BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE DOMINIONS, COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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ERRATA

Page 39, line 13, for *P. Mobola*, Olio. read *P. Mobola*, Oliv.

Page 392, line 13 from bottom, for *Haematoxylon brasileto* read *Haematoxylon Brasiletto.*

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THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

The Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire: (i) by arranging comprehensive exhibitions of natural products, especially of the Dominions, Colonies and India; and (ii) by providing for their investigation, and for the collection and dissemination of scientific, technical and commercial information relating to raw materials.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture and the Board of Trade.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the President of the Board of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. xi and xii and also of the various Committees which have been appointed (pp. xii–xvii).

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials.

The following are the principal departments of the Institute:

Public Exhibition Galleries.—The collections of raw materials, etc., illustrative of the industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except on Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, Northern Territory, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria; East Africa Protectorate, Zanzibar and Pemba; Uganda; Somaliland; Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and the Indian Empire.

An Egyptian collection is in course of formation.

A reference collection of standard raw materials of commerce is shown in the Upper East Gallery.

Arrangements are made to conduct parties from schools and educational institutions through the Collections and to explain the exhibits. Short lectures on the countries of the Empire and their resources are given periodically in connection with the Collections.

A Central Stand for the distribution of publications and an Enquiry Office have been opened in the main gallery to provide for the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining and other industries of the Dominions and Colonies, and also in regard to emigration, are available for free distribution or for sale. The publications of the Emigrants' Information Office may also be obtained. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application.

In 1917 the public galleries were visited by 99,555 persons, and 7,658 publications were distributed.

Owing to part of the Galleries being occupied temporarily by the Ministry of Food and the War Office, some of the facilities referred to above are now restricted. Space will, however, shortly be provided for the arrangement elsewhere of a representative collection of those raw materials which can no longer be shown in the Exhibition Galleries.

Scientific and Technical Research Department.—The technical laboratories and workrooms of this Department were established in order to provide for the investigation of new or little-known raw materials from the Dominions, Colonies and India, and of known products from new sources, with a view to their utilisation in commerce. Materials investigated in the laboratories of the Department are in promising cases submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

The work of this Department is chiefly initiated by the Home, Dominion and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office whereby Consular representatives abroad may transmit to the Department, for investigation, such raw materials of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Special analyses and investigations are also undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Application for such investigations should be made, in writing, to the Director.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal raw materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Department works in co-operation with the Agricultural, Mines and other Technical Departments in the Dominions, Colonies and India, whose operations it supplements by undertaking investigations and enquiries of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial valuation of products (animal, vegetable or mineral) which can be more efficiently conducted at home in consultation with manufacturers and merchants, with a view to the local utilisation of these products or to their export.

A large number of reports on these subjects have been made to the Governments of the Dominions, the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports which are presented to Parliament (p. ix).

Mineral Surveys are conducted in countries of which the mineral resources are little known. All minerals found that are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports and presented to Parliament.

Technical Information Bureau.—This is a branch of the Scientific and Technical Research Department which has been formed to deal with the large and increasing number of enquiries received by the Imperial Institute from manufacturers, merchants and others, throughout the Empire. The Bureau has devoted special attention to questions arising out of the war, particularly those relating to the opportunities presented for the development, within the Empire, of industries the raw materials of which were formerly monopolised by Germany. It has supplied technical information to enquirers, and has issued circulars and pamphlets dealing with various problems in connection with the supply and disposal of raw materials.

Indian Trade Enquiry.—The Secretary of State for India has requested the Indian Committee of the Institute to enquire into and report on the possibilities of extending the industrial and commercial utilisation of Indian raw materials in this country and elsewhere in the Empire. A number of Special Committees have been appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India. A list of the members of these Special Committees is given on pp. xiv and xv.

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in these Courses in the subject of Tropical Economic Products is given by a member of the Staff of the Imperial Institute. The Courses have been temporarily discontinued during the war.

Library, Reading-Rooms and Map-Room.—The library and reading-rooms of the Imperial Institute contain a large collection of works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the

United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The map-room, which adjoins the reading-rooms, is provided with a large collection of recent maps of the Dominions, the Colonies and India, which can be seen on application.

Colonial Conference Rooms.—These rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Dominions and Colonies and for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The BULLETIN is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, price *2s. 6d.* (annual subscription 11*s.*, including postage), and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture.

Handbooks to the Commercial Resources of the Tropics.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute and published by Mr. John Murray. The first four volumes are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Consulting Agriculturist, Ministry of Agriculture, Egypt, and lately Inspector of Agriculture for British West Africa, price 5*s.* net; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria, price 5*s.* net; *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute, price 6*s.* net.; and *Cotton and other Vegetable Fibres: their Production and Utilisation*, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute, price 6*s.* net.

Monographs on Industrial Resources.—The Imperial Institute has devoted special attention to the question of securing the utilisation in the United Kingdom of the large quantities of materials produced within the Empire which before the war were exported chiefly to foreign countries. It is intended to deal with this subject in a series of Monographs. In order to call attention to the subject of oil seeds, a monograph, entitled *Oil Seeds and Feeding Cakes*, has been issued. This book, which is published by Mr. John Murray, price 2*s.* 6*d.* net, deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed and mowra seed, and the oils and feeding cakes obtained from them.

The Mineral Resources Committee of the Imperial Institute have arranged for the publication of a series of monographs on mineral resources with special reference to those of the British Empire.

The first of these monographs, dealing with Zinc Ores, has been published, and may be obtained from the Imperial Institute, price 2*s.* post free. It gives a short statistical account of the world's production of zinc and zinc ores, and describes the minerals of zinc which serve as ores of the metal. This section is followed by an account of the principal zinc deposits of the Empire, special attention being given to Australia, the United Kingdom, Canada and India, which are the principal British sources of supply. Reference is also made to the more important deposits in foreign countries. The last section deals briefly with the uses of zinc for galvanising, the manufacture of alloys, etc.

Selected Reports from the Scientific and Technical Department.—These reports, which are issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of technical and commercial investigation of raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres"; Part II. "Gums and Resins"; Part III. "Foodstuffs"; Part IV. "Rubber and Gutta Percha"; Part V. "Oilseeds, Oils, Fats and Waxes."

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific and practical study of all questions connected with tropical agriculture, including the development and utilisation of natural resources, and to arrange for International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section receive the Bulletin of the Imperial Institute and are permitted to use the library and reading-rooms of the Imperial Institute.

British Women's Emigration Association.—The British

Women's Emigration Association has offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m. Advice and information respecting emigration and prospects for women in the Dominions may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—An office on the mezzanine floor has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

Tropical Diseases Bureau.—Temporary office accommodation on the mezzanine floor has been provided for this Bureau, the main purpose of which is to collect information regarding tropical diseases and to distribute it as widely as possible among those who are engaged in combating such diseases.

Universities Bureau of the British Empire.—An office on the mezzanine floor has been allotted to this Bureau, the object of which is the collection and dissemination of information relating to the Universities of the British Empire.

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[In addition to the Committees in which their names are included, the Chairman of the Executive Council and the Director of the Imperial Institute are *ex-officio* Members of all Committees.]

Imperial Institute,
June 1918.

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O. D. ROBERTS, F.I.C.
S. J. ROGERS, B.Sc. (Lond.), A.I.C.
F. W. ROLFE.
H. SPOONER.
D. M. STEWART, M.A., B.Sc. (Edin.).
J. D. F. WEST.
B. W. WHITFEILD.
W. O. R. WYNN.

Special Assistants: L. L. BLACKNELL; G. S. BOULGER, F.L.S., F.G.S.; S. C. GILMOUR; A. S. JUDGE.

MINERAL SURVEY.—*Ceylon:* J. S. COATES, B.A. (Cantab.).

Since the outbreak of war, the following members of the Staff of the Imperial Institute have joined H.M. Forces:

Assistant Secretary to the Director: The Hon. T. L. McCLINTOCK BUNBURY, M.A. (Cantab.).

Scientific and Technical Staff: F. BOULTON; G. T. BRAY, A.I.C.; H. J. BROUGHTON; W. G. CREASY; W. S. DAVEY; H. JOHNSON,[1] B.Sc. (Lond.); T. McLACHLAN; G. L. MATTHEWS, B.Sc. (Lond.); V. W. NEWMAN[1]; F. W. ROLFE; D. J. TAYLOR,[1] B.Sc. (Lond.); J. D. F. WEST; B. W. WHITFEILD; W. O. R. WYNN.

Clerical and Labour Staff: K. BLAIR, S. BLAIR, A. BOOTHER, F. BROWN,[2] H. CARTER, H. E. COULSON, F. W. ELDRIDGE, H. FOSTER, C. FURNEAUX, P. FURNEAUX, R. HENDERSON, S. HERBERT, G. H. MARDON, W. F. MILLER, H. G. PALMER, A. W. POTTER, P. J. REDMOND, F. RICKETTS, J. A. SIMPSON, J. WELLS, I. V. YEATMAN.

[1] *Killed.* [2] *Missing, assumed killed.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

NATURAL DYE-STUFFS

On the outbreak of war and the consequent cessation of trade with Germany, there was a marked scarcity of synthetic dyes in this country, with the result that a number of natural dye-stuffs which had been nearly or entirely replaced by the artificial products again came into use on a large scale. Amongst the more important of these were indigo and fustic, used respectively for the blue and the khaki cloths required for naval and military uniforms. As regards indigo, which is produced chiefly in India and Java, the exports from the former country rose from 10,939 cwts. in 1913–14 to 17,142 cwts. in 1914–15, 41,932 cwts. in 1915–16, and 33,539 cwts. in 1916–17, the corresponding values in those years being £141,938, £599,691, £1,385,795, and £1,382,931. The exports in 1915–16 were the greatest since 1904–5, when 49,252 cwts., valued at £556,405, were shipped, but they are still far behind what they were some twenty years ago, the exports in 1896–7 amounting to nearly 170,000 cwts., of a value approximating to £3,000,000. A considerable revival of the industry has also taken place in Java during the war.

Fustic, which consists of the wood of *Chlorophora tinctoria*, a large tree belonging to the natural order Moraceæ, is obtained chiefly from Jamaica, Honduras, and Brazil, and in smaller quantities from British Honduras. When the shortage of yellow dye-stuffs in this country first became apparent, the Imperial Institute took steps to place British dye firms in touch with exporters of fustic in Jamaica. A list of producers of fustic in Jamaica, with details of the quantity available and the price, was furnished by the local Government and sent by the Institute to firms in this country desiring to import the material. The chief markets for Jamaica fustic in the past were the United States and France, and this has continued to be the case, but direct exports to the United Kingdom have increased since the war began, as is shown in the following table:

Exports of Fustic from Jamaica

		1913.	1914.	1915.
Total quantity .	tons	3,450	3,885	8,160
,, value .	£	7,417	9,130	20,399
To				
United Kingdom .		60	260	567
United States . .		2,065	1,803	4,208
France . . .		1,091	1,248	3,384

The scarcity of synthetic dyes also led to a search for new natural dye-stuffs, and for new sources of supply of the better-known materials, and many samples of such products have been received for examination at the Imperial Institute since the commencement of the war. A brief account of some of the work done in this connection is given in the following pages.

Braziletto Wood and Logwood from the Bahamas

The name Braziletto is applied to several red dye-woods of the West Indies and Central and South America. According to the *Kew Bulletin* (1916, p. 214) the Braziletto of the Bahamas is *Caesalpinia bahamensis*, Lam., a medium-sized tree or shrub 8 to 9 ft. in height, with stems from 2 to 3 in. in diameter. The wood of this tree is stated to have been sent to England from the Bahamas and other parts of the West Indies many years ago in considerable quantities for dyeing, and that as a consequence supplies became scarce. Other species which yield red dye-woods known in commerce as Brazil woods, are

C. echinata, Lam., of Brazil; *C. brasiliensis*, Linn., the Braziletto of the Antilles; *C. bicolor*, C. M. Wright, a native of Peru and Colombia; and *Haematoxylon Brasiletto*, Karst., of Colombia, Venezuela, Mexico, Guatemala, Nicaragua and Lower California, the wood of which is better known as Lima or peach wood. The name Brazil wood was originally applied to the dye-wood of the East Indian tree, *Caesalpinia Sappan*, Linn., now known in commerce as sappan wood, and was transferred to that of the South American trees on the discovery of the New World, the country of Brazil being so called on account of the abundance of red dye-woods there. Brazil wood was at one time largely used as a dye-stuff in this country, but it was replaced to a great extent by the West African camwood (*Baphia nitida*, Afzel.), which is still occasionally imported into this country. The colouring matter of Brazil wood, peach wood and sappan wood is freely soluble in water, and extracts of the woods were formerly used to a great extent in calico-printing for producing pinks and purples, and, in conjunction with other dye-woods, for producing brown colours on wool. The colours produced by these woods are rather fugitive. Camwood, together with the allied dye-woods, barwood (*Pterocarpus Soyauxii*, Taub.), of West Africa, and red sanders or red sandal wood (*Pterocarpus santalinus*, Linn.) of India, is used principally for dyeing wool, in conjunction with other dye-woods, producing browns and other shades, which are extremely fast to soaping and milling, but are not so fast to light as those produced by certain synthetic dyes. The colouring matter of this latter group of red dye-woods is much less soluble than that of the former group, and the woods themselves in a rasped state are used in dyeing.

Logwood is one of the few natural dye-stuffs which has held its own in competition with synthetic dyes, owing to the fact that in conjunction with iron salts it yields one of the most satisfactory black dyes, especially on silk. It is obtained from *Haematoxylon campechianum*, Linn., a small tree 15 to 20 ft. high, native to Mexico and British Honduras, and introduced to most of the West India islands and other parts of the tropics. The chief commercial sources are the Campeachy and Yucatan districts of Mexico, Jamaica, British Honduras, Haiti and St. Domingo (see *Kew Bulletin*, 1916, p. 221). As a result of action taken by the Imperial Institute, a considerable supply of logwood from Mauritius has been made available for dyers in this country since the beginning of the war.

Three samples of Braziletto wood and one sample of logwood were forwarded to the Imperial Institute from the Bahamas in April 1917. They were as follows:

(1) "*Native Braziletto.*"—This consisted of three pieces of wood weighing 10 lb. and measuring from 16 to 38 in. in length and from 2 to 3 in. in diameter, from which the bark and sapwood had been removed. The wood was of a light golden-brown colour, with occasional streaks of white.

(2) "*Native Braziletto cut on New Providence.*"—This weighed 9 lb. and was similar to No. 1 in all respects.

(3) "*Out Island Braziletto.*"—This sample weighed 6 lb. and included four pieces of wood, from which the bark and sapwood had been removed. The pieces varied in length from 17 to 30 in. and in diameter from 1½ to 2 in. The wood was of a mahogany colour externally and dark yellowish-brown internally, with some streaks of white wood.

(4) *Logwood.*—This weighed 11 lb. and comprised three pieces of the heartwood, measuring 17 to 30 in. in length and 2 to 4 in. in diameter. The pieces were dark brown externally, and dark orange-brown internally with white patches.

The four samples were examined at the Imperial Institute with the following results, which are shown in comparison with those obtained with commercial samples of logwood and Brazil wood, and with a sample of "Brasilada" wood from the Bahamas, which was submitted to the Imperial Institute in 1916.

The results of the dyeing trials and chemical tests showed that the three samples of Braziletto wood are practically identical in dyeing properties. They all yielded colours similar to those obtained with a commercial sample of Brazil wood, the only difference noted

Samples.	Moisture.	Matter soluble in water.	Colour of a 1 per cent. solution of the wood.	Colour produced on adding the following reagents to a 1 per cent. solution of the wood: Hydrochloric acid.	Caustic soda.	Ferric chloride.	Colour of wool dyed after mordanting with: Chromium.	Alum.
	Per cent.	*Per cent.*						
A. From Bahamas:								
(1) *Braziletto* (Native)	10·0	11·0	Orange	Reddish-orange	Crimson	Dark reddish-brown	Maroon	Pink
(2) *Braziletto* (New Providence)	8·8	11·0	,,	,,	,,	,,	,,	,,
(3) *Braziletto* (Out Island)	10·3	8·2	,,	,,	,,	,,	,,	,,
(4) *Logwood*	9·7	18·1	Reddish-brown	Crimson	Blackish-purple	Black	Black	Purple
(5) *Brasilada*	6·7	23·6	,,	,,	,,	,,	,,	,,
B. Commercial Samples:								
(6) *Camwood*	11·4	6·2	Light reddish-brown	Reddish-brown	Dark reddish-brown	Brown	Brown	Apricot
(7) *Logwood*	9·8	16·0	Reddish-brown	Crimson	Blackish-purple	Black	Black	Purple
(8) *Brazilwood*	9·4	14·6	Orange	Reddish-orange	Crimson	Dark reddish-brown	Maroon	Deep pink
(9) *Logwood from British Guiana*	15·3	16·5	Reddish-brown	Crimson	Blackish-purple	Black	Black	Purple

being in the depth of colour obtained in the case of the wool mordanted with alum. These Braziletto woods were found to be quite distinct from the previous sample of "Brasilada" wood from the Bahamas, which resembled logwood in appearance and dyeing properties.

The present sample of logwood from the Bahamas behaved similarly to commercial logwood, and gave colours of equal depth on wool.

Samples of the Braziletto wood and logwood were submitted for trial to a firm of dye-stuff manufacturers, who reported that they had compared the Braziletto wood with commercial samples of Brazil wood and peach wood, and that in their opinion it could best be utilised as a substitute for peach wood, although it gives rather browner shades. They added, however, that this wood was not of much interest at the present time.

The logwood was pronounced by the manufacturers to be of good quality and equal to the best Jamaica logwood, the current value of which is £4 10*s.* per ton f.o.b. Kingston. The firm offered to purchase 50 tons of logwood from the Bahamas at a price of £4 10*s.* per ton f.o.b. Nassau, plus £8 to £9 per ton for freight and all insurance charges, that is £12 10*s.* to £13 10*s.* per ton c.i.f. Liverpool or Bristol (Liverpool by preference). They also expressed a desire to be placed in communication with exporters of logwood in the Bahamas.

There is no doubt that a market can be found in the United Kingdom for this logwood from the Bahamas if shipments can be made.

The Braziletto wood is not likely to be of much interest to dyers in this country at the present time. In view, however, of the confusion that has occurred with respect to the various red dye-woods which have appeared in commerce as Brazil wood and under other similar names, it would be useful to determine definitely the botanical identity of the trees yielding Braziletto and Brasilada woods in the Bahamas, and for this purpose the local authorities have been asked to forward herbarium specimens of the trees, together with samples of woods from the same trees.

Indigo

Specimens of indigo from Nyasaland and Nigeria, and of indigo-yielding plants from Natal, have been examined recently and enquiries have been received as to the advisability of encouraging the cultivation and manufacture of indigo in various British Colonies. In this connection it should be pointed out that the present demand for natural indigo will no doubt continue during the war, but as soon as conditions become normal, competition with the synthetic product will recommence, and will in fact probably be keener than ever. The manufacture of synthetic indigo has been started in the United Kingdom, the United States, France, Switzerland, etc., so that there appears to be a prospect of a considerable over-production of the material after the war. In these circumstances it may be difficult for the natural indigo industry in India and Java to hold its own, and it does not appear desirable to take steps to introduce the industry into other countries, where it is not already established, unless there is a sufficient local demand for the dye. Indigo is, however, an annual crop, and there seems to be no reason why an effort should not be made to increase supplies during the war so long as no large expenditure on plant is incurred.

In view of the fact that it is proposed to experiment with the production of indigo in certain countries, the following memorandum on its cultivation and preparation may be of interest in countries where such experiments are being undertaken.

The Cultivation and Preparation of Indigo

In forming an indigo plantation, the first necessity is good seed. For this purpose the seed crop should be grown quite separately from the leaf crop, the seed produced by allowing ordinary plants of the latter to seed being inferior to that of plants specially grown for seed. Experiments in Bihar, one of the chief indigo-producing areas in India, have indicated that excellent yields of good seed may be obtained in the case of Java indigo by sowing early in August in rows 2 ft. apart, and thinning out the plants to 9 in. apart. The plots should be on as high ground as possible, to ensure good drainage, and good soil aeration should be secured by proper cultivation. The seed can be stored in sheet-iron bins for some years without serious deterioration in germinating power.

For the production of indigo the plant should not be grown on a rich soil, and manuring experiments still in progress in India have shown that manuring is generally undesirable for indigo, except as an aid in the mechanical disintegration of the soil, for which purpose the waste leaf-product of the factory (known in India as "seeth") is generally used. The seed is sown in drills so as to facilitate weeding and cultivation, the time of sowing depending on the variety. Sumatra indigo, which is shallow-rooted, is sown in Bihar at the end of February or early in March, that is at the beginning of the hot weather, and Java indigo, which is deep-rooted and takes longer to come to maturity, is sown in October at the beginning of the cold season.

The essential feature of successful indigo cultivation is thorough aeration of the soil. For this reason the land must not be water-logged, and the soil must be kept stirred by means of a harrow or cultivator to a depth of about 3 in. during the growth of the plant. Weeding also must be thoroughly and systematically conducted.

The plants are cut when full grown, but before the flowers have formed. In Bihar, where the bulk of the rain falls between mid-June and mid-September, the first cutting is made in July, after which the plants ratoon and are ready for a second cutting in August.

It is advisable to leave one shoot on the plant after the first cutting, as the second crop then grows more rapidly. The shoots which arise after the second cutting are commonly allowed to grow and flower for the production of seed, but they are much weaker than the earlier shoots. The deterioration of Java indigo in Bihar is attributed to this cause, and it is for this reason that the growing of special seed crops is recommended.

