a building including furniture is estimated to cost Rs. 50,000.

Messing.

18. It is proposed that messing and living accommodation should be provided free for both Europeans and Indians, though it is possible that it might be found convenient in the Indian hostel to give a monthly allowance to each mess and let the apprentices make their own arrangements for cooking, etc., under the supervision of the Superintendent.

The cost of the present board inclusive of staff, etc., for Europeans is approximately Rs. 36 per head per mensem, or, say, Rs. 3,780 per mensem for 105 boys. The board for Indians would be less costly and might be put down at Rs. 15 per mensem per head, which for 56 boys would be Rs. 840 per mensem. Thus the monthly cost of the two hostels, in addition to the salaries of the Superintendent and Deputy Superintendent, would be Rs. 4,620 per mensem.

Hostel staff.

19. It would be necessary to have a capable European as Hostel Superintendent with full charge over all the catering and domestic arrangements, with an Indian Deputy Superintendent for the Indian hostel.

VII.—School Building.

School building.

20. The building should contain the following accommodation:—

One large lecture room.
Two smaller lecture rooms.
Laboratory for applied mechanics, etc.
Laboratory for chemistry and metallurgy.
Drawing office.
Principal's room.
Masters' common room.
Office.
Lavatory in outside building.

To this would have to be added a room for the industrial school, if it is considered desirable to hold this in a separate room.

From a rough design of such a building it is estimated to cost Rs. 70,000.

Furniture may be estimated at Rs. 10,000 and equipment and apparatus at Rs. 20,000, making the total cost of the School approximately Rs. 1,00,000.

Site.

21. As regards the site, this should be chosen so as to be conveniently situated for access to the workshops, but there must be room for expansion, and it should not be so close to the workshops that the noise would be a cause of annoyance and interruption to work. A proposal has been made that the school should be within the workshop enclosure, on the space near the Electrical Engineer's office. This site would, however, be noisy and dusty, and it is questionable whether all existing space within the workshop enclosure should not be reserved for future extensions.

VIII.—Accommodation for Staff.

Staff buildings.

22. The staff will be provided with house accommodation, for which they will have to pay rent under railway rules.

The following new houses will be required :—

Staff.	Houses.	Estimated cost.
		Rs.
(1) Principal . . .	One bungalow of the type built for District Officers.	30,000
(2) Assistant Master . .	2 five-roomed bungalows as built for Assistant District Officers.	40,000
(3) Workshop Instructor . .	1 four-roomed bungalow as built for senior subordinates.	15,000
(4) Junior Assistant Masters .	2 three-roomed bungalows as built for senior subordinates.	20,000
(5) Demonstrators and clerical staff.	3 sets senior Indian subordinates' quarters	3,600
	4 set clerks' quarters	3,000
(6) Menial staff	12 sets menials' quarters	3,600
	Total Rs. .	1,15,200

The total estimated cost of Rs. 1,15,200 does not include cost of land, as sites can probably be found on railway land, but outhouses, water supply and electric equipment should be able to be provided from the above sum.

IX.—Courses of Instruction.

23. *Theoretical.*—The first year's course for all apprentices would be mainly directed towards making good deficiencies in previous education, in the direction of mathematics, applied mechanics, elementary physics and chemistry, and drawing. **First year.**

For the locomotive Department apprentices the remaining four years would be employed in a progressive course in drawing, applied mechanics and mechanism, mathematics, elementary electricity and magnetism, physics and chemistry, and general knowledge. **Locomotive apprentices.**

In the last year some instruction could be given in general subjects, such as workshop methods, workshop organisation and accounts, machine design, etc.

The Engineering Department apprentices in the second year would have special courses in the subjects of their particular branches— **Engineering apprentices.**

(*a*) for P. W. I. apprentices, on lay-out of points and crossings, etc., and maintenance of road ;

(*b*) for Inspector of Works apprentices, building construction, strength of materials, elementary bridge and roof construction, simple accounts, estimating and surveying ;

(*c*) for Signal apprentices, interlocking and signalling and station working rules ;

(*d*) for Block Signal apprentices, electricity as applied to telegraphs, telephones and block instruments and station-working rules ;

(*e*) for Drawing office apprentices, design of buildings, and bridges computation of quantities, estimating and surveying.