After cutting, the plants are tied loosely in bundles and conveyed to the steeping vats in which they are stacked, generally in an upright position to facilitate escape of the gases produced in the fermentation which takes place later on, to about 10 in. from the top, and covered with water. The plants should be shaken free from dust and earth before being put into the vats, which are provided with taps near the base by which the liquid can be run off. The bundles are held in position by bamboos and planks suitably placed. After about two hours the commencement of fermentation is indicated by the liquid in the vat rising, and by the liberation of air and gases and the formation of a thick froth on the liquor. The length of time for complete extraction varies from nine to fourteen hours according to temperature, which should be about 90° F., and is usually determined by the leaves becoming pale and the tops tender, and by the subsidence of the liquor, which is then run into the beating vat. The issuing liquor should be at first orange-coloured, soon changing to yellow and finally to olive-green. The beating or agitation, which is done to aerate the liquid thoroughly and liberate the indigo from the solution, normally requires from 1½ to 3 hours. When nearing completion, the froth, which at first is bluish, becomes white and gradually disappears, while the liquid changes through various shades of green to dark indigo-blue. This stage is complete when a little of the liquid poured into a white plate readily deposits "grain" or "fecula," leaving a clear supernatant liquid. A better test is to saturate a piece of filter paper with the solution and subject it to the fumes of ammonia; if a blue colour is developed, the beating is incomplete. The precipitated indigo is allowed to settle, which requires two or three hours, the supernatant liquor run off, and the residual liquid containing indigo in suspension passed through strainers to a boiling tank heated by direct fire or steam. This heating prevents further fermentation, effects the solution of certain brown impurities, and produces a better granulation of the indigo. Before reaching the boiling tank, the indigo is again strained twice, and every precaution taken to keep it clean and free from twigs and dirt. After boiling, the product is run into a filter of cotton or linen cloth, and allowed to remain on the filter until it has the consistency of a stiff paste.

It is then transferred to wooden boxes with perforations and a lining of sail-cloth. The slab produced by cautious pressing is cut into cakes and dried at ordinary temperature on trellis-work shelves.

In the process described above and employed in India, steeping vats of 1,000 cubic feet capacity, and taking a charge of 11,000 to 15,000 lb. of green plant, are used. The beating vats are much larger, one beating vat taking the liquor from 6 to 8 steeping vats. The process is, however, quite suitable for use on a small scale.

Great care should be taken throughout to avoid the inclusion of any dirt or debris in the indigo.

Indigo from Nyasaland

The two samples of indigo from Nyasaland which are the subject of this report were forwarded by the Director of Agriculture, in January 1917. It was stated that the indigo had been prepared from wild plants.

The samples were as follows:

"*No. 1. Indigo from Agricultural Department, Nyasaland.*"—A hard, brittle slab of indigo, of greyish-black colour, and showing only a slight coppery lustre when cut.

"*No. 2. Indigo from Nyasaland, probably a different species from No. 1.*"—A small round tablet of indigo of blue colour, and showing a coppery lustre when cut.

The samples were submitted to chemical examination with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	6·5	—
Ash	22·2	—
Indigotin	20·4	36·1

The amount of indirubin (indigo-red) in the samples was negligible.

The percentage of ash in sample No. 1 was high, but it consisted principally of earthy matter, and could no doubt be reduced by more careful preparation. The lowest grades of commercial indigo contain not more than 25 to 30 per cent. of ash, and good Bengal indigo usually contains only 3 to 6 per cent. Sample No. 2 was insufficient for the determination of the percentage of ash.

Sample No. 1 would be regarded commercially as a "low grade indigo," but sample No. 2 was of "middling" quality, and compared favourably with an average quality of Madras indigo which usually contains about 30 per cent. of indigotin. Madras indigo is, however, inferior to Bengal indigo, which contains on an average from 60 to 66 per cent. of indigotin.

These two samples of indigo, prepared from wild plants in Nyasaland, were of low and medium quality respectively. It is probable that a product of better quality could be obtained by the adoption of cleaner methods of preparation, and by using cultivated instead of wild plants for the purpose.

Indigo from Nigeria

A sample of indigo prepared in the Northern Provinces, Nigeria, was received in May 1917. The true indigo (*Indigofera* spp.) and the so-called wild indigo (*Lonchocarpus cyanescens*) are both grown in Nigeria for the production of indigo, but no information was supplied as to which plant was the source of the present sample.

The sample consisted of irregularly conical pieces of indigo from 1¼ to 1¾ in. in diameter at the base and from 1¾ to 3 in. in height. The pieces were soft and crumbled easily: they had a deep blue colour with a bronze tint, and showed a marked bronze lustre on rubbing.

On examination the indigo was found to contain 4·8 per cent. of moisture, 31·3 per cent. of ash, and 27·5 per cent. of indigotin (indigo blue) and approximately 1·5 per cent. of indirubin (indigo red).

The sample was submitted for valuation to a firm of merchants, who stated that indigo as represented by the sample would be worth about 3*s.* 6*d.* per lb. (September 1917), but as the indigo market was then in a dull state, calculations for a trial shipment should be based on a lower figure, say about 2*s.* 6*d.* per lb.

This indigo was of rather low grade, being a little inferior to average Madras indigo, which contains about 30 per cent., and much inferior to Bengal indigo, which usually contains about 60 per cent. of indigotin.

2

The rather low percentage of indigotin in this Nigerian indigo is due to the large amount of mineral matter (ash) present. This mineral matter may have been introduced by the use of plants covered with sand and dirt, or by the use of muddy steeping water. If care is taken to avoid the inclusion of dirt in these and other ways, it should be possible to produce indigo of good quality in Nigeria. It is clear, however, that indigo of the quality represented by the present sample will be marketable in this country.

Indigo Plant from Natal

A sample of indigo plant was forwarded from Natal in March 1917. The plant was stated to be *Indigofera arrecta*, Hochst., and it was desired to ascertain its value as a source of indigo.

The sample consisted of entire indigo plants, without roots, in good condition. The plants had been cut into lengths of from 15 to 18 in. and most of the leaves had become detached from the stems. The leaves, including the leaf stalks, formed 46 per cent. of the entire sample.

The material was submitted to chemical examination, and the entire plants were found to contain :

	Per cent.
Moisture	9·4
Indigotin	0·42 [1]

[1] *Equivalent to a yield of approximately* 0·9 *per cent. from the leaves, as the stems do not contain any appreciable amount of indigotin.*

For comparison with these results the following figures showing the amounts of indigotin obtained by Bloxam from the dried leaves of *Indigofera arrecta* in India may be quoted :

	Indigotin. *Per cent.*
Old leaves	0·87
Young leaves	1·81

It will be seen from these figures that the leaves of this sample of *I. arrecta* from Natal contain about the same percentage of indigotin as the old leaves of plants of the same species grown in India, but much less than the young leaves. The yield of indigotin from the dried leaves is, however, usually less than that furnished by the fresh leaves, owing to changes having taken place during drying, and in order to obtain accurate data on this point, it is desirable that tests should be made on the spot with the fresh material.

Indigofera arrecta, Hochst., is one of the principal sources of indigo. It was introduced from Natal into Java, where it displaced the species of *Indigofera* previously cultivated, and has since been largely grown in India owing to its superiority over the Indian plant.

There is no doubt, therefore, that this species of *Indigofera* from Natal, assuming the correctness of its determination as *I. arrecta*, Hochst., would be quite satisfactory as a source of indigo.

"Indian Madder" from South Africa

A sample of the roots of the Indian madder (*Rubia cordifolia*, Linn.) was received from South Africa in June 1917. The material was stated to have been obtained from the Weenen District of Natal. This dye-stuff was at one time largely employed in India for dyeing cotton fabrics various shades of scarlet, coffee-brown or mauve, but it has been largely replaced by artificial dye-stuffs, although it is still employed for certain purposes and in remote localities. The roots of the European madder (*R. tinctorum*, Linn.) were also formerly used on a large scale, both in Europe and Asia for dyeing, but its employment has now almost died out, owing to the competition of synthetic alizarin.

The material from South Africa consisted of short irregular lengths of reddish-brown root, varying in thickness from ⅛ to ½ in.

It was examined in comparison with a sample of *R. cordifolia* roots from Kashmir and a commercial sample of ground madder roots (*R. tinctorum*). The results were as follows:

	R. cordifolia roots from Natal.	*R. cordifolia* roots from Kashmir.	*R. tinctorum* (commercial madder roots).
	Per cent.	*Per cent.*	*Per cent.*
Moisture	12·5	6·2	9·1
Matter extracted by boiling water .	41·0	50·0	50·5

The solutions obtained by the extraction of equal weights of the three materials with hot water varied in colour. The solutions from the commercial madder roots and from the *R. cordifolia* roots from Kashmir were cloudy and of brown colour, whereas that from the Natal sample was clear and reddish-brown.

A series of dyeing trials was carried out with the *R. cordifolia* roots from Natal, using 20, 40 and 60 per cent. of the material with woollen yarn, (*a*) unmordanted, (*b*) mordanted with chromium and (*c*) mordanted with alum. The percentages of the roots used in the experiments are expressed on the weight of wool dyed. Comparative trials were also made in the same way with the *R. cordifolia* roots from Kashmir and the commercial madder root, but in these tests only 40 per cent. of the material was used.

The results obtained in these experiments indicated that the Natal roots would give colours stronger than those yielded by the commercial madder root, and about equal in strength to those obtained with the *R. cordifolia* roots from Kashmir. The tints obtained with the Natal root, however, differed somewhat from those given by commercial madder root or by the *R. cordifolia* roots from Kashmir.

Specimens of wool dyed with the Natal roots, together with a sample of the roots, were submitted to a firm of manufacturers, who stated that the dyeing properties of the material appeared to be very good. They pointed out, however, that there is only a limited demand for madder root at the present time, and that they would not be prepared to import supplies of *R. cordifolia* roots until they had had an opportunity of trying the material on a commercial scale.

This sample of *R. cordifolia* roots from Natal was too small for complete investigation. The preliminary experiments indicate, however, that the roots possess tinctorial properties about equal to those of *R. cordifolia* from India, and stronger than those of a commercial sample of ground madder root. The roots could be used for dyeing in South Africa, and would probably give a fairly wide range of colours similar to those produced with madder, the shades obtained depending on the mordant used and the dyeing process employed.

LICHEN FROM THE FALKLAND ISLANDS

A small sample of a lichen of bushy form was forwarded from the Falkland Islands in September 1917. A specimen was identified at Kew as *Neuropogon melaxanthum*, Nyl. This lichen has a wide distribution in arctic, antarctic and alpine regions. According to Hooker (*Flora Antarctica*, 1845–47, ii. p. 520) it is abundant in the Falkland Islands, covering the surface of the quartz rocks with a miniature forest, and attaining its greatest size in the most exposed situations. This species is stated to be synonymous with *Usnea melaxanthum*, which is regarded by some authorities as a variety of *Usnea barbata*. The latter species is said to have been used in some parts of America as an orange dye.

The following trials were carried out at the Imperial Institute with the lichen, so far as the quantity available permitted, in order to ascertain its tinctorial properties on woollen yarn :

Details of Experiment.	Colour produced.
(1) 3 grams of wool was boiled for ½ hour with 3 grams of lichen and 150 cc. of water	Pale yellowish-buff.
(2) 3 grams of wool was boiled in the same bath for 2½ hours after the completion of Experiment 1	Orange-brown.
(3) A piece of wool, after dyeing as described in Experiment 1, was boiled for 2½ hours in water	The colour darkened to a light orange-brown.
(4) 3 grams of wool mordanted with 3 per cent. of potassium dichromate was boiled for 1 hour with 3 grams of lichen and 150 cc. of water	Pale yellowish-fawn.
(5) 3 grams of wool was boiled for ½ hour with 3 grams of lichen, 150 cc. of water, and 10 cc. of a 10 per cent. solution of ammonia	Light cinnamon-brown.
(6) 3 grams of wool was introduced into the same bath after the completion of Experiment 5, and boiled for 2½ hours with the addition of 20 cc. of the ammonia solution	Warm brown.

It is clear from the results of these experiments that the lichen could be used for the direct dyeing of wool by boiling the lichen and wool together in water for two to three hours. The use of potassium dichromate as a mordant did not strengthen the colour obtained, but prolonged boiling, as in Experiments 3 and 5, produced a much darker colour, especially after treatment with ammonia. In all cases the colour was deposited slowly and evenly.

The preliminary experiments described above show that this lichen from the Falkland Islands possesses distinct tinctorial properties. It gives colours on wool very similar to those recorded for the allied species *Usnea hirta*.

The lichen if available in sufficient quantity could no doubt be utilised for dyeing purposes in the Falkland Islands, but it would be of no interest for export to Europe.

UTILISATION OF RICE AND ITS BY-PRODUCTS

In a previous number of this Bulletin (1917, **15**, 198) a general account was given of the various uses to which rice and its by-products are applied apart from its direct use as food, and that article may now be supplemented with the results of an investigation carried out at the Imperial Institute as to the suitability of various kinds of Burmese rice for industrial and other purposes. The possibility of utilising rice straw and rice husks for paper-making has also been investigated recently, and the results of these investigations are given in the following pages.

Rice from Burma

A series of 12 samples of husked rice, and 12 corresponding samples of paddy, produced in the course of selection experiments at the Agricultural Station, Hmawbi, Lower Burma, were forwarded in March 1917. The samples were clean and free from dirt and extraneous matter.

The samples were divided at the Imperial Institute, after consultation with commercial experts, into four groups, viz. (1) Hard long grain, (2) Hard transparent grain, (3) Soft transparent grain, and (4) Soft opaque grain. This classification of the samples and the characters of the different kinds are summarised in the following table :

Sample.	Rice.					Paddy.
	Hardness.	Colour.	Shape.	Size. No. of whole grains in 10 c.c. volume.	Percentage of broken grains.	Percentage of husk.
Hard Long Grain :						
Emata (343) .	Hard	Transparent	Long and fairly broad	365	40·0	21·1
Letywezin (SS 25)	„	„	Same as Emata, but not so large	477	6·8	23·1
Bankouk (8) .	„	„	Long and fairly broad	390	25·2	21·2
Taungdeikpan (70)	„	„	Long and slender	481	35·8	24·5
Bausamati (105) .	„	„	Short and thin. Poor small grain	592	53·1	23·2
Hard Transparent Grain :						
Byatcale (10) .	Hard, but not so hard as 1st group.	Transparent to semi-transparent	Short and broad	388	48·6	21·4
Ngasein (8) . .	„	„	„	413	9·6	21·1
Soft Transparent Grain :						
Beelugyun-Ngasein	Soft	Semi-transparent	Long and broad	295	50·6	19·6
Byatthidat (14) .	„	„	Short and broad	346	16·2	20·7
Bawyut (32) .	„	„	„	383	11·6	21·2
Soft Opaque Grain :						
Byatcale (20) .	„	Opaque	Long and broad	314	32·5	20·8
Sabanet (311) .	„	„	Short and broad	364	13·6	21·3

The samples of rice were analysed with the following percentage results :

Sample.	Moisture.	Total proteins.	Fat.	Starch (by difference).	Fibre.	Ash.
Emata (343)	14·3	9·1	0·7	75·3	0·1	0·5
Letywezin (SS 25)	14·2	8·9	0·9	75·2	0·2	0·6
Bankouk (8)	13·7	9·3	0·6	75·3	0·5	0·6
Taungdeikpan (70)	13·6	8·9	0·8	75·7	0·3	0·7
Bausamati (105)	13·7	10·0	0·8	74·6	0·1	0·8
Byatcale (10)	14·1	7·4	1·1	76·5	0·2	0·7
Ngasein (8)	14·1	6·9	0·9	77·3	0·2	0·6
Beelugyun-Ngasein	12·6	8·0	0·7	77·9	0·2	0·6
Byatthidat (14)	12·9	8·0	0·6	77·5	0·2	0·8
Bawyut (32)	13·8	7·9	0·7	76·6	0·2	0·8
Byatcale (20)	13·5	7·4	0·7	77·5	0·2	0·7
Sabanet (311)	14·3	6·9	0·6	77·3	0·2	0·7

Suitability of the Rices as Food-stuffs

Samples of each variety of rice were submitted to commercial experts for expression of opinion as to their quality and suitability for the British market, with the following results :

(1) A firm of brokers reported that the following varieties, which are arranged in order of merit, would be saleable in the United Kingdom : Emata, Letywezin, Byatcale No. 10, Bankouk, Taungdeikpan, Ngasein. They stated that the first three samples were similar to Java rice, whilst the Bankouk and Taungdeikpan varieties were similar to Siam rice and the Ngasein rice was equal to a very superior Rangoon. They added that there might be a limited sale for the Beelugyun-Ngasein variety, but that the grain appeared to be too soft to compete with other rices, whilst the Bausamati variety is too small-grained to be of much commercial value.

The firm stated that the 4 remaining samples appeared to be very soft in grain and not suitable for the United Kingdom market, adding that Austria was the principal market for rice of this quality before the war.

(2) British rice millers were asked to report jointly on these rices, and furnished the following statements :

Emata.—This is a full-grained rice which would satisfy all the requirements of British millers.

Letywezin.—A useful grain, similar to the Emata variety, but inferior in size and quality.

Bankouk.—This has the appearance of being ordinary No. 1 Siam rice of good quality, containing the usual amount of defects but useful for general purposes.

Taungdeikpan.—This is a useful rice somewhat similar to the Bankouk variety, but inferior in size and colour.

Byatcale (10).—A good grain as regards transparency and evenness of quality, and answering all requirements of this class of grain.

Ngasein.—This appears to be a fine sample of ordinary pinky Ngasein grain, which is very useful and keeps well in hot climates, but is hard to mill and on that account not greatly liked by rice millers.

Beelugyun-Ngasein.—This is a good milling grain which should give the highest satisfaction to both millers and consumers. The production of this quality of Burma rice can be specially recommended.

Byatthidat.—A very useful soft-grained rice, much the same as the Beelugyun-Ngasein variety, but smaller in grain and not so good in colour.

Bawyut.—This is also a useful rice somewhat similar to the two previous samples, but again of inferior growth.

Byatcale (20).—This is a good full-grained rice, very similar to fine Moulmein rice from which a good grocery product is milled, and which is much sought after by some buyers.

Sabanet.—This is similar in type to the previous sample but very inferior, and not worth bringing to the notice of importers.

Bausamati.—An inferior rice of no value to British millers.

The percentages of broken grain in these samples show considerable variation, some of the best types containing large amounts. If the husking was conducted uniformly throughout in the preparation of these samples, these figures indicate considerable variations in the milling properties of the rices, but it is realised that as the grain was husked by native methods, no great importance need be attached to the amount of broken rice in these samples as an indication of the amount that would be produced by milling in modern machinery. The percentage of husk in the samples of paddy varies only slightly.

It will be seen that the brokers and millers are in agreement as to the merits of Emata, Letywezin, Byatcale (No. 10), Bankouk, Taungdeikpan, and Ngasein rices, but differ considerably in their estimates of the value of Beelugyun-Ngasein and Byatcale (No. 20). It was suggested to the Burmese authorities that as the millers were favourably impressed with the two last-named types, it would be useful to have large samples of these rices, preferably in the form of either cargo rice or "loonzein" (skinned rice), sent to this country for milling trials. The rices milled from these samples would be examined at the Imperial Institute, and it would then be possible to obtain the opinions of representative firms throughout the rice trade as to their commercial value, and the information so obtained should leave no doubt as to the suitability or otherwise of these rices for this market.

Suitability of the Rices for Industrial Purposes

I. *Starch-making*

The rices were submitted to a firm of starch manufacturers, who stated that the chief points to which starch makers devote attention when judging rice for their purposes are as follows:

(*a*) *Hardness of grain.*—Rice of medium hardness is preferred, as hard rices are troublesome to soften and grind.

(*b*) *Percentage of starch.*—The variation in the amount of starch in different kinds of rice is small. The percentage of starch cannot, however, be taken as an index of the yield of pure rice starch obtainable in practice, as some kinds of rice starch are more difficult to purify.

(*c*) *Fat.*—The amount of fat present only varies slightly and does not influence the value of the rice for starch manufacture.

(*d*) *Colour of the grain.*—"Red skin" is an objection, as it produces a dark liquid when the rice is treated with alkali for softening the grain before grinding and tends to stain the starch. Yellowness of the grain is also objectionable, but this appears to be due generally to heating during transit and not to be an intrinsic characteristic of special kinds of rice. In this connection the manufacturers suggested that disinfection of cargoes with sulphur dioxide would be useful.

(*e*) *Protein.*—The lower the amount of protein present the better, as a low percentage entails the removal of less material in the purification of the starch.

Starch makers are accustomed to buy clean broken rice, as it is suited to their needs and is cheaper than whole clean rice. With regard to the possibility of growing varieties of rice specially suited to starch manufacturers, the firm stated that there seems to be no need for this, as they depend entirely on broken grain for their supplies. They stated that a fully matured rice was preferable, as it seems to contain a higher proportion of starch granules of full size, and less of the very minute granules which cause waste of time and material in the "settling out" stages of the process of manufacture.

II. *Brewing*

The rices were submitted to a firm of brewers who specialise in the use of rice. They reported that all twelve varieties would be quite suitable for brewing, but that the rices with the minimum amount of fat are preferable to those containing a larger quantity, whilst rices with the greatest amount of starch will yield more beer for a given weight of rice. These points taken in conjunction with the price of the grain would be the governing factor in buying rice for brewing.

It appears from the results of these enquiries that any of these twelve varieties of rice could be used for brewing and starch manufacture.

It is clear, however, that better prices would be obtained for the whole rice for food purposes, and that only the broken rice need be considered as a raw material for brewing or starch-making. In these circumstances it would not be worth while to select varieties of rice for cultivation with the special object of meeting the requirements of these industries.

Rice Straw for Paper-making

A sample of rice straw was forwarded from Egypt in April 1917 in order to ascertain its suitability as a paper-making material.

The sample consisted of clean rice straw of brownish-yellow tint. It was examined with the following results :

	Per cent.	
Moisture	11·8	
Ash	17·6	Expressed on the dry straw.
Cellulose	50·0	

Length of ultimate fibres, 0·6 to 3·0 mm. ; mostly 0·9 to 1·3 mm.

The straw was submitted to treatment with varying quantities of caustic soda under conditions similar to those usually employed for the manufacture of paper pulp, with the results given in the following table :

Experiment.	Caustic soda used.		Conditions of boiling.		Yield of dry pulp expressed on the straw as received.
	Parts per 100 parts of straw.	Parts per 100 parts of solution.	Time.	Temperature.	
			Hours.		*Per cent.*
A	14	4·0	4	140° C.	44
B	10	2·5	4	140° C.	50
C	8	2·0	4	140° C.	52
E	6	1·5	4	140° C.	53

The pulp obtained in these experiments was in all cases of pale colour, and yielded a strong opaque paper of excellent quality which did not shrink greatly on drying. Except in the case of experiment E the pulp bleached easily to a very pale cream colour, almost a pure white.

A further experiment was made in order to ascertain whether the straw could be converted into a satisfactory pulp by boiling with milk of lime under the following conditions :

Experiment.	Lime (CaO) used. Parts per 100 parts of straw.	Conditions of boiling.		Yield of dry pulp expressed on the straw as received.
		Time.	Temperature.	
		Hours.		*Per cent.*
F	20	12	140° C.	56

The pulp produced by this method was bright yellow-brown and did not beat easily. It yielded an opaque paper of fair strength, but it could not be bleached satisfactorily. This pulp should, however, be quite suitable for the manufacture of brown paper and straw board.

It will be seen that this rice straw gives a good yield of pulp, and only requires mild treatment, i.e. the use of comparatively small amounts of caustic soda to produce a pulp which will bleach easily to a pale cream colour. The advantage which rice straw possesses of only requiring small amounts of caustic soda to convert it into pulp will, however, be counteracted to some extent by losses in the recovery of the soda, which is incomplete in the case of materials containing a large proportion of silica.

The results obtained at the Imperial Institute with this Egyptian rice straw confirm those already recorded in the United States, and show that the straw when treated by the soda process yields pulp of good quality which is suitable for the manufacture of white paper. The straw will also serve for the production of straw board and brown paper if treated by either the soda or lime processes.

It is improbable that rice straw could be remuneratively exported from the producing country as a paper-making material in normal conditions, but if adequate supplies are available, its conversion into "half-stuff" for export would be worth consideration. It is also possible that the rice straw might be used locally for the manufacture of paper or straw board, either to supply the requirements of the local market or for export.

Rice Husks

The profitable utilisation of the enormous quantity of rice husks produced in the milling of rice has long been under consideration. It has been suggested that they might be used for paper-making, and as no experiments on this subject appear to be on record, the matter was recently investigated at the Imperial Institute.

The sample of rice husks examined contained 7·9 per cent. of moisture and the dry husks yielded 14·7 per cent. of ash and 42 per cent. of cellulose. The ultimate fibres varied in length from 0·5 to 1·5 mm., being mostly from 0·5 to 0·7 mm.

The husks were treated with caustic soda under conditions similar to those employed at a paper-mill with the following results :

Caustic soda used.		Conditions of boiling.		Yield of dry pulp expressed on husks as received.
Parts per 100 parts of husks.	Parts per 100 parts of solution.	Time.	Temperature.	
		Hours.		*Per cent.*
16	4	4½	140° C.	36

The pulp contained a large proportion of gelatinous material which could not be satisfactorily removed by beating and washing. It furnished paper of a medium brown colour which was very weak and brittle and cracked when folded. The pulp could not be satisfactorily bleached.

The results of this experiment indicate that rice husks are unsuitable for the manufacture of paper. The pulp might be used as a filler in admixture with longer fibred pulps for the manufacture of low-grade paper or straw-board, but it is somewhat unlikely that its preparation for such purposes would be remunerative.

COFFEE AND TEA FROM UGANDA

At the present time coffee is by far the most important crop grown on European plantations in Uganda, and of all agricultural produce exported from the country is only exceeded in value by cotton. An account of the industry was given in an article by Mr. W. Small, M.A., B.Sc., Botanist to the Uganda Department of Agriculture, in a previous number of this Bulletin (1914, **12,** 242) and later statistics were given in a subsequent number (1916, **14,** 6), so that it is only necessary here to refer to the more recent progress.

According to the *Report of the Department of Agriculture, Uganda,* 1915–16, there were in that year 12,162 acres under *Coffea arabica* and 264 acres under *C. robusta,* of which 2,271 and 15 acres, respectively, were occupied by trees less than two years old. In addition coffee was interplanted with Para rubber on an area of 4,747 acres, 238 acres of which were planted with trees less than two years old. The *Report* for 1916–17 records totals of 9,258 acres under *C. arabica,* 238 acres under *C. robusta* and

3,541 acres under coffee and Para rubber, but in that year many plantations failed to send in returns. During the past two years 788 acres were also planted with *C. arabica* and 26 acres with *C. robusta* at the various missions. The area under coffee cultivated by natives in 1916–17 was 10,420 acres and in 1915–16 8,464 acres. Most of the coffee, both plantation and native, is grown in the Buganda Province, but rapid progress has been made recently in the Northern Province.

The exports of coffee from Uganda have continued to increase rapidly, the figures during recent years being as follows:

		Quantity. *Cwts.*	Value. £
1911-12		1,712	2,563
1912-13		3,336	8,940
1913-14		12,258	23,167
1914-15	Husked	2,103	5,542
	In parchment	18,998	35,462
1915-16	Husked	8,691	22,714
	In parchment	34,547	64,488
1916-17	Husked	31,136	81,323
	In parchment	17,473	32,616

Although interest is being taken in the cultivation of tea by European planters in Uganda, it is not yet grown on a commercial scale. The experimental plots at the Government Plantations, at Kampala and Kakumiro, Mubendi, have given encouraging results, and in 1915–16 the Kampala plot, which was planted in 1911, yielded at the rate of 135 lb. of prepared tea per acre.

The results of examination at the Imperial Institute of samples of Uganda coffee grown and prepared by natives were published in this BULLETIN (1916, **14**, 7), and a report on samples of tea grown and prepared at Kampala has also been published (1914, **12**, 540). In the following pages samples of Robusta coffee and tea grown and prepared at the Government Plantations, at Kampala and Kakumiro, respectively, are dealt with.

Robusta Coffee

Six samples of Robusta coffee were forwarded in August 1917. They varied in weight from 4 to 10 oz., and all consisted of beans in the parchment. The beans were mostly oval and flat on one side, but a few rounded beans ("peaberries") were also present. The parchment was of a light straw-brown colour, and in many cases showed brown discolorations, this being most noticeable in sample 4, whilst samples 3 and 6 were the cleanest in this respect.

The samples were examined at the Imperial Institute with the following results:

No. of sample.	Percentage of parchment.	Percentage of bean.	Average weight of a single bean in grams.	No. of beans required to fill a 50 cc. measure.	Size of beans.	Colour of beans.	Description of seed-coat.
1	11	89	0·13	232	Small	Opaque greyish-cream	Light brown, lightly adhering.
2	13	87	0·18	193	Fairly large to small	Grey with occasional small cream-coloured opaque patches	Dark brown, firmly adhering.
3	12	88	0·22	156	Fairly large to medium	Grey with cream-coloured opaque patches	Light brown, lightly adhering.
4	11	89	0·13	282	Medium to very small	do.	Light brown, fairly firmly adhering.
5	14	86	0·14	253	do.	do.	Light brown, firmly adhering.
6	12	88	0·15	233	do.	Grey or opaque greyish-cream	Light brown, firmly adhering in some cases and lightly in others.

The samples were submitted for valuation to a firm of brokers, who furnished the following report:

Sample 1 consisted of small and well-made beans, but was rather over-dried, causing a bleached appearance which detracted from the value. The firm regarded the value of the sample in London as about 72*s.* per cwt. (December 1917).

Samples 2 and 3 represented good types of Robusta coffee, of first-class quality for this variety and consisting of well-made beans. The value of such coffee in London would be about 80*s.* to 85*s.* per cwt.

Samples 4 and 5 were small beans of good medium quality, and worth 70s. to 75s. and 75s. to 80s. per cwt. respectively in London.

Sample 6 was described as an almost wild coffee of a common variety, and uneven in curing, which would be worth about 60s. to 65s. per cwt. in London.

In November 1917 six further samples (Nos. 7–12) of coffee berries in the parchment were forwarded. The parchment was of light straw colour, clean, and practically free from discolorations. The size of the beans and their character after removal of the parchment are given in the following table :

No. of sample.	Size of beans.	Description of seed-coat.
7 . .	Medium	Light brown, easily removed.
8 . .	,,	,, ,, ,, ,,
9 . .	Medium to small	Light brown, rather hard to remove.
10 . .	,, ,,	,, ,, ,, ,, ,,
11 . .	,, ,,	Light brown, easily removed.
12 . .	,, ,,	,, ,, ,, ,,

The colour of the beans after the parchment was removed was in each case grey with opaque cream patches.

The present samples as received in the parchment were of lighter colour, cleaner, and of better appearance than the previous six samples. The beans after the removal of the parchment were also of better quality, and on the whole larger.

Samples Nos. 7–12 were submitted to a firm of brokers in London, who described and valued them as follows (February 1918) :

Sample.	Description.	Value per cwt.
7.	A good medium quality of well-grown beans .	About 80s. to 85s.
8.	Similar to No. 7, but of slightly better quality .	,, 85s. ,, 90s.
9.	Fair, rather small beans, very green ; apparently picked too early	,, 70s. ,, 75s.
10.	Similar, but preferable in quality to No. 9, consisting of bolder beans and less unripe in appearance	,, 75s. ,, 78s.
11.	Similar to sample No. 8, but rather smaller .	,, 83s. ,, 88s.
12.	A good type of Uganda plantation coffee, consisting of well-grown beans of good colour and fair size. A type of coffee always in demand in the London market	,, 95s. ,, 100s.

The firm added that if larger samples of these coffees can be furnished, they will be glad to carry out roasting trials in order to determine the character of the liquor produced, and the authorities in Uganda have been requested to forward samples for this purpose.

The report of the brokers on these samples (Nos. 7–12) confirms the results of the examination of the previous six samples, and indicates that the Robusta coffee grown at Kampala is of very promising quality. The valuations quoted above are abnormally high owing to war conditions, but there appears to be no doubt that the coffee would at all times be readily marketable in the United Kingdom at good prices.

Tea

This sample consisted of manufactured brownish-black tea containing a good proportion of golden tip. The leaves were on the whole large and loosely rolled. A small amount of broken leaf and a few seeds were present in the sample.

The tea was chemically examined with the results shown in the following table, to which have been added for comparison the figures obtained for previous samples of tea from Uganda (this BULLETIN, 1914, **12**, 540).

		Present sample.	Previous samples from Uganda.		
			(1)	(2) Golden Tip.	(3) Broken Leaf.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent*
	Moisture	11·2	8·1	8·8	8·8
Expressed on the dry tea	Caffeine	4·7	4·0	5·4	4·2
	Tannin	12·8	10·3	13·8	17·0
	Ash	6·2	5·2	4·6	5·3
	Extract (after infusion for 10 minutes)	32·2	39·1	38·6	38·4

The three earlier samples of tea from Uganda which were examined at the Imperial Institute varied somewhat in composition, and the present sample differs slightly from all of them. The percentages of moisture and ash are higher and the amount of extractive matter lower than in the previous cases, whilst the percentages of caffeine and tannin are approximately equivalent to the average of the earlier figures.

Uganda teas apparently tend to be rich in caffeine, as Indian teas usually contain only 3·5 to 4·0 per cent. and China teas somewhat less. Apart however from the high percentage of caffeine and a somewhat higher percentage of tannin, the composition of the present sample resembles that of a number of Indian teas examined at the Imperial Institute (*loc. cit.*, p. 541).

The tea was submitted for valuation to two firms of brokers, who furnished the following reports :

(1) One firm described the sample as unassorted leaf which, judging from its appearance, could be separated into useful and distinct grades, *i.e.* Broken Orange Pekoe, Orange Pekoe, Pekoe, Broken Pekoe Souchong and Pekoe Fannings. They stated that the tea contained a good deal of tip, which however was of too dull a colour, probably owing to faulty fermentation. The smell of the tea was described as " dullish," and it was suggested that this was probably caused by over-withering and insufficient firing. The liquor was of useful colour, but rather " soft " in taste, and the infused tea showed too many greenish unfermented leaves. The tea was valued nominally at about 2*s*. 2*d*. per lb. in London (November 1917).

(2) The second firm stated that the tea was very irregular in make and of uneven appearance, being composed of whole leaf, broken leaf, fannings and dust ; there was, however, a good proportion of brightish golden tip. The tea was deficient in aroma and furnished a poor liquor, whilst the infused leaf was inclined to be greenish instead of a bright coppery red. The firm stated that the value of this tea was purely nominal, the only feature making it worth any price on the market being the tip, which would not raise its value beyond 1*s*. 3*d*. per lb. under normal market conditions. In order to be suitable for the market, the tea would have to be properly sorted into various grades of whole and broken leaf.

From the results of this and the previous investigations of Uganda tea at the Imperial Institute there appears to be no reason why tea grown in the Protectorate, if properly fermented and graded, should not be readily marketable in the United Kingdom.

AJOWAN SEED AND THYMOL

AJOWAN seed is the produce of an annual herb, *Carum copticum*, Benth., closely related to the ordinary caraway. The plant is grown on a commercial scale mainly in India, and before the war the seeds were exported chiefly to Germany, where the oil distilled from them was used as the principal source of the antiseptic thymol (cf. this BULLETIN, 1914, **12**, 599). Since the outbreak of war the plant has been grown experimentally in other parts of the Empire, including Seychelles and several of the West Indian Islands. Samples of the seed grown in Seychelles and Montserrat have been received at the Imperial Institute recently, and these are dealt with in the following pages.

SEYCHELLES

The sample of ajowan seed dealt with in this report was forwarded by the Curator, Botanic Station, Seychelles, in October 1916.

The sample consisted of ajowan seed of poor appearance, a large proportion being small and immature.

The seed was found to yield about 3·4 per cent. of thymol. The quantity of seed available was too small to allow of the preparation of oil and the estimation of phenols by absorption with caustic soda in the usual way. A modified method had therefore to be employed which gave approximate results only. These were however sufficiently accurate to show that the yield of oil from the seed was about 9 per cent.; and the oil therefore contained about 38 per cent. of thymol.

Indian ajowan seed yields only from 3 to 4 per cent. of oil containing from 40 to 55 per cent. of thymol, so that the present sample of Seychelles ajowan seed yielded about twice as much thymol as the Indian seed. The oil itself, however, contains less thymol than the Indian oil, though the yield from the seed is larger.

The present sample was grown from acclimatised seed, and if further samples are found to afford an equally high yield of oil and thymol, Seychelles ajowan seed would be a particularly valuable source of thymol.

Montserrat

Ajowan seed was grown experimentally on a small scale in Montserrat during the season 1916–17. The best results were obtained in the case of plants raised from seed sown on November 1, on a particularly good section of a well-sheltered plot. The seed was harvested about six months from the date of sowing, and yielded at the rate of 1,128 lb. per acre. A sample of the seed produced was forwarded by the Curator of the Botanic Station in May 1917.

The seed was in good condition and of good average quality. As received it contained 7·9 per cent. of moisture, and yielded 3·1 per cent. of a pale yellowish-brown volatile oil. The oil was submitted to chemical examination with the following results:

	Present sample.	Figures recorded for normal ajowan seed oil.
Specific gravity at $\frac{15° C.}{15° C.}$	0·925	0·90 to 0·93
Optical rotation in a 100 mm. tube	+ 0·90°	+ 1° to + 2°
Thymol . . . *per cent.*	54	40 to 55

Indian ajowan seed usually furnishes from 3 to 4 per cent. of volatile oil, so that the yield in the present case is somewhat below the average; on the other hand the percentage of thymol in the oil is above the amount usually present.

The seed was submitted for valuation to three firms of manufacturing chemists, with the following results:

(1) One firm stated that the seed did not contain quite so much volatile oil as is usually found in Indian ajowan seed of good quality, but that this should not appreciably detract from its value as a source of thymol. They were of opinion that as large quantities of thymol are now being produced in India, it would probably be essential for growers in Montserrat to undertake the distillation of the seed locally, as the heavy freight charges on the seed if shipped to Europe would make competition with Indian thymol impossible.

The firm stated that under the present abnormal conditions ajowan seed oil containing about 50 per cent. of thymol would probably realise not less than 10*s.* per lb. (December 1917).

(2) A second firm also expressed the opinion that it would be more economical to distil the oil in Montserrat than to export the seed, provided that the distillation could be carried out in a satisfactory manner. With reference to the value of the seed, they stated that Indian ajowan seed is not coming forward very freely to the London market at present, but that some time ago, when thymol was selling at 25*s*. to 30*s*. per lb., they were able to buy considerable quantities at £15 per ton. The present value of thymol crystals is from 40*s*. to 50*s*. per lb. in London, so that consignments of seed would be expected to realise a higher price than that mentioned above.

(3) The third firm stated that the percentage of thymol in the oil from this seed is satisfactory, and that, as the seed is of normal appearance, there should be a good market for it in competition with Indian ajowan seed. In view, however, of the difficulties of freight and the competition of thyme oil from Spain as a source of thymol, the firm considered that if the distillation of the seed could be carried out in Montserrat economically, it would be better to export the oil rather than the seed. They added that oil yielding 50 per cent. of thymol would probably be worth about 15*s*. per lb. in the United Kingdom (December 1917).

The results of the examination of this Montserrat ajowan seed appear to indicate that the seed could be cultivated successfully in the island as a source of thymol. The actual yields of ajowan seed per acre in countries where it is already grown do not appear to be on record, so that no comparisons on this point are possible. The distillation of the seed for the production of the oil should offer no difficulty.

AROMATIC OILS FROM SEYCHELLES

In a previous number of this Bulletin (1917, **15**, 322) an account was given of the results of examination at the Imperial Institute of samples of volatile oil distilled from *Ocimum viride*, Willd. (Nat. Ord. Labiatæ). The oil was found to consist largely of thymol, that obtained from the leaves containing 62 per cent., and that from the green shoots 52 per cent. It was pointed out, therefore, that if the oil can be marketed at a suitable price, it should form a useful source of that antiseptic, and it was suggested to the Seychelles Government that the cultivation of the plant should be continued in the Colony. Several other species of *Ocimum* have been introduced into Seychelles and now occur in a wild or semi-wild state. *O. gratissimum*, Linn., known locally as "Basilic grandes feuilles," is a common roadside weed in Mahé, and *O. Basilicum*, Linn., known as "Basilic de France," is subspontaneous near Victoria in Mahé, and the Curator of the Seychelles Botanic Station considers that it might be grown easily for the production of oil.

Samples of oil distilled in Seychelles from *O. gratissimum* and *O. Basilicum* were forwarded for examination in April and May 1917. In each case the whole shoots were distilled, including the flower spikes, the former species yielding 0·1 per cent. of oil, and the latter 0·21 per cent. The results of examination of the oils at the Imperial Institute are as follows:

Ocimum gratissimum Oil

This sample consisted of a light brown oil, possessing a pronounced odour of cloves, together with a peculiar secondary aroma which was not very pleasant. The oil was cloudy owing to the presence of moisture.

The oil was submitted to chemical examination with the following results, which are shown in comparison with the results recorded for a sample of *Ocimum gratissimum* oil from the Ivory Coast:

	Ocimum gratissimum oil from Seychelles.	*Ocimum gratissimum* oil from the Ivory Coast.
Specific gravity at 15° C. .	0·995	0·9105
Optical rotation . . .	− 14·1°	+ 0°58′
Refractive index . . .	1·526 at 21° C.	—
Solubility in 80 per cent. alcohol	Soluble in 0·7 vol. at 15° C.	Soluble in 1·2 vols.
Phenols . . *per cent.*	62 (principally eugenol)	44 (almost entirely thymol)

It will be seen from these results that the Seychelles oil contained 62 per cent. of phenols which were principally, if not entirely, eugenol, the characteristic constituent of oil of cloves, whereas the oil stated to be derived from *O. gratissimum* in West Africa is recorded to have contained 44 per cent. of phenols, which were almost entirely thymol. The two samples therefore differ widely in composition. No other analyses of *O. gratissimum* oil are available for comparison.

The Seychelles oil shows most resemblance in composition to an oil stated to be derived from a large-leaved variety of *Ocimum Basilicum* and recorded by Gildemeister and Hoffman to contain from 30 to 40 per cent. of eugenol.

The oil was submitted for valuation to a firm of essential oil distillers, who stated that it was not sufficiently pleasant in odour to be of use in perfumery, and that in order to be of interest as a source of eugenol, oil containing 50 per cent. of eugenol would have to be offered at 2*s.* to 2*s.* 4*d.* per lb., so as to compete with clove oil which at the time of valuation (August 1917) was nominally worth about 4*s.* per lb. Owing to the scarcity of cloves, the price of clove oil has risen greatly during the past year, the current market price being 22*s.* per lb. (April 1918), and the Ocimum oil would now have a correspondingly higher value than that mentioned.

In view of the small yield of oil, and the comparatively low value of the oil, it seems unlikely that the plant could be utilised remuneratively as a source of oil.

Ocimum Basilicum Oil

This sample consisted of a pale greenish-yellow oil with a sweet anise-like odour.

The oil was submitted to chemical examination with the following results, which are given in comparison with those obtained from commercial *Ocimum Basilicum* oil ("sweet basil" oil):

	Present sample from Seychelles.	French, German, Algerian and Spanish sweet basil oil.	Réunion sweet basil oil.
Specific gravity at $\frac{15° C.}{15° C.}$	0·962	0·904 to 0·930	0·945 to 0·987
Optical rotation	+0·82° at 28° C.	−6° to −22°	+0·36° to +12°
Refractive index	1·514 at 21° C.	1·481 to 1·495	1·515 to 1·517
Acid value	0·8	Up to 3·5	Up to 3
Ester value	2·5	1 to 12	Up to 22
Solubility in 80 per cent. alcohol	Nearly soluble in 4 vols., but not completely soluble even in 10 vols.	Soluble in 1 to 2 vols.	Soluble in 1 to 7 vols.

The constants of the present sample thus agree generally with those of Réunion sweet basil oil, except as regards solubility in alcohol. From its odour and taste the Seychelles oil appears to contain anethole as well as methylchavicol, and thus differs somewhat in composition from commercial sweet basil oil.

A sample of the oil was submitted to two firms of oil distillers, who reported on it as follows :

(1) The first firm stated that at the present time there is very little demand for sweet basil oil, and they doubted whether the oil could be used as a source of anethole in competition with star anise oil which is obtainable at a very low price.

(2) The second firm reported that they could not make a definite statement as to the probable commercial value of the oil without having a larger quantity for investigation, but they considered that under existing conditions the oil might be worth from 4*s*. to 6*s*. per lb. (September 1917).

In view of the facts that there is little demand at present for sweet basil oil, and that other oils which are more suitable for the preparation of anethole are available, it does not seem likely that any considerable market could be found for this basil oil from Seychelles. It was pointed out, however, that if the oil could be prepared in commercial quantities, a further sample should be sent so that it can be submitted to a number of firms for trial and its commercial value definitely ascertained.

NEW OIL SEEDS FROM SIERRA LEONE

In the following pages an account is given of several new or little-known oil seeds and oils from Sierra Leone, including the kernels of *Pentadesma butyracea*, piassava nut oil, and " Po-yoak " nuts and oil.

Pentadesma butyracea

P. butyracea, Don., is a large tree belonging to the Nat. Ord. Guttiferæ, and confined to tropical West Africa, where it is generally known as the " butter or tallow tree." In Sierra Leone it occurs in small patches in the Colony and in Northern Sherbro, but is not common. It is said to be easily grown, however, matures early, and the fruits can be collected with little labour, so that if a demand arose for the seeds in Europe as a source of oil, it might pay to plant the tree.