Electrical apprentices. For the Electrical Department apprentices, the course in the last four years would be based on that given to Locomotive Department apprentices, but special courses would be given in electricity, and the general maintenance and up-keep of electrical plant, wiring, etc.

First year. 24. *Practical.*—In the first year all apprentices would go through a graded course of practical workshop work, the object being to acquaint them with the use of tools.

Locomotive apprentices. During the next three years the Locomotive Department apprentices would be posted to different shops in turn and have to work as workmen under the foremen of the shops, the object being to give them as wide a knowledge of workshop methods as possible.

In the last year the Locomotive Department apprentices might be allowed to specialise in any one shop, for the work of which they had shewn a special fitness.

Engineering apprentices. For the Engineering Department apprentices in the second year, special practical courses would be arranged for each branch.

(*a*) P. W. I. apprentices would work practically on linking, maintenance and lay-out of permanent way and points and crossings under an experienced permanent-way inspector and also on building construction.

(*b*) Inspector of Works apprentices would be taught practical surveying and setting out, building construction and use of tackle, working with their own hands.

(*c*) Signal Inspector apprentices would work as fitters in the signal shop and also be given practical experience in erecting signals and interlocking gear.

(*d*) Block Signal apprentices would receive practical training in constructing and repairing telephone and block instruments, testing lines, etc.

(*e*) Draughtsmen apprentices would receive practical instruction in surveying, levelling, plotting and estimating on actual works.

Electrical apprentices. The Electrical Department apprentices would receive their last four years practical training in the Electrical Department workshops and the power house and other allied work.

X.—Recruitment.

25. Recruitment for posts as apprentices in all three departments will be on the results of an examination coupled with selection. Candidates for examination should not be under 16 nor over 19 years of age.

Examination. The principal will hold an annual open examination. Before entering, each candidate will be required to say which branch of the service he wishes to join. After the examination every candidate will be examined for physical fitness and a report on his health made by the Railway Medical Officer.

Selection. 26. The Locomotive Superintendent, Chief Engineer, and Electrical Engineer will then select from the lists, after personal interviews or interviews with a selection board whichever may be found most suitable. The candidate's place on the examination list and his physical fitness will be taken into consideration, but selection will largely depend on his general level of intelligence, strength of character and the impression he makes at the time of his personal interview.

A candidate would have the option of putting down his name for more than one department, and in that case he would come up for selection for the different departments in the order in which he places them in his application.

In view of the different systems on which the education of Europeans and Indians is at present conducted, it is doubtful whether for some time to come it would be possible to have the same examination for both. The proportions of actual recruitment must depend largely on the vacancies in the hostels and school and, provided the examination secures that the selected candidates have the necessary education to assimilate the work at the school, it is not of much importance whether the same papers are set to Europeans and Indians. It is suggested that the standards adopted should be roughly the Junior Cambridge for Europeans and the Matriculation for Indians. **Standard of examination.**

XI.—Cost of Scheme.

27. The initial cost of the scheme may be summarised as follows:— **Initial cost.**

	Rs.
School building	70,000
Furniture and equipment	30,000
Hostels (1) Addition to Europeans	10,000
(2) For Indians	50,000
Houses for staff	1,15,200
Total	2,75,200

28. The recurring cost is estimated as follows:— **Recurring cost.**

	Monthly. Rs.	Annual. Rs.
Staff	5,100	.....
Stipends of apprentices 160 at Rs. 15	2,100	.....
Board of apprentices—		
European 195 at Rs. 34	3,570	...
Indian 56 at Rs. 15	840	...
Up-keep of equipment and apparatus stores	300	.....
Contingencies of school	100	...
Ditto hostel	100	...
Monthly	12,410	.....
Total annual	.....	1,48,920

or say Rs. 1,50,000 per annum.

The initial annual expenditure will be somewhat less than this, or say Rs. 1,20,000 in the first year.

29. The present expenditure on the training of apprentices is approximately as follows:— **Present expenditure.**

	Monthly. Rs.	Annual. Rs.
Salaries—		
Locomotive Department	3,600	.....
Electrical „	330	.....
Engineering „	870	.....
	4,800	
		57,600
School grant	50	600
Total annual expenditure	.....	58,200