A specimen of the fat obtained from the kernels in Sierra Leone was examined at the Imperial Institute some years ago (cf. this BULLETIN, 1908, **6**, 375), and samples of the fruits and kernels have been received from Nigeria and the Gold Coast (this BULLETIN, 1913, **11**, 569). In August 1916 a supply of the kernels was forwarded from Sierra Leone under the name of "Shea butter seeds," the local Creole name for the product. The tree is quite distinct, however, from the true Shea butter tree, *Butyrospermum Parkii*, Kotschy (Nat. Ord. Sapotaceæ).

The kernels were large, dark reddish-brown and of irregular shape. They were in moist condition, and as received contained 29 per cent. of moisture.

When dried so as to contain 12·4 per cent. of moisture the kernels yielded 36·6 per cent. of pale yellow fat of rather soft consistency, and having a slight but agreeable odour. This yield is equivalent to 41·8 per cent. from the dry kernels.

The fat was examined with the following results, compared with those previously obtained at the Imperial Institute:

	Present sample.	*Pentadesma butyracea* fat from: Sierra Leone.	Nigeria.
Specific gravity at $\frac{100° C.}{15° C.}$	0·8565	0·859	0·857
Melting point of fat	33° C.	—	—
Acid value [1]	17·4	3·6	3·1
Saponification value [1]	191·7	190·1	186·0
Iodine value . *per cent.*	42·8	41·8	46·5

[1] *Milligrams of potash for 1 gram of oil.*

It would not be possible to market these kernels in the United Kingdom as moist in condition as this sample, but if shipped in commercial quantities and in good dry condition, so as to yield about 40 per cent. of fat, they should be readily saleable.

Three firms of oil-seed crushers were consulted as to the commercial value of the kernels which were dried to contain 8·9 per cent. of moisture before being submitted to valuation. All three firms stated that the kernels yield a residual meal which cannot be used for feeding purposes, and is of very little value as manure owing to the small amount of nitrogen present. For this reason the kernels are only of value for the fat they contain. One firm, who have a special use for fats of this description and who have already used *P. butyracea* kernels, stated that under existing conditions the kernels would be worth about £22 per ton, their pre-war value being about £14 per ton. The second firm valued them at present at £14 per ton, but mentioned that in normal times they would only be worth £7 to £8 per ton. The third firm did not suggest a definite price, but stated that in their opinion a price remunerative to exporters in West Africa could not be obtained for the kernels.

The reason for these discrepancies in valuation is that certain firms have special uses for the fat from these kernels and are willing to pay fairly high prices for them. The Imperial Institute is now endeavouring to interest certain other firms in the kernels with a view to extending the market for them. It should be pointed out, however, that there is no immediate prospect of the kernels being exported in commercial quantities from Sierra Leone.

Piassava Oil

A sample of oil described as "piassava oil," and presumably obtained from the fruit of a species of *Raphia*, was received in February 1917. The fruits of a number of palms belonging to the genus *Raphia* are fleshy and yield an oil analogous to palm oil, the most important species being *Raphia Sese* of the Congo, *R. Hookeri* and *R. textilis* of the coastal region of tropical West Africa, and *R. pedunculata* of Madagascar, the source of bass or raffia (see this Bulletin, 1917, **15**, 434). The oil in these cases occurs mainly in a scaly envelope around the fruit and not in the pulp as in the oil palm. It is extracted by natives of West Africa, and used for lighting and lubricating and to some extent as an edible oil.

The oil received from Sierra Leone was of a dark orange-red colour, and contained a fair proportion of separated stearin. It resembled palm oil in odour, but was darker in colour, and more liquid.

The oil after being freed from dirt and moisture was submitted to chemical examination, and the results are given in the following table in comparison with figures recorded for commercial palm oil :

		Piassava oil.	Commercial palm oil.
Specific gravity at $\frac{15^\circ \text{ C.}}{15^\circ \text{ C.}}$		0·919	0·9209 to 0·9245
Solidifying point of fatty acids		41·1° C.	36° to 46° C. (usually 44° to 45° C.)
Acid value[1]		6·2	—
Saponification value[1]		192·7	196·3 to 205·5
Iodine value	*per cent.*	79·5	53 to 57·4
Hehner value		94·7	94·2 to 97
Insoluble fatty acids	*per cent.*	92·6	—
Unsaponifiable matter	,,	2·1	—
Volatile acids, soluble		0·3	0·86 to 1·87
Volatile acids, insoluble		0·2	—

[1] *Milligrams of potash for 1 gram of oil.*

It will be seen that this piassava oil is similar in character to ordinary palm oil, derived from *Elaeis guineensis*, but, as already mentioned, it is more liquid. The sample appeared to have been fairly well prepared, as the amounts of moisture and dirt present were not large and the acid value was comparatively low.

If this oil is obtainable in commercial quantities, it should be saleable in the United Kingdom at prices similar to those obtained for palm oil, the current maximum (controlled) price of which is £44 per ton, the pre-war prices ranging from about £25 to £32 per ton.

In order to determine the amount of oil obtainable from the fruits, the authorities in Sierra Leone have been asked to forward a supply of fruits to the Imperial Institute, and herbarium specimens of the plant have also been requested for identification.

"Po-Yoak" Nuts and Oil

A sample of "Po-Yoak" oil, accompanied by a specimen of the fruit and kernel yielding it, was received from Sierra Leone in February 1917.

The fruit was almost spherical and measured 1·4 in. from the apex to the base and 1·3 in. in diameter. It weighed 17 grams. The shell was dark brown in colour and had a rough surface. The kernel measured 1·0 in. from apex to base and 0·9 in. in diameter. The surface was slightly wrinkled and of a light brown colour. The flesh was fairly soft, dark reddish-brown in colour, and very oily; it had a peculiar smell resembling that of Tung oil (Chinese wood oil) obtained from *Aleurites* spp.

The fruit was examined at Kew and reported to be probably derived from a species of *Parinarium* (Nat. Ord. Rosaceæ). Herbarium specimens of the tree yielding it have been requested in order that its exact identity may be established.

Several species of *Parinarium* occur in West Africa, including *P. curatellaefolium*, Planch., *P. excelsum*, Sabine (grey or rough-skinned plum), *P. macrophyllum*, Sabine (ginger-bread plum), *P. Mobola*, Olio. (Mola or Mobola plum), and *P. polyandrum*, Benth. The first and last-named are small trees 12-25 ft. high; the remainder are large trees yielding timbers suitable for local use (cf. this BULLETIN, 1908, **6**, 231), that of *P. excelsum* being used in Sierra Leone for building purposes. The fruit is similar in appearance and size to a plum and is edible, that of *P. curatellaefolium* being said to be one of the best of native fruits.

The sample of oil received at the Imperial Institute was pale yellow in colour, and contained a considerable deposit of dark cream-coloured "stearin," together with a layer of black insoluble matter (dirt) at the bottom of the bottle. On standing for some time in a cool place the oil became thick and pasty. It had a smell resembling that of Tung oil.

The oil after being freed from dirt and moisture was submitted to chemical examination with the results given in the following table, to which have been added for comparison the figures recorded for Tung oil:

		Po-Yoak oil.	Tung oil.
Specific gravity at $\frac{15° C.}{15° C.}$		0·963	0·9406 to 0·9440
Solidifying point of fatty acids		30·6° C.	31·2° C.
Acid value [1]		2·6	—
Saponification value [1]		189·1	192·0 to 196·6
Iodine value	*per cent.*	156·9	166·4 to 176·2
Unsaponifiable matter	,,	0·84	—

[1] *Milligrams of potash for* 1 *gram of oil.*

The high iodine value of Po-Yoak oil indicates that this oil belongs to the class of "drying" oils, and it was found to have marked drying properties when exposed to air and light in thin films. The "skin" formed on drying was rather rough and not transparent. In its behaviour on drying the Po-Yoak oil somewhat resembled Tung oil, but it did not form a solid gelatinous mass like the latter oil when heated to 280° C. for ten minutes or longer, but merely became thick like linseed and other drying oils.

This Po-Yoak oil could be utilised as a drying oil for the manufacture of paints and varnishes, but technical trials will be necessary to determine its precise value for these purposes. A large sample of the fruits or the nuts, or of the carefully dried kernels, has been asked for, in order that the oil can be extracted by suitable treatment and fully investigated. Information has also been requested as to the quantity of the fruits available. It is interesting to note in this connection that the kernels of *Parinarium Mobola* from Liberia were introduced on the Liverpool market some forty years ago as an oil seed.

SPECIAL ARTICLE

THE MATERIAL RESOURCES OF BURMA

By Sir Harvey Adamson, K.C.S.I.

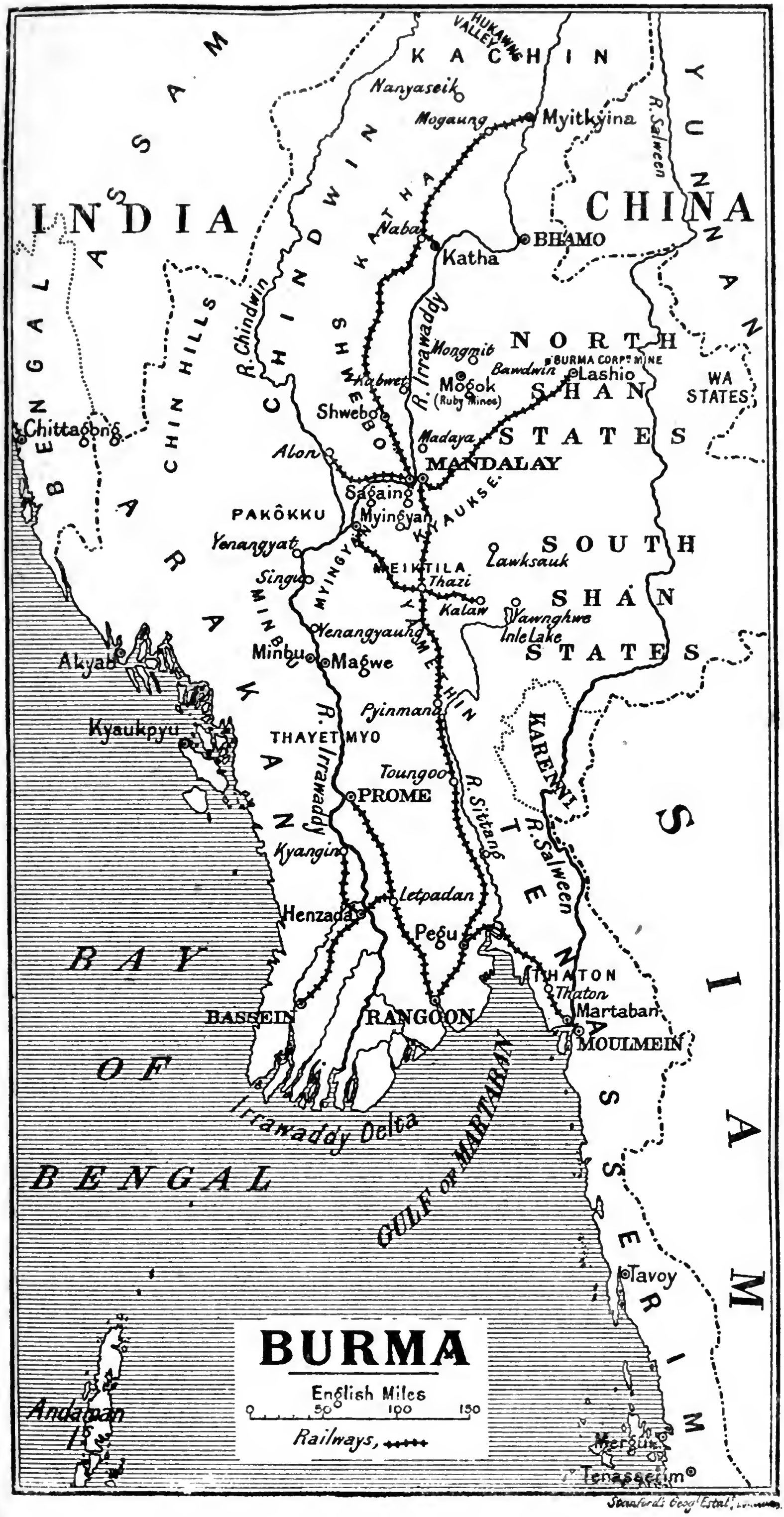
Lately Lieutenant-Governor of Burma

Burma, with a fertile soil, a rainfall that has never been known to fail, abundant fisheries, magnificent forests, and rich but hitherto almost unexplored mineral wealth, might be expected to offer a promising field for commercial enterprise. Yet, with the exception of rice, teak, and mineral oil, its products have not to a great extent attracted British capital. The chief reasons for this failure are dearness of labour and deficiency in means of transport. With an area three times as large as Bengal, Burma has only about a fourth of the population of that province. Consequently the wages of labour are twice as high as in the Continent of India. The population of Burma is rapidly expanding by both natural increase and immigration. It would expand still faster if the

PLATE I

SKETCH MAP OF BURMA

To illustrate the article on "The Material Resources of Burma," by Sir Harvey Adamson, K.C.S.I., BULLETIN OF THE IMPERIAL INSTITUTE, 1918, 16, No. 1.



second great deterrent to the influx of capital were removed, and Burma were equipped with adequate railways and roads.

Nature has given the province a fair complement of waterways. The Irrawaddy is navigable by large river steamers to Bhamo, 900 miles from the sea, and its affluent the Chindwin for 300 miles. The Salween is navigable by river steamers only for a short distance above Moulmein. The steamers of the Irrawaddy Flotilla Co. ply on the Irrawaddy and the creeks of its delta. Arakan is a network of tidal creeks, which are navigated by the steamers of the Arracan Flotilla Co. Some smaller streams are traversed in the rainy season by native barges and boats which carry cargoes up to a hundred tons. But outside tidal influence, and the chief rivers, there is little water transport. The British India Steam Navigation Company provide excellent services by sea between Rangoon and Calcutta, Rangoon and Madras, and the provincial ports of Burma. The sea passage from the Irrawaddy to the Hooghly occupies only forty-eight hours. The Bibby Line, with a fleet of magnificent steamers, and the Henderson Line with steamers only a little inferior, ply between Burma and England, and many other ocean steamers carry away cargoes of rice and other exports.

To serve an area nearly twice the size of the United Kingdom, Burma has only 1,598 miles of railway. The rice plains of Lower Burma are tapped by the Rangoon-Prome line, the Letpadan-Bassein line, the Henzada-Kyangin line, the Pegu-Martaban line, and the Rangoon-Mandalay line, which after leaving Lower Burma at Toungoo, runs through Upper Burma to Mandalay. The other railways in Upper Burma are the Mandalay-Myitkyina line, crossing the Irrawaddy at Sagaing by a boat ferry, with a branch from Sagaing to Alon on the Chindwin, and another from Naba to Katha on the Irrawaddy, the Mandalay-Lashio line running into the Northern Shan States, the Thazi-Myingyan line running through the Meiktila and Myingyan districts to the Irrawaddy, and the Southern Shan States Railway running to the borders of the Shan plateau and there for the present ending in space. There is ample room for railway expansion in Burma. The most pressing immediate needs are the extension of the Southern Shan States Railway to Yawnghwe on the Inle Lake, the construction of a railway bridge to span the Irrawaddy at Sagaing, a line from Moulmein through the Tenasserim peninsula to Tavoy and Mergui, where of late wolfram and rubber industries have assumed prominence, and a line from Pyinmana to Magwe, which would open out large pyinkado forests. These projects have been surveyed and are ready for construction when funds are available. They are by no means exhaustive, for in both Upper and Lower Burma there are many practicable projects of remunerative railway enterprise.

There is no railway connection between Burma and India. Three routes have been surveyed, of which the Pyinmana-Akyab-Chittagong project at present holds the field. But as the existing communication by sea between Calcutta and Rangoon is excellent, there can be little doubt that if financial conditions render it necessary to make a choice between Burma provincial railways and a railway connecting the capitals of Burma and Bengal, it would be to the advantage of Burma that the former should obtain priority.

Burma's deficiency in railways is totally eclipsed by its deficiency in roads. The length of metalled roads in the whole province is put down on paper as 2,100 miles. But most of these roads are not worthy of the name. Outside towns and their environs there are few roads that are fit for other than bullock-cart traffic, and very few miles where motor traffic is possible. Railways and rivers have no adequate system of feeder roads, and though in most places country carts can be bumped across paddy fields in the dry season, there are huge tracts that are closed to all traffic for the rest of the year. The residents of the dry zone who migrate in large numbers to Lower Burma twice a year to engage in agricultural operations are unable to take their carts with them. In the Tenasserim division, which is suitable to rubber cultivation, the boom in rubber attracted few settlers owing to the absence of roads, and the inability of the Local Government to find money to construct them.

Wolfram was discovered in Tavoy district, but for the same reason was extracted with great difficulty, and it was not until the exigencies of war compelled attention to this product that a remedy was found.

Indian provinces are financed by a system of provincial contract. Certain heads of revenue and expenditure are classed as provincial, and certain heads as imperial. From the provincial share the ordinary provincial expenditure is met, and what is over is available for public works. A provincial contract was given to Burma in 1907. It was framed on the same lines as those of other Indian provinces, and proved to be quite inadequate. The older provinces of India were very fully equipped with roads and buildings when they received their contracts. Burma was almost totally unequipped with roads, while the buildings were mostly of wood which had outlived their natural period of duration. To put Burma on a level with other provinces a large initial assignment for equipment was required in addition to a contract for ordinary expenditure. The financial history of Burma since 1907 is a record of persistent applications by the Local Government for an enhanced share of revenue for development purposes, and as persistent refusals by the Imperial Government. As the revenue of Burma is large, it might be imagined that the capital for development could be obtained by borrowing on the security of the revenue, but such loans are contrary to the financial policy of the Government of India. In 1911 the Burma Government, finding no other course available, proposed to obtain the necessary funds by internal taxation. With the support of the mercantile community, and a strong backing even from the rice interest, it was proposed to impose an export duty on rice for a period of years, and to utilise the proceeds in equipping the province with roads. This proposal was after long delay negatived by the Government of India, who, however, at length admitted the insufficiency of the provincial contract, and added to it an assignment of fifteen lakhs of rupees (£100,000) a year, a welcome addition, though inadequate to equip within a reasonable time a large province with roads and buildings.

A statement of these difficulties is a necessary preliminary to any consideration of the economic possibilities of Burma. The lack of transport facilities and labour is a deterrent to the influx of capital, without which the great resources of the province cannot be rapidly developed.

Agriculture

The plains of Burma comprise three zones, a wet zone covering nearly the whole of Lower Burma, with a rainfall varying from 70 to 200 in., a dry zone extending from the border of Lower Burma north through Upper Burma to the latitude of Shwebo, with a rainfall varying from 25 to 40 in., and north of this another wet zone, with a rainfall varying from 60 to 100 in. The plain area has been cadastrally surveyed on the scale of 16 in. to a mile, and, as this survey is kept up to date by an annual supplementary survey, it furnishes accurate agricultural statistics. East of Upper Burma lie the Uplands of the Northern and Southern Shan States, with a rainfall varying from 40 to 60 in., and a soil capable of yielding many of the products of a temperate zone, but hitherto undeveloped on account of difficulties of transport and distance from a market. The railway to Lashio in the Northern Shan States, and the Southern Shan States Railway, under process of construction and already open to the borders of the plateau, may be expected when completed to assure to these tracts a promising future, but administered as they are by native Chiefs under the superintendence of political officers, they as yet furnish no statistics of agricultural conditions. To the west and north of Upper Burma lie the Chin and Kachin Hills, consisting mostly of mountainous tracts, partly administered in a patriarchal way by Chiefs under political officers, and partly untouched by British administration, which from an agricultural point of view are not and probably never will be of any importance.

Cultivation is carried on by native industry, and almost entirely under native ownership of the land, or direct lease by the State to the cultivator. The peasant proprietorship form of tenure, under which the cultivator pays the revenue direct to the State, has been found by experience to be best suited to the province, and it is a leading principle of Government policy to maintain it. In former days large grants of land, amounting in some cases to 30 square miles in extent, were made by Government with the object of enabling capitalists to bring these estates speedily into cultivation by means of imported labour. This anticipation was not realised. The estates were leased out in small blocks to Burmese or Indian residents, who might as readily have obtained their holdings direct from Government. The only result was to create a small class of Zemindars, who took all that they could from their tenants, and put little of their own capital into the land. The policy of large grants was abandoned many years ago, in favour of the policy of peasant proprietorship.

Consequently, there are few large estates in Burma. A holding that exceeds a thousand acres in area is very rare. The average estate runs from twenty to thirty acres. In recent years, when large tracts of waste land have become available, as for instance by the deforestation of reserves, the practice has been to colonise them in blocks to be converted into small holdings through the agency of agricultural co-operative credit societies.

The policy of peasant proprietorship is relaxed when the applicant for land proposes to cultivate special staples such as rubber, tea or indigo. For these purposes waste land is still leased or granted in large blocks to capitalists. Up to the present date the relaxation has been utilised only in respect of leases for the cultivation of rubber.

An immense amount of money is required to finance agriculture. It is lent to the cultivator by money-lenders, chiefly the Chetty bankers of Madras. The rate of interest is high, never less than 20 and often as much as 50 per cent. The exorbitant rate of interest weighs heavily on agriculturists. Of recent years attempts have been made to cheapen money by the establishment of co-operative credit societies. The co-operative movement, though still in its infancy, is making rapid progress. It is only twelve years since it originated, and already there are 2,251 co-operative credit societies in Burma with a membership of 51,356 and a working capital of 107 lakhs of rupees (£713,000). Large as the beginning is, it scarcely yet touches the fringe of agricultural indebtedness. Something further is done by Government in the shape of agricultural loans.

Another misfortune which the cultivator has to bear is cattle disease, which causes a heavy mortality. Simple rules have been framed for the segregation of diseased cattle and the prevention of disease, and are enforced by the village headmen. But the Burman is careless and unbelieving in these matters. Co-operative cattle insurance societies have been started, and a promising beginning has been made with 305 societies. As members of these societies will have a joint as well as an individual pecuniary interest, it is hoped that they will tend to the co-operation of agriculturists in enforcing the rules of prevention.

The Agricultural Department of Burma has an institute and experimental farm at Mandalay, with a chemical laboratory and a staff of which the chief officers are a Director, two Deputy Directors, an Agricultural Chemist, a Botanist and an Entomologist. The Department undertakes a considerable amount of agricultural research. Seed selection of the various products of Burma, seed distribution, the investigation of plant disease, and the experimental introduction of new products may be mentioned as within the scope of its endeavours. The chemical department undertakes a large number of analyses of field cultures and manurial tests. The entomological work embraces among other things a study of insect pests. Besides the Mandalay farm, the Department has seven experimental stations in various parts of the province. The Department provides agricultural education for probationary assistants, and for district agriculturists who are posted to districts on the completion of their course. It devotes attention to the introduction of improved agricultural implements, and keeps a stock for sale to cultivators. It publishes bulletins on various subjects, and is a bureau for conveying agricultural information to the public.

Cropped Area

The following figures of cropped area in the plains are taken from the Season and Crop Report for the year 1916–17:

	Acres.
Cereals:	
Rice	10,569,821
Wheat	47,580
Millet	751,564
Maize	170,285
Gram	68,429
Other cereals	64,550
Oil seeds:	
Linseed	458
Sesamum	1,216,772
Rape and mustard	3,306
Ground nut	261,378
Other oil seeds	116
Condiments:	
Chillies	77,195
Onions	20,972
Other condiments	3,560
Sugar:	
Sugar cane	18,136
Toddy tree groves	22,651
Fibres:	
Cotton	223,401
Other fibres	607
Dyes, Indigo	263
Drugs and narcotics:	
Coffee	81
Tea	1,799
Tobacco	83,722
Betel vine	5,337
Betel nut	33,815
Other narcotics	75
Fodder crops	84,651
Beans and pulses	664,817
Vegetables:	
Tomatoes	17,952
Other vegetables	39,462
Gardens and Orchards	426,997
Miscellaneous food crops	9,850
Rubber	59,257
Other non-food crops	92,220
Total cropped area	15,041,079

The area cropped more than once during the year was 626,553 acres, and the current fallows 3,937,786 acres.

The area officially returned as culturable waste, which is exclusive of reserved forests, was 23,336,435 acres; but under present conditions of agriculture much of this area is not likely to come under the plough. It includes land left uncultivated for grazing purposes, land that is unsuited for rice cultivation and on which no other produce has yet been attempted, and land that could be cultivated only after large expenditure on protective bunds.

A large proportion of the cropped area is dependent solely on natural rainfall. Less than 9 per cent. is irrigated. The gross irrigated area is 1,304,403 acres—of this area 490,344 acres are irrigated by the large Government canals in Minbu, Mandalay, Shwebo and Kyaukse districts of Upper Burma. The remainder is accounted for by minor canals, tanks and wells.

The Northern and Southern Shan States, covering an area of 52,000 square miles, with a population of 1,250,000, are not included in the returns of cropped area. In this tract all of the crops mentioned above are grown chiefly for home consumption. The Mandalay-Lashio and Southern Shan States Railways as yet tap only a small portion of the Shan States, which are mainly dependent for carriage on pack bullocks. This tract contains much waste land which is suitable for wheat and other crops of a temperate climate. Potatoes and tea are flourishing products. The exports of all kinds to other parts of Burma, roughly registered at frontier stations, were valued in 1915–16 at 242 lakhs of rupees (£1,613,000), and include 167,694 cwts. of potatoes and 50,036 cwts. of tea. In the states adjacent to the Chinese frontier the poppy is cultivated, and a considerable amount of opium finds its way into Yunnan. In some of the unadministered Wa States the poppy is reported to be the principal crop.

Hillmen throughout Burma practise a very destructive form of cultivation called "Taungya." They migrate from year to year, clearing, burning and cultivating patches of hill forest, not included in Reserves, and cause much damage to the forests.

Rice [1]

More than two-thirds of the cropped area is under rice. The estimated yield is 1,450 lb. of paddy per acre. The total outturn of unhusked rice in 1916–17 was 6,913,000 tons, and the surplus available for exportation was 2,700,000 tons of cleaned or cargo rice. In the chief rice districts of Lower Burma most of the available land has already come under the plough, and there is little room for the extension of cultivation. It would therefore appear that the production of rice under existing methods of agriculture has nearly reached its limit. In Lower Burma the peasant works his rice land continuously, rarely giving it a season's rest, and uses manure only in the plant nurseries. It is amazing to see the good crops that are obtained even after fifty years of continual use. Increased production may be achievable by more intensive cultivation. The agricultural department is devoting attention to this subject. It is possible that manuring and increased thoroughness of cultivation may produce as beneficial results as in Spain, where the average yield of rice under intensive cultivation is said to be three times as high as in India. With the actual cultivation of rice, British capital has had little concern. It is in the preparation for shipping and in distribution that the British merchant takes his part. Mills are established at Rangoon and at the other ports, Bassein, Moulmein and Akyab, where the unhusked rice is converted into cargo and white rice, and shipped to its various destinations across the sea. The principal British rice firms are Steel Brothers & Co., Bulloch Brothers & Co., and the Arracan Co., Ltd. Before the war a considerable share of the milling industry was in the hands of Germans.

It would be beyond the scope of this article to follow the rice to its western market and explain the uses that are made of it there, but mention may be made of one

[1] *In this and the following paragraphs outturns per acre are taken from the measured experiments of Settlement officers. The figures for the area under the different crops are for the year* 1916–17. *Exports are for the three years before and the two years after commencement of the war. These are not carried down to the subsequent year because, owing to shortness of freight, export conditions are now abnormal. They include trade between provincial ports as well as exports from Burma to India and other countries.*

misuse. The rice which is best for food, and which is eaten by residents of tropical countries, is rice which has been milled but not polished. The rice used as an article of food in England is white rice highly polished by machinery and coated or faced by powdered talc, colouring matter and oil, so as to impart a lustrous surface and translucent appearance. These processes rob the rice of its proteins and fat, and leave it a less nutritious and more insipid food than the unpolished rice. Further information on Burma rice will be found in the article on "Production and Uses of Rice," published in this BULLETIN (1917, **15**, 198).

The exports of rice from Burma in recent years are as follows:

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Rice (unhusked)	*tons*	126,896	97,301	302,454	327,590	292,209
Rice (husked)	,,	2,068,813	2,249,432	2,451,274	2,027,944	1,905,621

Sesamum

Second to rice in cropped area comes sesamum. Early sesamum sown at the beginning of the rains and reaped three months later covers 855,530 acres, and is often followed by a second crop of millet, beans, or rice. Late sesamum sown a few months later covers 361,242 acres. Sesamum is confined almost entirely to the dry zone. The average outturn is 200 lb. per acre. The oil extracted by crushing is used for cooking purposes and the oil-cake as food for cattle. Burma does not supply her own needs in this commodity, but imports, chiefly from India and partly from the Straits Settlements, a yearly average of 150,000 cwts. of sesamum seed and 30,000 gallons of oil.

Millet

There are two main varieties of millet, *Sorghum vulgare*, red millet (Burmese, *Kunpyaung*), occupying an area of 462,880 acres, and white millet (Burmese, *Sanpyaung*), occupying an area of 203,257 acres. The latter produces a palatable grain which is used as food in the uplands, though it is despised in rice-growing tracts. Another variety, little millet (*Panicum miliare*—Burmese, *Lu*), covers an area of 85,427 acres, and is also used as food. The chief use of millet is as fodder for cattle, the stalks and leaves as well as the grain being utilised for this purpose. Millet is confined to the dry zone. The average outturn of grain is 450 lb. per acre. The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Millet	*cwts.*	235,012	41,416	183,778	254,627	67,256

Beans

Beans are of several kinds, of which the following are specified in the Season and Crop Report of Burma : White beans (*Phaseolus lunatus*), red beans (*P. lunatus*), "peyin" (*P. calcaratus*), and Goa bean (*Psophocarpus tetragonolobus*). The last-named is grown mainly for the sake of its swollen, edible roots. The area under beans is as follows :

White beans	283,606 acres.
Red beans	127,440 ,,
Beans (peyin)	16,628 ,,
Goa beans	1,948 ,,
Other kinds	235,195 ,,

They are chiefly grown in the dry zone, the contribution from the wet zone being less than 50,000 acres. The outturn per acre of white beans (Burmese, *Pegyi* and *Pebyugale*) is 600 lb., and of red beans (Burmese, *Pegya*), the principal article of commerce, 800 lb. The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Beans	*tons*	43,150	33,797	39,795	61,186	63,578

Against this there is an annual import, chiefly from India, averaging 12,000 tons.

Further information on Burma beans is given in the last number of this BULLETIN (1917, **15**, 513).

Ground Nut

Ground nut covers an area of 261,378 acres, all of which, except about 3,000 acres, is in the dry zone. The yield is 1,000 lb. per acre.

The exports are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Ground nut	*cwts.*	61,848	307,587	560,240	41,758	1,780

It is only within the past twenty years that the ground nut has come into prominence as a product of Burma. Ground-nut oil is largely consumed, and a considerable oil-crushing industry has developed. In 1911–12 the net import exceeded 2,000,000 gallons. It is now reduced to about a third of that figure. The export of oil was in 1911–12 86,000 gallons, and it has now reached 300,000 gallons.

Cotton

The area under cotton, 223,401 acres, is nearly all in the dry zone. The staple is somewhat short. There is room for considerable improvement in seed and methods of picking and sorting, to which the agricultural department is devoting attention. The yield is 125 lb. of cleaned cotton per acre. The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Raw cotton .	*cwts.*	179,794	249,851	248,518	235,989	141,770
Cotton seed .	,,	137,681	203,452	108,661	10,232	6,677

The annual imports of cotton in the shape of twist and yarn, manufactured articles and piece goods are enormous, and amount in value to 600 lakhs of rupees (£4,000,000).

Maize

The area under maize includes 155,218 acres in the dry zone and 15,067 acres in the wet zone. The outturn per acre is 4,500 cobs or 700 lb. of grain.

The exports are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Maize . .	*cwts.*	—	128,376	33,482	21,269	72,127

Wheat

The area under wheat, 47,580 acres, is all in the dry zone. The yield is 600 lb. per acre. The export of wheat is insignificant. The average annual import, chiefly from India, is 100,000 cwts. of grain and 400,000 cwts. of flour.

Gram

The area under gram includes 65,014 acres in the dry zone and 3,415 acres in the wet zone. The yield is 400 lb. per acre. The exports are :

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Gram . . *cwts.*	138,448	100,458	76,880	72,107	35,246

The imports, chiefly from India, average 150,000 cwts. a year.

Sugar

Sugar cane is grown in small areas in most districts of Burma, and especially in Thaton district in Lower Burma and Yamethin district in Upper Burma. The area under cultivation is 18,136 acres. The juice is extracted in wooden presses, and is converted into cakes of brown sugar.

Sugar is also made from the juice of the toddy tree. The area of palm groves is given as 22,651 acres, mostly in the dry zone, but these figures are deceptive, as toddy palms are found in large numbers as solitary trees throughout Burma. The juice is boiled down and then spread on mats, where it hardens into a brown cake.

Tobacco

Tobacco is grown in all districts of Burma in small patches on the rich alluvial deposits left as mudbanks on the bends of streams, when the water falls after the rains. The area under crop is 83,732 acres. An acre of land is said to produce eight cwts. of leaves. In Burma, men, women and children smoke. For consumption among Burmans, tobacco is sun-dried, both leaves and stalks being utilised. The export figures are :

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Unmanufactured tobacco . *lb.*	12,662,758	23,864,207	16,004,119	8,648,539	11,443,486

The average imports of unmanufactured tobacco from India amount to 20,000,000 lb. a year.

Chillies

Chillies are grown as a field crop chiefly in the dry zone, the acreage being 77,195. The yield per acre is 45 standard or nine-gallon baskets, or, say, 1,600 lb. The exports are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Chillies .	*lb.*	2,864,195	3,318,560	3,527,363	8,925,578	1,914,694

The imports from India average 4,000,000 lb. a year.

Rubber

Rubber (*Hevea*) is a new industry in Burma, and until twelve years ago, except for a Government experimental estate in Mergui, was hardly known. The area returned under rubber is 59,257 acres, mostly in Tenasserim Division, where the soil and climate are very suitable for its growth. But this is the total area of rubber estates, and it is probable that the area planted does not yet exceed 15,000 acres. Unfortunately the deficiency in roads and other means of transport is more acute in Tenasserim than in any other part of Burma. Moreover, in anticipation that rubber would be a paying venture, a rate of land revenue was imposed, which, though low in its initial stage, had a potential rise to as much as Rs. 25 (£1 13*s.* 4*d.*) an acre. These drawbacks had a deterrent influence on capital, and in consequence the boom in rubber, which caused great activity in the East a few years ago, was not utilised in Burma to anything like the same extent as in the neighbouring Malay States.

The lack of transport facilities still remains, but the revenue difficulty has been removed. New rules provide for a land revenue assessment of Rs. 3 (4*s.*) per acre, capable of enhancement only within defined limits, and at intervals of twenty years, combined with a royalty under the Burma Forest Act of 2 per cent. on the net value of all rubber produced. They also grant concessions to lessees in respect of valuable trees standing on leased or granted land.

The exports of rubber, as may be expected, show a steady progressive increase. They are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Rubber .	*cwts.*	2,770	4,698	6,831	8,816	11,482	20,546

The results obtained by the Mergui Crown Rubber Company and the Burma Para Rubber Company prove that the cultivation of rubber in Burma is a success.

Tea

Tea is grown in a small area of 1,399 acres in the Upper Chindwin and Katha districts, but it is much more extensively cultivated in the Northern Shan States. The leaves are picked in the third or fourth year. There are two methods of preparation. In the first the leaves are dried in the sun and then steamed. The damp leaves are thrown into brick wells, and weighted down. There they ferment, and the result is pickled tea or letpet. In the second, the leaves are steamed and compressed, and then loosened and spread out on mats to dry. This is dry tea or letpet chauk. A large amount of the tea is consumed in the Shan States and Burma. The export figures are:

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Tea . . *lb.*	116,296	140,035	140,795	219,899	146,111

There appears to be no reason why the tea-plant should not be cultivated and treated on European methods.

Betel Nut and Betel Vine

The betel palm covers 33,815 acres and the betel vine 5,337 acres. The latter is found in all districts, and the former chiefly in the wet zone. The nut of the *Areca* or betel palm, with lime and the leaf of the betel vine, is chewed as a stimulant by men and women in Burma. The province does not supply its own requirements. The average import of the nut is 42,000,000 lb., chiefly from India, but partly from the Straits Settlements, and vastly exceeds the export, which is about 2,000,000 lb. per annum.

Orchards and Gardens

The area returned under this head, 426,997 acres, is classed as plantains 120,258 acres, mangoes 77,455 acres, coconuts 11,991 acres, oranges 820 acres (there is a much larger area under orange cultivation in the Shan States), and mixed gardens 216,473 acres.

The chief fruits of Burma are plantains, mangoes, oranges, pineapples, custard apples, coconuts, guavas, limes, apricots, peaches, plums, quinces, strawberries, melons, jackfruit, marians, mangosteens, papayas, grapes, citrons, pomegranates, and that strange fruit the durian, incomparably delicious to the initiated, whose rind exudes so atrocious a smell that Mark Twain has declared that when a durian is in the room, the presence of a polecat would be a refreshment.

The following are the export figures of the more important by-products of agriculture :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Rice bran and meal	*cwts.*	298,137	261,443	285,512	243,471	249,218
Fruit and vegetables, dry, salted and preserved	*cwts.*	47,110	40,068	29,953	19,726	21,203
Vegetable oils	*gallons*	141,661	180,794	377,615	388,043	393,332
Oil cake	*cwts.*	477,845	609,233	741,393	934,818	850,351

Agricultural Stock

A census of agricultural stock was taken in 1916–17 and gave a return of five millions of cattle, of which nearly half are bulls or bullocks, and one and a quarter millions of buffaloes. Neither the breeding of cattle for slaughter nor the milking of cows appeals to the Burman. Butcher meat and milk are unobtainable except in the vicinity of towns, where they are supplied by natives of India.

The breeding of sheep is almost unknown, although the climate of parts of Upper Burma and especially the Shan States would be most suitable for the purpose.

The Burmese pony, in height from 12 to 12·3 hands, is a very superior animal; but it has deteriorated owing to inattention to breeding. The Burman gelds every colt that shows signs of good quality, and lets loose the unfit and immature to consort with the mares. The infusion of foreign blood has not been very successful. The Burman is a born gambler, and his only aim is to obtain a pony that can win races. The attention of Government, assisted by the Burma Turf Club, has of recent years been directed to the restoration and improvement of the indigenous pony.

Walers are imported in large numbers from Australia, and are used chiefly by European residents.

Mules are not bred in Burma, yet thousands of these animals are required every year for transport purposes in the frontier districts and the Shan States, especially by the Military and Military Police. They are hired in China for the season and brought over by Panthay muleteers. As the expeditions in which mules are used are often in conflict with Chinese interests, attempts have been made by Chinese officials to stop the source of supply. These attempts have hitherto been unsuccessful, but there is a constant risk of grave embarrassment. The Shan States are in every way suitable for mule breeding, and in this respect there is scope for lucrative enterprise.

The export figures of raw hides are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Hides (raw) .	*cwts.*	156,889	151,278	170,781	106,309	106,787

Fisheries

Fisheries provide a substantial part of the food consumed in Burma. They are of two kinds, inland and net fisheries. Inland fisheries (Burmese, *In*) are formed in low-lying tracts when the monsoon floods have receded. The most valuable are in the delta districts of Lower Burma. They are usually disposed of by auction on a lease of three to five years. Net fisheries are worked by licence holders on the principal rivers and along the sea shore, the revenue being assessed by the net or fishing trap or implement, of which there are many varieties.

Towards the end of the rainy season the lessee of an inland fishery erects strong weirs across the exits. The weirs are kept in position till nearly all the water has drained off, leaving a number of shallow pools full of fish which can be easily taken by net or thrown out by shovels. Large pools are divided into small sections by bunds, and if necessary the water is baled out, so as to facilitate the capture of fish. The inland fisheries vary greatly in value and in methods of working.

The fish are partly sun-dried and made into salted fish, or Ngachauk, and partly pickled and made into a condiment called Ngapi, which is offensive in smell and loathsome to Western ideas. A finer quality of fish paste (Balachaung) is made from shrimps and prawns and is much appreciated as chutney by Europeans.

Ngapi and Ngachauk are in great demand among Burmans and are used at most meals.

In Bassein and Tavoy districts valuable turtle banks are leased for the collection of eggs.

There are pearl fisheries at Mergui on the Tenasserim coast which at one time were thought promising. Pearls of considerable value have occasionally been found, but the industry is not in a flourishing condition. The oysters are more valuable for their shells than for the pearls they sometimes contain. Owing to absence of demand for mother-of-pearl, due doubtless to the war, fees for pearling licences yielded only Rs. 6,000 (£400) in 1915–16, as compared with Rs. 18,000 (£1,200) in 1914–15 and Rs. 52,000 (£3,467) in 1913–14.

An attempt has been made to produce pearls artificially by an American expert, Mr. Solomon. He slips some irritating substance below the mantles of the oysters, and imprisons them in floating crates, where he feeds them for about eighteen months. The irritation causes the animal to cover the cause of offence with nacreous secretions. I was present at Mr. Solomon's depot in Quoin Island in the Mergui Archipelago in 1912 when he opened for my inspection a dozen oysters that had been thus treated. Each contained either one or two pearls with a flat side attached to the shell. They were of the size of a small marble and had an excellent lustre. Mr. Solomon assured me that these pearls could find a remunerative market in Paris.

The fishery revenues of Burma for 1914–15 and 1915–16 were as follows :

	From net licences.		From leased fisheries.		Total.	
	Rs	£	Rs.	£	Rs.	£
1914–15 .	3,09,660	20,644	32,79,046	218,603	35,88,706	239,247
1915–16 .	2,90,412	19,361	27,44,395	182,960	30,34,807	202,321

Notwithstanding her wealth in fisheries, Burma does not provide the supply of fish required for home consumption. In 1913–14, an average year, the imports, chiefly from the Straits Settlements and India, were 264,000 cwts. of salted and unsalted fish. The sea fisheries are of great potential importance and are very imperfectly worked. A few years ago a Syndicate (the Du Bern's and Chin Tsong's) brought out two steam trawlers which worked for some time with varying success and brought fish to Rangoon. The fish are abundant, and with some expenditure of capital a great harvest might be obtained. Burma should be able to supply her own requirements and to export this commodity.

Forests

The forests of Burma are more remunerative than those of any other Indian province. They are the storehouse of teak from which the world's requirements of this valuable timber are supplied. They comprise 28,567 square miles of reserved forests and 118,755 square miles of unclassed forests. The reserved forests occupy the best teak-producing tracts of the province, and include a few fuel and cutch reserves.

The procedure in acquiring and exploiting a teak reserve is briefly as follows. The area suitable for reservation is selected by a Forest Officer. When the District and Divisional Officers have approved, and the Local Government is satisfied that it is desirable to reserve the tract, a notification of the intention of reservation is published. An enquiry is then held by a civil officer empowered as Forest Settlement Officer assisted by a Forest Officer. The object of the enquiry is to ensure that the customary rights of adjacent villages to grazing and forest produce for domestic and agricultural purposes are not infringed. A period is allowed for presenting claims ; when this period has expired, the Forest Settlement Officer adjudicates on the claims, which may be for rights of way, water-user, pasture or forest produce. If the claims are reasonable, they are provided for by excluding sufficient land for their exercise or by granting the privilege of pasturing so many head of cattle, or of extracting certain quantities of forest produce annually, or by commuting the rights into a payment of money. An appeal is allowed from the orders of the Forest Settlement Officer.

When the period for appeal has expired, the proceedings are scrutinised by the Conservator and Commissioner and submitted to the Local Government. If finally approved, a notification is issued declaring the area in question to be a reserved forest. When a forest has been reserved, it is closed to the girdling of teak or other trees until a working plan for its treatment has been designed. A map is prepared on the 4-in. scale. The forest is divided into suitable blocks and subdivided into compartments formed with regard to configuration of soil and the natural boundaries of ridges and streams. Sample plots are marked off and the existing stock of teak trees of different girth classes are counted. From the existing stock as determined by the countings, and an estimate of the rate of growth, a plan is laid down for the utilisation of the trees, and a programme for maximum girdling operations for a period of years is determined.

Within reserved forests everything is at the disposal of Government, and no tree can be felled or produce extracted without a licence. In unclassed forests teak has always been recognised as the exclusive property of the Government. Certain other trees having a commercial value are classed as reserved trees and may be cut and extracted only under licence upon payment of revenue, while unreserved trees growing on land outside forest reserves may be cut unrestrictedly for *bona fide* home consumption, but only under a licence for purposes of trade.

Forests are exploited either by Government Agency or by private enterprise. The policy of Government in respect of private enterprise is explained in the Quinquennial Review of Forest Administration in British India for the period 1909–10 to 1913–14 in the following words:

" In forest administration the object in view is two-fold—first to conserve and improve the forests, and this is the first concern of the trained staff, and secondly, to secure to the tax-payer the greatest immediate benefit from their commercial working. To obtain the best commercial results departmental or private agency should be employed as circumstances dictate, and provided always that Government receives a fair share of the profits earned, private agency should be freely employed. But when this is done, the term of the contract should on the one hand be sufficiently long to enable the initial outlay to be recovered, while on the other hand provision should invariably be made for a revision of the rates of royalty at stated intervals, so that Government may not be deprived of its fair share of any rise of prices which may take place. Should it be found impossible to employ private agency on these terms, departmental working should be adopted, and if this cannot be undertaken by the trained staff without prejudice to its work of conservation and improvement, there seems to be no reason why a separate staff specially trained in commercial exploitation should not be employed. At times, indeed, departmental working is essential, as for instance in the extraction of little known timbers or other products, for which it is desired to create a market, when for any reason the system of extraction by purchasers breaks down, or when it becomes necessary to prevent trade manipulation or the creation of a monopoly."

Teak

The outturn of teak by Government agency and private enterprise during the year 1915–16 was as follows:

	Tons.	*Revenue.*
Government agency	65,347	Rs. 14,16,489
Private enterprise	253,909	56,49,119
Total	319,256	70,65,608[1]

[1] £471,000.

The teak extracted by Government agency is brought to depots and sold by auction. The European timber firms in Rangoon and Moulmein, of which the principal are the Bombay Burma Trading Corporation, Steel Brothers & Co., Foucar & Co., MacGregor & Co., and T. D. Findlay & Son, have contracts for the extraction of teak from defined forest areas. They fell and extract trees selected and marked by the Forest Department, and use them for the supply of their sawyards. The royalty varies with the quality of timber and averages Rs. 25 (£1 13*s.* 4*d.*) a ton. A small amount of teak (7,500 tons in 1915–16) is worked out by native licensees holding permits from the Forest Department.

Other Timber

The outturn of timber other than teak for the same year was as follows :

Kind of timber.	Extracted by Government agency.	Extracted by private enterprise.	Revenue.
Reserved trees :	*Tons.*	*Tons.*	*Rs.*
Pyinkado (*Xylia dolabriformis*) . .	3,772	47,162	4,43,240
Padauk (*Pterocarpus macrocarpus*) .	452	230	59,079
Kanyin (*Dipterocarpus turbinatus*) .	594	13,717	71,574
Pyinma (*Lagerstroemia Flos-Reginae*)	376	4,105	19,881
Other reserved trees . . .	1,153	14,331	96,597
Unreserved trees :			
In (*Dipterocarpus tuberculatus*), Thitya (*Shorea obtusa*), Ingyin (*Pentacme suavis*) .	3,721	86,206	2,97,950
Other unreserved trees . . .	2,818	111,664	1,90,624
Total . . .	12,886	277,415	11,78,945[1]

[1] £78,600.

With the exception of Pyinkado these woods are not extracted by European firms. The main extraction is by native licensees under permits.

After teak, pyinkado is the most important timber. It is the ironwood of Burma ; it is utilised for railway sleepers, house building, wheels of limber carts, and many other purposes. It is the most suitable of all Burman timber for paving blocks, for which it has been successfully tried in Rangoon.

Padauk is used in ordnance work for making naves, spokes and felloes of wheels, and also for furniture and the wheels of bullock carts. Most of the padauk extracted by Government agency is bought by the Ordnance Department at Rs. 100 (£6 13*s.* 4*d.*) per ton.

Kanyin, Pyinma, Thitya, In and Ingyin are used for house building, bridges, boats, planking, scantling, furniture, ploughs, telegraph poles, etc.

Other useful timbers that might find a market in India and even in England if they were extracted on a large scale instead of by the existing haphazard methods are : Tankkyan (*Terminalia tomentosa*), Pinle Kanazo (*Heritiera minor*), Yemane (*Gmelina arborea*), Thingan (*Hopea odorata*), Maniawga (*Carallia intereggima*), and Thitkado (*Cedrela Toona*).

The cotton tree (*Bombax malabaricum*) may be mentioned, as it is more suitable than any other Burman tree for the manufacture of matches. A match factory has been established in Mandalay by a British firm, J. W. Darwood & Co., and another in Rangoon by a Chinese merchant, the Hon. Mr. Lim Chin Tsong. Unfortunately, the cotton tree, though common in Burma, is not gregarious, and it has been found expensive to collect this wood in sufficient quantities.

Troup, in his *Indian Woods and their Uses*, describes 554 kinds of Indian woods that are used for specific purposes, of which more than half are to be found in the forests of Burma. The attention of the Forest Department has been directed mainly to teak. There are enormous quantities of fine timber of other kinds for which no remunerative market has yet been found.

The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Teak . .	*tons*	178,603	193,316	162,892	137,661	135,431
Other timber .	,,	24,982	35,800	46,799	42,396	28,619

Fuel

The system of exploitation of fuel is as follows. All trees of unreserved species other than Ingyin, Thitsi (*Melanorrhoea usitata*) and Thitya may be felled on public forest land and converted into firewood or charcoal without licence or payment. Such fuel becomes liable to royalty if intended for use by steamboats, railways, brick kilns, factories, or engines, or if taken into certain specified towns. The right to collect royalty on fuel taken into the specified towns is sold by auction, the rates levied by the monopolist being fixed. The outturn of fuel for the year 1915–16 was as follows :

	Quantity. *Tons.*	Revenue. *Rs.*
Government agency	49,676	1,72,721
Private enterprise	582,597	2,26,283
Total	632,273	3,99,004 [1]

[1] £26,600.

Minor Forest Produce

Besides timber and fuel, a small amount of minor forest produce is extracted from the forests. This consists chiefly of bamboos, canes, fibre, barks, thitsi varnish, wood oil, cutch, dammar, indwe, pwenyet, cardamoms, myrabolans and lac. In minor forest produce grazing fees are included. The revenue obtained in 1915–16 from minor forest produce was Rs. 10,22,190 (£68,146). Bamboos accounted for Rs. 2,58,911 (£17,261) out of this total, cutch for Rs. 2,29,842 (£15,323), and grazing fees for Rs. 3,63,165 (£24,211), leaving only Rs. 1,70,272, or, say, £11,000 for other articles of minor forest produce. A mere statement of these figures shows to how limited an extent the minor resources of the forests have as yet been developed. Vast quantities of gums, resins, dyestuffs and tanning materials are still waste products.

The following is a brief description of the more interesting articles of minor forest produce.

Thitsi.—The tree, *Melanorrhoea usitata,* is usually found abundantly in the drier forests up to an altitude of 3,500 feet. A full-grown tree is 50 to 60 feet in height with a girth of 9 feet. The tree is tapped and the varnish collected from June to January while the sap is flowing. The varnish exudes as a thick, greyish fluid, which becomes jet black on exposure to air. The oleo-resin or varnish is used for Burmese lacquer work, of which it is the principal constituent. This work is chiefly betel boxes, cups, trays, tables and monks' begging vessels. The varnish is also used as a coating for surfaces intended to be gilded with gold leaf, such as the spires and minarets of sacred buildings. This varnish though in daily use in Burma, is almost unknown in Europe. The annual extract is about 1,50,000 viss of 3·6 lb. For an account of the results of technical trials of thitsi, conducted in the United Kingdom and on the Continent on the initiative of the Imperial Institute, see this BULLETIN (1917, **15**, 42).

Cutch.—Cutch is a brownish extract obtained by boiling chips of the heartwood of *Acacia Catechu.* The liquor obtained is further boiled down to the consistency of syrup, poured into moulds, and allowed to harden. It is used as a tanning and dyeing agent. Natural reserves of cutch forests have been formed, and a considerable expenditure has been incurred in plantations. Dyers have to a great extent discarded cutch for artificial dyestuffs, and it is now used chiefly for curing and preserving fishing nets and sails. Licences for boiling cutch are issued free of charge, and an export duty of Rs. 4 (5*s.* 4*d.*) per hundred viss or 365 lb. is charged. The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Cutch . .	*tons*	5,365	4,557	3,990	4,348	8,526

Bamboos.—Bamboos grow in profusion in the forests of Burma and are used for innumerable domestic purposes. It has been established by trials on a large scale at the Titaghur Paper Mills in Bengal that bamboo pulp is suitable for the manufacture of high quality paper. A concession for the extraction of bamboos for this purpose over a large forest area in Burma was granted to Heilgers & Co., a European firm in Calcutta, and negotiations were in progress for a similar concession to another firm, Burn & Co., but the outbreak of war delayed the commencement of manufacture.

Tanning Barks.—For the purpose of obtaining tanning extract from the bark of mangroves, a factory on a small scale was established several years ago in Rangoon, but owing to want of expert supervision it was not successful. The forests contain many valuable tanning materials other than mangrove bark, but the possibility of utilising them has not yet been fully investigated.

Lac.—Lac, a resin deposited on the twigs of trees by the lac insect, is found in considerable quantities in many parts of Burma. The exports of stick lac and shellac from Rangoon in the four years ending in 1906–7 averaged 27,300 cwts. a year. Licences are issued free of charge for the collection of lac from forest land for trade purposes. A royalty of R. 1 (1*s.* 4*d.*) per cwt. on stick lac and R. 1–4 (1*s.* 8*d.*) per cwt. on shellac is levied on export by sea from Burma. The licences contain the conditions that no trees shall be felled or branches cut in the process of collection, and that a portion of living lac must be kept on each tree from which lac is collected. But owing to deficiency of establishment no real attempt has been made to enforce these conditions. A shellac manufactory was started in Rangoon a few years ago, but owing to shortness of material it was not successful. It is probable that if attention were paid to cultivation, and if destructive methods of collection were prohibited, a greatly increased outturn could be obtained.

The export figures are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Stick lac	. *cwts.*	1,805	9,454	6,439	2,971	19,346
Shellac	. ,,	6,091	7,634	4,068	836	93

It is a curious fact, indicating the lowness of revenue yield of the forests, that the value of lac, the deposit of an insect, exported annually from India is nearly equal to the total revenue of the Indian forests.

Indwe.—The In tree (*Dipterocarpus tuberculatus*) and the Ingyin tree (*Pentacme suavis*) produce a clear resin used for caulking boats and similar purposes, and a dark thick oleo-resin used for torches. These products, which are known as Indwe, are largely consumed in Burma. The Forest returns for 1915–16 show an output of 1,532,692 lb., which is probably far below the total amount extracted.

India Rubber.—*Ficus elastica* is found in considerable quantities in the Hukawng Valley, an unadministered tract adjoining the Myitkyina district. The hillmen extract the rubber by making incisions in the bark of the trees, out of which it oozes as a white milky juice, which when dried and hardened is twined into balls. The pernicious practice of tapping the roots is common, and the trees often die after having been worked for a few years. The amount brought in annually from unadministered territory is about 36,000 lb.

Myrabolans.—Myrabolans are plentiful in Burma, but a market has not yet been found for them. They are inferior to Indian myrabolans in having non-tannins in excess. They have been examined by the expert leather chemist at the Allahabad Tannery and pronounced to be a useful tanning material in conjunction with Babul bark.

Turpentine.—Pine forests are found in various parts of Burma, but especially in the Shan States and Chin Hills. They consist mostly of *Pinus Khasya.* In 1896 Professor Armstrong examined specimens of oil distilled from the *Pinus Khasya* of Burma, and concluded that it corresponded in properties with French oil of turpentine, and was of high quality. The resin of *Pinus Khasya* from the Southern Shan States was examined in 1911 in the laboratory of the Forest Research Institute, and Professor Armstrong's results were confirmed. No attempt, however, has yet been made to manufacture turpentine in Burma. For an account of the distribution of pine trees in Burma and the results of examination of the turpentine and rosin of *P. Khasya* at the Imperial Institute, see this Bulletin (1917, **15**, 544).

Dammar.—Rock dammar is obtained from the Thingan tree (*Hopea odorata*). It yields a yellow dammar used as varnish, which is of considerable value.

Pwenyet.—This is a dammar made by bees in a funnel-shaped opening at the mouth of their hives, and is used chiefly for caulking boats. The outturn stated in the Forest Report for 1915–16 is 18,000 lb.

Wood Oil.—An oleo-resin called gurjan oil in India and Kanyin-si in Burma is obtained from the Kanyin tree (*Dipterocarpus turbinatus*). It is largely collected and to some extent exported to India. Watts says that it has been used in Europe as a varnish with good results, and that it is reported to be a useful ingredient in lithographic ink. It has also been employed as a substitute for balsam of Copaiba in medicine. This oleo-resin should not be confused with "Chinese wood oil," now better known in this country as tung oil.

Minerals

There are two forms of mineral concessions, Prospecting Licences and Mining Leases.

The surface of unoccupied and unreserved land which is the property of Government may be freely searched without authority.

The applicant for a prospecting licence must first obtain from the Revenue Secretary a Certificate of Approval, which extends to one year and may be renewed, the fee payable for which is Rs. 50 (£3 6*s.* 8*d.*) and Rs. 10 (13*s.* 4*d.*) additional for every year of renewal. Having obtained a Certificate of Approval, the applicant for a prospecting licence demarcates the land for which he desires to apply, presents his application to the Collector accompanied by a plan of the land, and deposits as security a sum of Rs. 100 (£6 13*s.* 4*d.*) per square mile of the area applied for. If the Collector, after enquiry, finds that there is no valid objection, a prospecting licence is granted. The licence confers on the licensee for the period of the licence the sole right to mine, quarry and carry away any mineral or mineral oil on or beneath the land specified in the licence. A prospecting licence is ordinarily in operation for one year, but may be renewed for a further period not exceeding two years. The licensee is required to pay a surface rent not exceeding one rupee and not less than one anna per acre of the land covered by the licence. He is also required to pay royalty at a rate not exceeding 15 per cent. of the value on all precious stones won and carried away, and a royalty at the rates mentioned later (p. 70) on all other minerals won and carried away, over and above a certain quantity, which is allowed to be taken free for purposes of experiment.

On or before the termination of the prospecting licence the licensee acquires a right to a mining lease on the whole or part of the land covered by the prospecting licence, subject to the condition that no mining lease may be granted by an authority lower than the Government of India so as to cause the total area held under mining leases by the applicant to exceed 10 square miles.

The procedure in applications for mining leases is very similar to that in respect of prospecting licences. The application must specify the mineral or minerals for which it is intended to mine, show the areas already held in prospecting or mining right, and state the period for which the lease is required. Mining leases are granted by the Local Government, not by the Collector, and leases of mines of precious stones are granted only by the Governor-General in Council. The term of a lease must not exceed thirty years, but renewals may be permitted.

The lease may contain such special conditions as the Local Government may in each case consider necessary. If any mineral other than those contained in the lease be discovered, a mining lease in respect of that mineral may be granted. The lessee is required to pay a surface rent subject to a maximum of R. 1 (1*s.* 4*d.*) and a minimum of 4 annas (4*d.*) per acre. He is required to keep correct accounts showing the quantity and particulars of all minerals obtained, and to pay royalties at the rates specified below, or in the alternative a dead rent at a rate not exceeding R. 1 (1*s.* 4*d.*) per acre, if this rent exceeds the royalty on the minerals extracted.

Coal and mica	5 per cent. on the sale value at the pit's mouth.
Oil	8 annas per 40 gallons or 5 per cent. *ad valorem.*
Gold and silver	7½ per cent. on profits or 2½ per cent. of gross value.
Iron	½ anna per ton of ironstone.
Precious stones	30 per cent. on net profits.
All other minerals	2½ per cent. on the sale value at the pit's mouth, convertible at the option of the Local Government to an equivalent charge per ton to be fixed for a term of years.

The activity in prospecting for minerals may be judged from the fact that 147 prospecting licences and three mining leases were issued in Burma in 1915.

Gold

Grains of gold are washed down by many streams in the province, and the sifting of gold dust from sand forms a precarious means of livelihood in many places. The upper reaches of the Irrawaddy and the Sittang appear to be the most prolific. In the Irrawaddy above Myitkyina the Burma Gold Dredging Company has carried on operations for some years, but has met with many difficulties. The largest yield in a year has been 8,000 oz. of gold.

An attempt was made to extract gold from quartz at Kyaukpazat in Katha District where quarrying and crushing were started in 1895. The yield of gold was about 1,200 oz. The gold-bearing quartz proved to be only small in amount and was soon exhausted.

The washings in streams show that many parts of the province are rich in gold, but it has nowhere as yet been found near the surface in remunerative quantities. It may some day be mined profitably from lodes, but capital has not yet been applied to such a venture.

Silver

The Chinese at one time had silver workings at Bawdwin in the Northern Shan States, now the scene of the industries of the Burma Corporation. That these workings must have been very extensive is shown by the amount of slag that has been left on the surface, and by the bareness of the adjacent hills from which they consumed the firewood. The mine is now worked chiefly for lead, and will be referred to later. The only other silver mine in Burma worked in recent years is at Bawzaing in the Southern Shan States, where the Chief of the State, assisted by a Chinese lessee, extracts silver in small quantities from argentiferous galena by very primitive methods.

Iron

Broad tracts of ferruginous laterite are found in many parts of Burma. Some of these have been worked for iron in the past, and the abandoned workings can still be seen. But imported iron is cheap, and iron ores have never had any economic importance in the province.

Coal

Coal is found in Thayetmyo, Upper Chindwin, Shwebo and Mergui districts, and in the Shan States. The Burmese, having abundance of wood within easy reach, have never utilised coal as a fuel.

The only important attempt to extract coal was made in 1891 by a Syndicate at Kabwet in the Shwebo district. The enterprise existed for a few years, and in 1896 the output reached 23,000 tons. The coal was used to a limited extent by the Burma Railways and the steamers of the Irrawaddy Flotilla Co. It was of poor quality, and eventually the mine closed down.

In Mergui district coal of Tertiary age is found at Kyamitthe and Kamapyin, and was pronounced by the Geological Survey in 1893 to be of superior quality.

But there was no market in the vicinity, and the want of transport facilities and dearness of labour rendered it unlikely that it could compete at Rangoon or Moulmein with Bengal coal. It has never been worked.

At Lawksauk on the Zawgyi River in the Southern Shan States, coal of fair quality exists, but for similar reasons it has never been utilised.

Upper Chindwin coal is of good quality, but the fields are inaccessible. Dr. Noetling of the Geological Survey, in a report published twenty-five years ago, said:

"As regards the proportion of fixed carbon, which is the most important factor in the properties of heat, the Chindwin coal is far inferior to English coal, but nearly equal to the Raniganj coal. It is superior to the latter as regards percentage of ash, which is less than half the quantity in the best peninsular coal. The average Chindwin coal represents a high quality of fuel."

He estimated the total amount available in the Chindwin field at 105,000,000 tons.

Petroleum

Burma has a very large wealth of petroleum.

The oil-fields of Kyaukpyu in Arakan were the first to be worked by European agency. In 1878 the Boronga Oil Company commenced operations on a considerable scale. Experts were brought from Canada, and deep borings were made through rock. The efforts were not rewarded by success, and in 1885 the Company went into liquidation. Operations are still carried on by native industry, but the yield is comparatively small.

The annexation of Upper Burma in 1885 brought into prominence the oil-fields of Yenangyaung and Yenangyat in Magwe district, which had long been worked by the Burmese under primitive methods that drew oil only from the higher strata. These fields are now worked under the best scientific systems by British companies, of which the Burma Oil Company is the most important, and yield an enormously increased quantity of oil. The oil is brought by a pipe line to refineries near Rangoon.

Simultaneously, prospecting has been carried on throughout the province with the object of discovering new oil-fields. New fields have been found at Singu in Myingyan district (recently transferred to Magwe district), and in Minbu, Thayetmyo, Pakokku, and Upper Chindwin districts. The most profitable of these is the Singu field.

The revenue from royalties on petroleum in 1915–16 exceeded thirty-seven lakhs of rupees or £246,000.

The export figures are :

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Mineral oil, *galls.*	107,043,354	129,073,019	134,296,560	134,922,437	137,189,009
Paraffin wax, *cwts.*	227,676	261,841	296,155	362,119	355,384
Candles . *lb.*	10,164,497	10,910,353	13,514,155	13,659,426	12,011,014

Tin

Tinstone has long been worked in Tavoy and Mergui districts. It is found in granite and also in alluvial deposits. The mine workers are mostly Chinese. The physical difficulties of the country, the high rate of wages and the absence of communications, have impeded commercial undertakings, and the industry is carried on on a small scale. Tin undoubtedly exists in large quantities in these districts, and its working may become a commercial success when better means of communication and transport have been established.

The export figures are :

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Tin ore and tin *tons*	279	429	395	290	330

Jade

Jade stone is found in large quantities in the Mogaung township of Myitkyina district. It finds an unlimited market in China. Under British rule it has always been regarded as a perquisite of the Kachin hillmen, and their possession of the mines was guaranteed when the first British expedition occupied the country.

The Kachins extract jade by very destructive and uneconomical processes. The surface of the rock is heated by fire. The fall of temperature cracks the jade, which is then dug out by crowbars and wedges.

The blocks of stone are taken to Mandalay to be sawn up. The jade is then exported from Rangoon to China.

The right to collect duty on jade at $33\frac{1}{3}$ per cent. *ad* *valorem* is sold by auction, and the purchaser is always a Chinaman. The revenue in 1915–16 was Rs. 48,200 (£3,213).

There can be little doubt that jade would be a remunerative industry on a large scale if the stone were extracted by European methods and under European superintendence. But there are political objections to European industries being started in the wild and remote tracts where the stone is found.

The export figures are:

	1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Jade . *cwts.*	994	1,754	2,864	4,194	4,381

Amber

Amber is found in the low ranges of hills in the south-west corner of the Hukawng valley, an unadministered tract north of Myitkyina district. It is extracted in small quantities by native diggers by very primitive methods. It is used in Mandalay in the manufacture of rosaries, ear cylinders, and trinkets in the shape of animals or figures of the Buddha. The levy of royalty is included in the jade licence. The outturn varies from 40 to 200 cwts. a year.

Rubies, Spinels, Sapphires

The ruby mines of Mogok formed a monopoly of the Burmese kings. They have for many years been leased to the Ruby Mines Company, who have expended much capital in machinery and tunnelling.

The surface soil down to the ruby-bearing stratum is removed, and the byôn or ruby-bearing sand is dug up and carried by trollies to the steam-cleansing mill, washed, passed through sieves, and examined for stones. The stones are sorted according to size and kind, and may be rubies, spinels, or sapphires.

In addition a large amount of digging for rubies is done in native ways by licensees.

The Ruby Mines Company has been carried on with persevering efforts and the outlay of much capital, but has not achieved a financial success. No dividend has been paid to the shareholders since 1900.

Rubies in large numbers and of good quality have been found, but the fashion in America, the best market, has gone against red stones, and the introduction of the artificial ruby, which except under a magnifying-glass is in appearance undistinguishable from the real ruby, has proved a deadly blow to the trade. The ruby, however, finds a limited market in Madras.

Rubies are found also at Nanyaseik in Myitkyina district and Sagyin in Mandalay district, but not in remunerative quantities.

Lead

The Burma Corporation's mine at Bawdwin in the Northern Shan States is the only important source of lead and silver in Burma. In 1915, 42,000 tons of ore and slag were smelted. The total production of hard lead was 13,522 tons, of which 6,947 tons were refined and sold in Eastern markets, and 6,575 tons, containing 248,875 oz. of silver, were shipped to England to be refined. The mine is connected by the Company's light railway with the Mandalay-Lashio Railway. The roasting plant, which consists of three roasters in operation and two under construction, will, when completed, have a daily capacity of 150 to 200 tons of ore. In June 1916 the daily production was at the rate of over 50 tons of lead, containing from 3,000 to 4,000 oz. of silver. Fine silver is not yet produced on the spot. No zinc concentrates were exported during the year. The Geological Department of the Government of India considers that the question of the ultimate treatment of the Bawdwin concentrates is an important one for India, since if it were found possible to erect zinc smelteries in Burma, the resultant production of large quantities of cheap sulphuric acid should have a far-reaching effect on industrial development.

The Company has not yet paid a dividend, but the £1 shares are now quoted at £4 10*s*. Development work has been carried on for some years on systematic lines, and lodes containing an immense quantity of lead, zinc, silver, and some copper have been proved. This is one of the big mining propositions of the world, and in all probability has before it a great future.

The figures for export of lead are :

		1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
Lead	. *tons*	10,131	7,489	3,422	6,499	10,846

Wolfram

Of recent years a great demand arose for wolfram in the manufacture of high-speed steels, and attention was directed to the source of supply in Tavoy and Mergui districts. The whole of the supply went to Germany, from which country all tungsten used in England was obtained. Since the war began a greatly increased amount of tungsten steel has been required for the manufacture of munitions. The methods of working which before the war amounted to little more than surface extraction have been improved. All wolfram produced is earmarked for despatch to the United Kingdom, and has been taken over by the British Government at a fixed rate of £2 15*s.* per unit as compared with the pre-war rate of about £1 10*s.* Since January 1, 1918, the rate has been raised to £3, with 3*s.* 4*d.* added for exchange compensation and 4*s.* 3*d.* for increased cost of freight. Roads have been made and a labour force has been imported. As a result of these measures, the output, which was 2,326 tons in 1914 and 2,645 tons in 1915, rose to 3,034 tons in 1916 and 4,000 tons in 1917, and is rapidly increasing. The Tavoy field produces one-third of the world's output.

In the Mawchi mines in Karenni 11,500 tons of ore were crushed in 1916 and yielded 368 tons of concentrates, containing approximately equal amounts of tin and wolfram. These mines are very inaccessible, and the transport of the concentrates to Rangoon is a difficult undertaking.

Other Minerals

Other mineral products which may be mentioned are tourmaline, which is found in the Shan States of Mongmit and Maing Long ; plumbago and mica, which are extracted in the Ruby Mines district ; alabaster, a soft white marble extensively used in making images of the Buddha, which is found in the Sagyin quarries of Mandalay district; steatite, used chiefly in making pencils for writing on palm leaves; and limestone, which is common throughout Burma.

General Conclusions

Within the limits of an article it is not possible to do more than give an enumeration of the products of Burma, with the briefest statement of their existing and potential commercial importance. Fuller information regarding agricultural conditions will be found in the Settlement Reports of the various districts, the Annual Season and Crop Reports, the Agricultural Surveys of districts and the pamphlets and bulletins of the Agricultural Department of Burma. The Forest bulletins, pamphlets, memoirs and records of the Government of India, and the reports of the Forest Research Institute, Dehra Dun, contain much information on the Forest resources of Burma. The series of reports of the Geological Department of India give accounts of the various mineral resources of Burma. The Land Revenue, Forest, and Mineral Manuals of Burma contain the rules under which concessions may be granted. All of these publications are obtainable at the Record Department of the India Office.

Some indication has been given of the extent to which the resources of the province have been exploited, and it will be inferred that there is ample room for a fuller development. In agriculture rice as an article of commerce has made enormous strides during the past thirty years, and it might be thought that it has almost reached its limits, but it is probable that the supply could be largely increased if intensive methods of cultivation were adopted. Other agricultural products have a large field open for expansion in area of cultivation, selection of seed, introduction of new kinds, and improved methods of cultivation. The forests of Burma, rich in timber and other produce, have as yet received the attention which they deserve only in respect of teak. Of the mineral products, oil is the only one that has reached a high stage of commercial exploitation, but from the fact that as many as twenty-seven prospecting licences for oil were granted in 1915, it may be hoped that new and unknown fields may yet be discovered. The other mineral resources of the province are still only in the prospecting stage of development.

The capital expended in Burma from time to time on revenue-producing public works, which amounts to a large total, has given a handsome return. The completed irrigation systems of Upper Burma, which are only a few years old and have not yet had time to reach their full stage of efficiency, are yielding after deduction of working expenses and payment of interest a net revenue of 6 per cent. on capital outlay. The protective embankments of the Irrawaddy in Lower Burma, an older work which has brought a large area under cultivation, are yielding a net return of 32 per cent. The Burma Railways Company, which took over the Railway from Government twenty years ago, and during that time have increased the length of open line from 886 to 1,598 miles, are paying to their shareholders on the whole system new and old a dividend of 7 per cent. Forest Reserves, awaiting exploitation, are not yet paying a full return on the capital expended on their conservation and improvement, but they are yearly growing in economic value as the unreserved areas are being cleared for agricultural occupation. The first requirement of further progress is an adequate system of roads to carry the produce to the railways and rivers. In a country rich in material resources expenditure on roads will in the long run be as productive of wealth as any other outlay of capital.

The provision of roads can be made only by Government. Railways may be an object of either State or private enterprise. Light railways would be useful in many localities, for instance in Tenasserim, and might remuneratively attract private capital. Motor carriage would be provided readily enough by private enterprise if the roads were in existence to make it possible.

There is no truth in the opinion often expressed that Government is adverse to private enterprise. In a previous paragraph (p. 61) the policy of the Government of India in respect of private enterprise in the exploitation of forests has been quoted. *Mutatis mutandis*, the pronouncement applies to concessions of all kinds. In the interest of the tax-payer Government is bound to reserve for itself a fair share of the profits earned from the exploitation of the products of the country. Within this limit it welcomes and is ready to give priority to private enterprise.

Unfortunately applicants for concessions have too often been adventurers who desire to take much and give nothing in return, and who possess neither expert knowledge nor sufficient capital to utilise the products which they wish to exploit. For instance, not a few prospecting licences for minerals have been taken out by persons who make no real endeavour to prospect, but hold the licences merely to secure an option which can be sold if by good fortune anything of value is discovered on neighbouring land. Such applications should of course be rejected, but where *bona fide* applications for concessions are made by experts or capitalists, the Government of Burma is always ready to welcome them, and never turns them down without reasonable cause.

Burma is a land of rich resources and great potentialities, and there can be no doubt that capital judiciously expended, whether by Government in improving communications and developing natural resources, or by private enterprise in exploitation, would be profitably employed.

GENERAL ARTICLES

THE WORK OF THE IMPERIAL INSTITUTE IN CONNECTION WITH BRITISH COTTON CULTIVATION [1]

THE Imperial Institute since its establishment as a Government Institution in 1903 has continuously promoted the interests of British cotton cultivation by conducting investigations respecting the quality of cotton grown, in association with the Agricultural Departments of the countries concerned and with the British Cotton

[1] *Memorandum prepared for the Empire Cotton Growing Committee*, 1918.

Growing Association; by collecting and publishing information respecting the progress of cotton growing in all countries, and by arranging and maintaining reference collections of cottons from every country of the Empire.

The first report from the Imperial Institute was issued as a Blue Book in 1904 (Dunstan: *Cotton Cultivation in the British Empire and in Egypt* [Cd. 2020], 1904). This report drew attention to the importance of cotton cultivation to the Empire and the desirability of its extension, and described the position and prospects of cotton cultivation in each country. In 1905, the year following the issue of this Report, a Cotton Exhibition was held at the Imperial Institute with the co-operation of the British Cotton Growing Association. It was opened by H.R.H. the Prince of Wales (now H.M. the King), and was intended to arouse further interest in the subject of Empire cotton growing. It included samples of cotton grown in each British producing country so arranged as to display the length of staple and other characteristics, whilst for comparison a collection of the chief cottons of the United States, Brazil, Peru, China, and other foreign countries were similarly shown. The various uses of cotton for textile purposes were fully illustrated, and the chief types of machinery employed were shown. The Handbook issued in connection with this exhibition supplied information respecting the position of cotton growing in each country of the Empire. The collections of cotton thus brought together at this exhibition have been maintained and added to so as to make a comprehensive illustration of the types of cotton produced in British territories, which has proved of the utmost service as a reference collection to enquirers from all parts of the world.

The Imperial Institute has acted continuously as a centre for information and investigation respecting many aspects of cotton cultivation. Numerous reports have been made to the local Governments, to planters and others respecting the quality and commercial value of cotton grown, as to the quality of the soil and its improvement by manuring, as to the types of cotton most likely to be suitable for trial in particular countries, as to the supply of seed and methods of seed disinfection, and as to the treatment required for insect and fungoid pests. Much information has also been supplied concerning the methods of improvement of varieties of cotton by seed selection, by breeding, etc. In order to cope with the increasing demand made on the Imperial Institute for information and investigation respecting cotton, the work has been organised in three chief branches of exhibition, information and investigation. The work of exhibition has involved the display in the Public Exhibition Galleries, in the individual Courts assigned to the exhibits of the various countries of the Empire, of a series of samples, photographs, statistical and other diagrams illustrating the position of cotton cultivation in each country, and also the maintenance of the Reference Collection of samples of Empire-grown Cotton and of the chief cottons of foreign countries.

Information has been systematically collected and arranged from publications respecting cotton cultivation in every part of the world, and also that obtained by special application to Governments and planting companies. This information, which includes particulars as to land available, cost of labour, etc., is utilised in dealing with the numerous enquiries addressed to the Institute and in connection with the preparation of periodical publications.

In connection with investigation, the work has chiefly consisted in examining samples of experimentally grown cotton mainly as to length and strength of fibres and its suitability for special purposes in comparison with other cottons or with the same type of cotton grown in other countries. This work has been carried out in collaboration with the local Agricultural Departments, whose efforts have been directed to secure the type of cotton best adapted to the particular country and its improvement by various means. Numerous analyses of cotton soils have been conducted before and after experimental manurial treatment. The commercial value of various experimentally grown cottons has also been determined by reference to manufacturers as well as to brokers, and this section of the work has been carried on in close touch with the British Cotton Growing Association. The whole of these operations have been conducted with the aid of a small grant of £500 a year made by the Treasury in the first instance for a term of five years from 1905 and then renewed for a further term of five years. This grant has not been again renewed during the period of war.

The Director of the Imperial Institute as well as members of the Staff have visited cotton-growing countries and made a special study of the economic and other conditions under which cultivation is carried on. Reports by Professor Dunstan on Cotton Cultivation in Cyprus and in Asia Minor have been published as Parliamentary Papers and are referred to later.

The Director and Staff of the Institute have also contributed various papers and reports to Societies and Congresses connected with cotton cultivation. At the International Congress of Tropical Agriculture held in Brussels in 1910, the Director of the Imperial Institute presented a General Report on the Position of Cotton Cultivation with special reference to the British Empire, and also a collection of special reports on Cotton Cultivation in each country, some of which were contributed by the local Directors of Agriculture, and others by members of the Staff of the Imperial Institute.

At the next International Congress of Tropical Agriculture which was held in London in 1914, and of which the Director of the Imperial Institute was President and two principal members of the Staff were Organising Secretaries, prominence was also given to the subject of cotton cultivation and a large number of papers and reports were contributed, and have since been published in the Transactions of the Congress. Concurrently with the London Congress an International Exhibition of Cotton and other Fibres was held at the Agricultural Hall. The Director of the Imperial Institute as President of this Exhibition offered a silver trophy for the best large sample of British-grown cotton established within the preceding ten years and which had furnished at least three successive crops. From a number of excellent samples submitted and examined in detail at the Imperial Institute the trophy was awarded to the "Buri" and

"Rosea" cottons from the Government Experimental Farm at Akola in the Central Provinces of India.

Finally, reference may be made to the reports on the various aspects of cotton cultivation which have appeared in successive years since 1905 in the quarterly BULLETIN OF THE IMPERIAL INSTITUTE, the more important of which are included in the following list, which illustrates the wide range of the work of the Institute on this subject. The titles are also given in this list of the special reports alluded to previously, and of that of a Handbook by Dr. Ernest Goulding on "Cotton and Other Vegetable Fibres" in the Imperial Institute Series on the Commercial Resources of the Tropics, which has been recently published.

In addition to these published reports, numerous special reports on cotton cultivation have been made to the Governments and Agricultural Departments of the principal cotton-growing countries of the Empire. Classification of some hundreds of the reports shows that reports based on the results of investigations conducted at the Imperial Institute have been made among others to the following countries: India, Egypt, the Sudan, British East Africa, Uganda, Nyasaland, Union of South Africa and Rhodesia, British West Africa, Australia, British North Borneo, Fiji, West Indies, British Guiana, Mauritius, British Honduras and Cyprus.

It will be seen that the Imperial Institute, which took a prominent part in the inception of the movement for cotton growing within the Empire, has become a recognised centre and clearing-house for investigation, information and exhibition respecting the various aspects of cotton production. The need for the work undertaken by the Imperial Institute will not diminish with the extension of activity throughout the Empire to produce more and better cotton, whilst its work as a central clearing-house will be of special value to any agencies which may be inaugurated to assist cotton cultivation by scientific research. Such research can only be properly conducted and controlled in the countries in which cotton is grown, and under the auspices of their Agricultural Departments and Planting Companies, and it is by the strengthening and extension of the scientific work of the Government

Agricultural Departments in all cotton-growing countries that advances will best be made. It is as a centre for collecting, collating and recording the results of this and all other cotton work in British countries, in conducting investigations of the quality and value of the cotton produced, in affording general information and in publishing statistics and reports of progress, that the Imperial Institute will continue under the extended constitution provided by the Imperial Institute Act of 1916 to be of service in this subject to the Empire as a whole.

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Cotton Cultivation in Cyprus. [Cd. 2717.] 1905.
Cotton Cultivation in Asia Minor. [Cd. 4324.] 1908.
British Cotton Cultivation. [Cd. 3997.] 1908.
The Present Position of Cotton Cultivation: Report to the International Congress of Tropical Agriculture, Brussels, 1910.
Papers and Reports on Cotton Cultivation. International Congress of Tropical Agriculture, Brussels, 1910.
La Culture du Coton dans le Monde. Revue Economique Internationale, 1911.

BY ERNEST GOULDING, D.SC. (LOND.)

Cotton and Other Vegetable Fibres: their Production and Utilisation. Murray, 1917.

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Cotton Growing in Northern Nigeria. Vol. III (1905), No. 1, pp. 49–55.

Fungoid Diseases of the Cotton Plant. Vol. III (1905), No. 1, pp. 60–62.

Cotton Exhibition at the Imperial Institute. Vol. III (1905), No. 2, pp. 113–116.

Cotton from British East Africa. Vol. III (1905), No. 2, pp. 139–142.

Cotton from British New Guinea. Vol. III (1905), No. 3, pp. 225–226.

Cotton Cultivation in Rhodesia. Vol. III (1905), No. 3, pp. 247–249.

Cotton Growing in the Portuguese Colonies. Vol. III (1905), No. 3, pp. 250–251.

Cotton from the Federated Malay States. Vol. III (1905), No. 4, pp. 314–316.

Cotton Growing in Cyprus. Vol. III (1905), No. 4, pp. 327–334.

Cotton Cultivation in the United States of America. Vol. III (1905), No. 4, pp. 334–345.

Cotton from British North Borneo. Vol. IV (1906), No. 1, pp. 22–23.

Insects which attack Cotton in Egypt. Vol. IV (1906), No. 1, pp. 48–52.

Cotton Cultivation in Corea. Vol. IV (1906), No. 1, pp. 66–67.

Cotton Cultivation in Ceylon. Vol. IV (1906), No. 2, pp. 178–179.

Cotton Cultivation in British East Africa. Vol. IV (1906), No. 4, pp. 291–296.

Improvement of West African Cotton. Vol. IV (1906), No. 4, pp. 349–350.

Cotton from Bermuda. Vol. IV (1906), No. 4, pp. 363–364.

Cotton from Nyasaland. Vol. IV (1906), No. 4, pp. 386–388.

Cotton Growing in Spain. Vol. V (1907), No. 1, pp. 31–35.

Cotton Growing in Portuguese East Africa. Vol. V (1907), No. 1, p. 61.

Insect and Other Cotton Pests, and the Methods suggested for their Destruction. Vol. V (1907), No. 2, pp. 140–166.

Cotton Growing in Algeria. Vol. V (1907), No. 3, pp. 269–273.

Cotton Cultivation in German East Africa. Vol. V (1907), No. 4, pp. 425–426.

Cotton from Cape Colony. Vol. V (1907), No. 4, p. 440.

Cottons from India. Vol. VI (1908), No. 1, pp. 11–19.

Cotton Growing in Central Asia. Vol. VI (1908), No. 1, pp. 60–74.

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Cotton Experiments in Eastern Bengal and Assam. Vol. VI (1908), No. 2, pp. 202–203.

Cotton Experiments in Punjab. Vol. VI (1908), No. 2, p. 203.

Cotton Experiments in Bombay. Vol. VI (1908), No. 2, pp. 204–205.

Cotton Growing in the French Colonies. Vol. VI (1908), No. 3, pp. 288–292.

Cotton from British Guiana. Vol. VI (1908), No. 4, pp. 383–387.

Notes on the Present Position of Cotton Cultivation in the United States. Vol. VI (1908), No. 4, pp. 404–417.

Cultivation of Egyptian Cotton in Sind. Vol. VI (1908), No. 4, pp. 418–419.

Cotton Growing in Togo. Vol. VI (1908), No. 4, pp. 420–421.

Cotton from the Gold Coast. Vol. VII (1909), No. 1, pp. 14–20.

Cotton in Nyasaland. Vol. VII (1909), No. 1, pp. 29–40.

Cotton Ordinances of the Uganda and East Africa Protectorates. Vol. VII (1909), No. 1, pp. 92–93.

Cotton from Southern and Northern Nigeria. Vol. VII (1909), No. 2, pp. 154–159.

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Agricultural Development of Nyasaland. Vol. IX (1911), No. 4, pp. 380-382.
Recent Progress in Cotton Cultivation. Vol. IX (1911), No. 1, pp. 66-70; No. 2, pp. 164-169; No. 3, pp. 304-306; No. 4, pp. 409-412.
Some Cotton Soils of the Nyasaland and Uganda Protectorates. Vol. X (1912), No. 1, pp. 55-74.
Cotton from Papua. Vol. X (1912), No. 2, p. 215.
Economic Developments in the Belgian Congo. Vol. X (1912), No. 2, p. 296.
Improvement of Cotton in India. Vol. X (1912), No. 3, pp. 351-372.
Recent Agricultural Developments in Uganda. Vol. X (1912), No. 3, pp. 422-431.
Work of the British Cotton Growing Association. Vol. X (1912), No. 3, pp. 479-481.
Cotton from Uganda. Vol. X (1912), No. 3, pp. 481-482.
Cotton Industry of Nyasaland. Vol. X (1912), No. 4, pp. 527-536.
Cotton Worm in Egypt. Vol. X (1912), No. 4, pp. 584-620.
Cotton from Ceylon. Vol. X (1912), No. 4, p. 657.
Cotton Growing in French Colonies. Vol. X (1912), No. 4, pp. 657-658.
Recent Progress in Cotton Cultivation. Vol. X (1912), No. 1, pp. 158-162; No. 2, pp. 321-324; No. 3, pp. 500-502; No. 4, pp. 677-679.
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Progress of Egyptian Agriculture with Special Reference to Cotton. Vol. XI (1913), No. 1, pp. 90-101.
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Cotton Growing in the Ivory Coast. Vol. XI (1913), No. 4, pp. 672–673.

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Insect Pests of the Southern Provinces, Nigeria. Vol. XII (1914), No. 2, pp. 294–296.

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Cotton from British Guiana. Vol. XIII (1915), No. 3, pp. 380–384.

The War and the World's Cotton Crops. Vol. XIII (1915), No. 3, pp. 385–392.
Cotton Breeding in the United Provinces, India. Vol. XIII (1915), No. 3, pp. 476–478.
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The Improvement of Cotton in India.—II. Vol. XV (1917), No. 2, pp. 149–177.
Cotton from Cyprus. Vol. XV (1917), No. 3, pp. 298–300.
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THE WORK OF THE IMPERIAL INSTITUTE

Proceedings of the Executive Council and Committees: Recent Published References

The following is a summary of the proceedings at recent meetings of the Executive Council and Committees of the Imperial Institute so far as these relate to matters not of a confidential nature.

Executive Council.—The Executive Council at their quarterly meetings, under the chairmanship of Lord Islington, has considered and discussed reports on the work of the Imperial Institute in all its Departments, from which it appears that, in addition to confidential enquiries and investigations carried out for a number of Government Departments, special reports have been made chiefly as to the value and commercial prospects of raw materials to the following countries: Canada, Newfoundland, Australia, New Zealand, South Africa, Rhodesia, Egypt, the Sudan, Uganda, East Africa Protectorate, Nigeria, Sierra Leone, the Gambia, India, Ceylon, Seychelles, the West Indies and British Honduras.

The Council has also received and considered reports from the various Committees of the Institute, and references to these will be found later in this summary.

The Council has made representations as to the necessity of providing adequate accommodation for the raw materials required in connection with the work of the Imperial Institute, so long as the greater part of the Exhibition Galleries are occupied by the Ministry of Food.

Committee for Canada.—The Committee for Canada, under the Chairmanship of Sir George Perley, the High Commissioner in London, has taken action to secure the co-operation in the work of the commercial community throughout the Dominion, and has also taken steps with a view to the reorganisation of the Canadian exhibits at the Imperial Institute. The Committee has received and considered reports on the work of the Imperial Institute for Canada in the Scientific and Technical Department and in the Technical Information Bureau. Among the more important subjects reported to the Commitee is that relating to the despatch of a representative collection of various types of Indian cow-hides to Canada at the instance of the Hides and Tanning Materials Committee of the Imperial Institute, which has been exhibited at various centres by the Ministry of Trade and Commerce. Numerous enquiries have been received from Canadian tanners as to supplies of these hides, from which it would appear that as soon as Government restrictions on the sale of Indian hides are relaxed, a considerable trade will probably be done by Canada direct with India. So far but little trade has been done, and this has passed through the United States.

Committee for India.—The Committee for India, under the Chairmanship of Sir Charles McLeod, has been chiefly concerned with the conduct of the Indian Trade Enquiry which is being carried on at the Imperial Institute by various Special Committees at the request of the Secretary of State for India, with a view to ascertaining the prospects of extending the Empire's utilisation of Indian raw materials. Considerable progress has been made, and reports on hides, lac and rice have been completed and forwarded to the Secretary of State.

The question of the publication of the reports of these Special Committees has been the subject of correspondence with the India Office, and is still under consideration.

Raw Materials Committee.—The Raw Materials Committee, under the Chairmanship of Sir Algernon Firth, has taken action to bring to the notice of British traders a number of raw materials derived from within the Empire which have been investigated at the Imperial Institute and are ready for commercial action in this country. The Committee has forwarded information to the various Chambers of Commerce respecting the utilisation of South African spent wattle bark as a paper-making material; of sant pods from the Sudan as a tanning agent, and of sugar-cane wax from Natal as a substitute for waxes used in the manufacture of polishes, gramophone records, etc. The Committee has also drawn attention to the importance of utilising the coarser Indian cottons for the manufacture of certain special types of cotton materials hitherto manufactured chiefly abroad, and to the desirability of securing a larger market in this country for the cod-liver oil from Newfoundland, which is now claimed to be of quality equal to that hitherto obtained from Norway.

Rubber Research Committee.—This Committee, of which the Director of the Imperial Institute is Chairman, has been chiefly concerned in considering the results of the examination from the technological point of view of various samples of rubber specially prepared in different ways in Ceylon, with a view to ascertaining the method of production and preparation which furnishes rubber of a quality best suited to the needs of the manufacturer. This Committee works in co-operation with a similar Committee in Ceylon, and a first report on some of the results of the investigations conducted under its auspices has appeared in this BULLETIN (1916; **14**, No. 4, pp. 495–566).

Committee on Silk Production.—The meetings of the Committee on Silk Production, under the Chairmanship of Sir Frank Warner, have been chiefly concerned in considering the prospects of extending the cultivation of silk in India and in Cyprus. The Committee is in communication with both these Governments on this subject. It is also investigating the prospects of the wild silk which occurs both in East and West Africa, and which was beginning to be utilised for German purposes before the war.

Timbers Committee.—At the various meetings of the Advisory Committee on Timbers, of which Mr. H. D. Searles-Wood is Chairman, in addition to various special questions referred from other Committees of the Imperial Institute for consideration, the Committee has discussed the possibilities of developing the employment of West African timbers, on which it has taken a great deal of evidence. It has also been dealing with the question of the increased usage in this country of Canadian timbers, and has systematically dealt with the possibilities of the further utilisation of Indian timbers, on which subject it has completed a report to the Committee for India.

Mineral Resources Committee.—The Mineral Resources Committee, of which Lord Rhondda was Chairman and Admiral Sir Edmond Slade is Vice-Chairman, has arranged for the issue of a series of monographs on Mineral Resources with special reference to those of the British Empire in the preparation of which co-operation has been arranged with Mines Departments throughout the Dominions and Colonies. The first monograph on Zinc Ores has been published and others are in preparation. The Committee has also had under consideration a map compiled at the Imperial Institute illustrating the chief countries of production of the more important minerals within the Empire, with diagrams illustrative of output. It has been decided to issue this map at an early date. The Committee has also decided to arrange for the issue of an Annual Statement of Mineral Production within the British Empire, the preparation of which has now been commenced.

Recent Published References

The Imperial Institute and the Dominions Royal Commission.—The following article appeared in *Indian Engineering* for February 9, 1918:

"Why there exists a feeling in the Empire to belittle the work of the Imperial Institute it is difficult to understand. We should have thought that an Institution of this kind which exists to forward the industrial and commercial claims of every unit of the British Empire would receive the unstinted support of each of those units. Yet what do we find? Just this—that there is a movement on foot to restrict the scope of the Institute, to confine its activities to a section of the Empire, and strike a blow at that principle of co-ordination, which is the one thing that has been prominently proclaimed (since the war has brought its revelations) to have been in the past the stumbling-block to British progress. The Dominions Royal Commission has, among other questions, examined the position of the Imperial Institute, and has recommended its break up and a restriction of its scope to India, the Crown Colonies and the Protectorates, while such work as it has done in the past for other units of the Empire be withdrawn from it and distributed among certain other official bodies, the Royal Colonial Institute and institutions in the Dominions. This proposal is naturally stoutly opposed by the Executive Council of the Imperial Institute on what appear to us good grounds.[1] In the first place, evidence taken by the Dominions Commission from the authorities of the Institute dates back to 1914, a time long anterior to its final reorganisation, hence any criticisms made upon its working are out of date. It was in 1916 that its management was transferred from the Board of Trade to the Colonial Office and vested in a large and representative Executive Council including nominees of the Home and Dominion Governments, of India, of the Colonies and Protectorates, and of the Commercial community. This Council has barely got to work yet, and for this one reason any proposal to deal drastically with the Institute is wholly premature. But even before the reorganisation, the Institute had been demonstrating its usefulness, as two articles in our *Journal* which appeared respectively on November 4, 1916, and on November 3, 1917, endeavoured to show. If the Royal Colonial Institute has done more, we cannot say; if it has not, then its claim to take over much of the work of the Imperial Institute lacks support. It must be remembered that it is not asking only for the exhibits now shown in the galleries of the Imperial Institute and a part of the Endowment Fund, but also for the building which was erected largely with funds collected in India. This country, therefore, has a voice in the decision, and is not likely to take the side of the Royal Colonial Institute.

[1] See this BULLETIN (1917, 15, 184).

"It would appear from the Report of the Executive Council of the Imperial Institute that the Royal Colonial Institute do not maintain a large and specialised staff to do technical and commercial research work, as is done in the Imperial Institute, and therefore until such a staff is organised it will fail in what is really the most important side of the activities of the latter organisation. There is no reason whatever why the Colonies should not carry out for themselves any investigations they need for promoting the uses of their own products; but something more than this is needed if they desire to push their products in Imperial markets. It is necessary to have a central organisation where the various products of the various units of the Empire can be compared and tested under similar conditions. In no other way can the suitability of each for utilisation generally be determined. There is much of this kind of information already collected at the Imperial Institute, and free use of it has been made when the British Government has desired to replace raw material cut out of trade by the war. There is not the least doubt that as the British Museum serves as a repository for samples of all objects of value or interest in the Empire, a clearing-house such as the Imperial Institute should become a repository for samples of all the materials used in the industries of the Empire, together with the whole of the known literature connected with such materials. It may often happen that information gathered regarding a product of one country apparently places that product in a misleading light. It may be thought that no other similar product could compete with it until it transpires that such products do exist, perhaps superior, perhaps better placed for commercial exploitation, perhaps forthcoming in larger quantity. A clearing-house stocked with such information would be of the highest use in correcting mistakes of this kind, and the more fully this kind of information is concentrated in a central bureau, the more valuable such a bureau must prove.

"Some of the leading Home papers are adverse to the proposals put forward, among them being *The Times* and *Daily Telegraph*.[1] The latter concludes a strong leading article as follows: 'The Institute is not an isolated Institution working aimlessly *in vacuo*. On the contrary, it is working closely in touch with the Associated Chambers of Commerce, with a large number of important business firms, especially in the rubber, tanning, dyeing and fibre industries, and with the authorities of India, the Do-

[1] See this BULLETIN (1917, 15, 194).

minions, and the Crown Colonies. Moreover, what is more important, in view of the adverse conclusions of the Commissioners, we believe the Imperial Institute will be found, when the matter comes to the test, to have the confidence of the Dominions, in whose name, but without whose authority, this unreasonable condemnation may seem to the public to have been uttered.' It is now the duty of India, through its leading papers, to take up the challenge and see that what was originally really its bantling is not dismembered. What the Institute asks for is more funds in order to extend its usefulness; this is being met by a suggestion to take away a large part of the funds it has, and the grounds on which this suggestion is made will not bear fair examination. India is on the eve of starting on an active industrial campaign. Is the Imperial Institute likely to support the campaign better or the Royal Colonial Institute? Let India judge."

The Imperial Institute and Canada.—The following leading article is reprinted from *The Leather World* for March 28, 1918:

"CANADA AND INTER-EMPIRE TRADE

"Rather an important announcement has reached us from official sources in connection with the East Indian hide trade; it is stated that according to information laid before the Imperial Institute Committee for Canada, at a recent meeting in London, under the Chairmanship of Sir George Perley, the High Commissioner for Canada, great interest is being taken by Canadian tanners in the representative collection of cow hides which was despatched to the Dominions by the Hides and Tanning Materials Committee of the Imperial Institute. It is further stated that the collection is being exhibited at various centres, under the auspices of the Canadian Ministry of Trade and Commerce, and that several enquiries have already been received from Canadian firms as to the supplies of the hides. The communiqué concludes by stating 'that it is probable that as soon as the Government restrictions on the disposal of Indian hides are relaxed, a considerable trade will be done direct with India.'

"We congratulate the Imperial Institute Committee on this quiet but effective piece of work in furtherance of British trade, and sincerely hope it will be fruitful in results. The work of the Institute has, we fear, been hardly appreciated by British traders, as it is done in an unostentatious manner, and with no desire to blazon its usefulness abroad. We know, however, from past experience that every year samples of tanning materials, hides, leather, and leather goods are received by this Institute, and that traders who have been wise and sharp enough to take advantage of the data supplied have been greatly helped thereby. After all, if our traders have not availed themselves fully of the advantages offered by the Imperial Institute, they cannot logically blame its executive for negligence, and possibly point to the Imperial Institute as 'another of those White Elephants of the Government.' We have ourselves obtained very valuable information from the Institute with reference to new and strange tanning materials, whilst if visitors to London in pre-war days had taken the trouble to visit the Institute, and examine the fine exhibits of tanning materials and leather samples always to be seen there, we feel sure some of them would hardly so often reiterate the statement that 'the British Government has done nothing for our trade.' We can certainly state with confidence that representatives of enemy nations formerly made the most of such useful places in London as the Imperial Institute, and that they must have picked up a vast amount of valuable information, which was of the greatest value in competing in this and other markets.

"At a time when the members of the English-speaking nations must show a united front against the German menace, we feel sure British readers all the world over will read with interest and pleasure that there is a probability that the Canadian tanners and curriers will in future take more than a platonic interest in the Indian hide trade; as Sir Henry Ledgard pointed out in his memorable contribution on the subject, the resources of India in raw hides and skins are enormous, and readers who have not carefully studied his figures, published in our issue of March 14, are strongly advised to do so at the first opportunity. We are to-day up against hard, stern facts, and unless there is an enormous expansion in the tanning of Indian hides in Great Britain before the conclusion of the war, it is useless to assume we can take the greater part of the total output of Indian raw materials. It is true, however, that in India serious attention is being devoted to dealing with her own supplies, and already we hear of new tanneries being opened up and big extensions made to existing concerns. Even in chrome tanning we have for some years had ample proof that there is no difficulty in the process which cannot be surmounted on the spot; in fact, we have had many samples of both chrome sole and upper leathers sent us which are highly satisfactory goods. We admit some of the upper stock lacked the superior finish of, say, the best British or American glacé, or box calf, but we must remember that even in this country manufacturers have done, and still do, turn out some rather 'dud' stuff in the initial stages of chrome leather manufacture.

"From the above it is probable that in future Canada may enter the lists as a manufacturer and exporter of finished leather made from Indian hides, as her tanners will not be slow to make a bid for a supply of raw material which is inexhaustible, and cheap in comparison with many classes of home hides. We must also recognise the fact that Canada is well up to date in tanning and currying, and that in many cases she is as well equipped with big buildings and plant as is her neighbour the United States. In fact, there is a constant interchange of men and experience going on between the two countries which is valuable to both. It will be as well, then, to remember that the friendly competition of both countries will have to be reckoned with in the future, and this should spur our tanners on to every possible effort to prepare themselves for dealing with Indian raw stock. Prior to the war Canada was gradually forging ahead in her exports of leather to this country, as in 1913 the value of Canadian rough-tanned leather imported here was £295,457. Unfortunately Canadian imports of dressed leather were not scheduled separately, but are included in those from 'Other Countries'; still, we know that prior to the war Canada was sending here quite a fair quantity of first-class calf leathers, and that these were obtaining a high price. However, we wish our Canadian confrères the best of luck in whatever departure they may undertake; there is room for us all, but we want the competition to come from friends in future, and not from treacherous enemies."

The Imperial Institute and South Africa.—The following note has appeared in the official *South African Journal of Industries* for February 1918, in reprinting a memorandum descriptive of the work of the Imperial Institute and of the Committee for South Africa which advises in relation to that work:

"In giving publicity to the foregoing it should be pointed out that the Imperial Institute has for many years past rendered excellent service to South Africa. Apart from the samples of natural products forwarded by private individuals, the Department of Industries has made very extensive use of the Institute for analytical as well as commercial purposes. The files of the Department contain many valuable reports on mineral, vegetable, and other products which have from time to time been published, and which continue to serve as a useful reserve of information for current enquiries."

The Imperial Institute and the Mineral Resources of the Empire.—The following note was published in the *Bulletin of the Canadian Mining Institute* for February 1918:

"The Director of the Imperial Institute has requested that the attention of the members of the Canadian Mining Institute be called to, and their co-operation invited in connection with, an endeavour on the part of the Imperial Institute to extend the usefulness of its Mineral Department so that it will serve as a "central clearing-house of information respecting the mineral resources of the Empire, for which it is believed there is a great need especially in connection with the development of Imperial mineral resources, and in finding markets within the Empire for those minerals for which an outlet is needed. This, undoubtedly, is a worthy object. It is now evident, however, that work is going on along several different lines towards the establishment of something more or less corresponding to an Imperial Department of Mines. The War Board has recommended the creation of an entirely new body with this object in view, and the recommendation was received with some enthusiasm in this country. On behalf of the Imperial Institute it is advanced that it possesses all the necessary powers and machinery for the purpose, that it is already in relation with most of the bodies with which such a central mining authority would have to deal, that it is not a private institution, but in a sense a branch of Government, and that it possesses among its governing body and special committees a large number of mining and metallurgical engineers of the highest eminence. The feeling of most Canadians will probably be that it does not greatly matter where or by whom the central mining authority for the British Empire is provided, so long as it is provided in the near future. In the meantime the Imperial Institute has the advantage that it is already organised and 'on the job,' and its request to be supplied with all such information as will enable it to fulfil its functions as a clearing-house for mining information should meet with a sympathetic response. It is to be hoped that the Government and the mining men of Great Britain will see to it that no unnecessary duplication is permitted to occur."

The Imperial Institute and the Association of Chambers of Commerce.—The following reference occurs in the *Report of the Executive Council of the Association of Chambers of Commerce for* 1917–18 to the Raw Materials Committee of the Imperial Institute which includes representatives of the principal Chambers of Commerce:

"During the year three meetings of the Raw Materials Committee have been held at the Imperial Institute on the following dates: March 22, July 19, and December 12. At these meetings the Committee considered the following raw materials: Timbers from India, South Africa, etc.; Shellac from India; Corundum from South Africa; Bauxite from India, British Guiana and the Gold Coast; Manganese Ore from Canada; Cod Liver Oil from Newfoundland; Indian Cotton; Spent Wattle Bark; Sant Grains from the Sudan; Indian Opium; Dura from the Sudan; and others. The recommendations of the Committee concerning the above raw materials have been circulated to the Chambers. The Council are of the opinion that the work of this Committee is of great importance, and they direct the attention of manufacturers to the valuable help they can obtain from the Imperial Institute."

The Work of the Imperial Institute on Cotton.—The following notice of Dr. Goulding's book on Cotton and Other Fibres, one of the Imperial Institute Handbooks to the Commercial Resources of the Tropics, is reprinted from the *Asiatic Review* for April 1918:

"Some penny-wise folks, of the kind that has starved science and research in this country, would make of the Imperial Institute a mere card-indexing establishment, and one wonders whether they ever condescend to glance through the publications which vindicate the existence, and demonstrate the usefulness, of the Institute. Varied in their scope, ranging from mineralogy to zoology, embracing botany on the way in its purely academic form as well as in its applications, the papers found every quarter in the quarterly *Bulletin* are, every one of them, dignified protests of a practical character against the blindness of those who refuse to see their value to the agriculturists and industrial workers of the whole Empire. It would have proved an easy matter to collect and reprint in one volume the papers and notes on cotton and industrial fibres scattered through the quarterly *Bulletins*, but Dr. Goulding has followed the more commendable plan to present in a compact form a digest of the knowledge available, keeping strictly within the subject of *fibres* only and leaving the by-products of cotton out of the book. The treatment in eight chapters covers the classification and methods of examination of fibres; the morphology of the cotton plant; its cultivation, pests, preparation of the fibre, production of cotton, prices, etc., with statistics up to 1914. The only criticism one feels compelled to offer is that micro-photographs of the fibres, cotton and others, might have been more valuable than a mere reference to two standard books on the subject; surely blocks could have been easily found. And also one regrets the absence of a selected bibliography, for which there is ample material: the monograph by Dr. True, published in 1896 by the United States Government, is not even mentioned. This criticism applies equally to the other fibres; flax, hemp, ramie, jute, Manila hemp, banana fibre, sisal hemp, phormium, etc., dealt with in Chapters VI and VII. The last chapter (VIII) covers pineapple fibre, coir, piassava, and miscellaneous fibres, good photographs being given of the plants under review. The book contains a mass of information which should prove useful to all users of fibres, but we would urge the inclusion in later editions of some of the additional material alluded to above. Further details, particularly relating to the improvements in Indian and Australian cotton cultivation, appear in the quarterly *Bulletin* for 1917, in which we note also an important and comprehensive paper on rice, together with a number of articles of topical interest on oil seeds and minerals."

NOTES

Tobacco Beetle in Nyasaland.—Owing to the shortage of freight, a large part of the 1916 tobacco crop could not be exported from Nyasaland, and had to be stored at Chinde, in Portuguese East Africa, the port of shipment for Nyasaland produce. This difficulty, naturally, had not been foreseen, and efficient storage accommodation was not available for such large quantities of tobacco. The result of these abnormal conditions was that the tobacco became attacked by the tobacco beetle (*Lasioderma serricorne*), and it was feared that a large part of the crop would be destroyed. A Commission consisting of the Hon. T. M. Partridge, G. C. Duncan, E. W. Howard, and the late Mr. C. Mason, F.E.S., Government Entomologist, was appointed by the Nyasaland Chamber of Commerce in 1917, the object being to inspect the storage accommodation at Chinde and elsewhere, and to adopt any practicable measures to lessen or limit the damage. A copy of the report by Mr. Mason on the work done has been forwarded to the Imperial Institute by the Director of Agriculture, by direction of His Excellency the Governor, together with a report on experiments which were carried out by Mr. Mason with a view to ascertaining whether the paper used in packing the tobacco in casks and bales, is efficient in preventing the tobacco from being infected by the beetle.

The Commission first visited the railway sheds at Mikolongwe and Luchenza, where no sign of the tobacco beetle was found and a visit to Port Herald gave a like result. At Chindio, the southern terminus of the Shiré Highlands Railway and situated on the Zambezi river in Portuguese East Africa about 16 miles south of Port Herald, numbers of dead beetles were found, and though at the time it was not considered that the attack had been severe, from a later examination at Chinde it became evident that the attack had been serious. Although Chinde is probably not free from tobacco beetle at any time, it is practically certain that the present conditions there have been caused mainly through shipping badly infected tobacco from Chindio, and the position has been made worse through ignoring the advice given in a report by the Government Entomologist submitted in August 1916, that old and new tobacco should not be stored together. Some tobacco was already at Chinde ; infected tobacco was shipped from Chindio to Chinde, being followed by consignments of the 1917 crop, and the whole became infected.

Immediate steps were taken to devise means for eradicating the beetle at Chinde. The Commission decided that as the heating process was out of the question, fumigation with prussic acid should be tried. Owing to the cost of materials it was not found possible to erect a brick fumigating chamber—the best type for the purpose—and fumigation in barges or lighters was impossible since all were required for transport. A shed built of matchboarding, and made as air-tight as possible with red lead, tar and felt, was therefore used. The building used had a capacity of 4,200 cubic feet, and was capable of holding 25 casks and 200 bales of tobacco.

The first fumigation was carried out early in October, the material used for producing the prussic acid being sodium cyanide 10 oz., sulphuric acid 10 oz., and water 40 oz. These quantities were used for every 1,000 cubic feet of space, the fumigation being continued for 48 hours. This treatment did not destroy all beetles, and fumigations with the prussic acid liberated from a mixture of sodium cyanide 64 oz., sulphuric acid 80 oz., and water 128 fluid oz., per 1,000 cubic feet for 70 hours, was resorted to. After this no living beetles, larvæ or pupæ were found to a depth of 3 in., which is approximately the maximum in well-packed tobacco to which beetles had penetrated. It is doubted, however, whether eggs will be destroyed by this treatment.

The total quantity of tobacco to be fumigated at Chinde at the time amounted to 312 casks and 2,769 bales, or approximately 520 tons. The shed is estimated to hold 30 tons, so that some 14 fumigations in all were needed.

The method adopted in filling the fumigating shed was to place a layer of casks on light rails to keep them off the sand floor, so that the gas might reach all parts; the bales were stacked on the casks, but separated from each other and from the casks by wooden supports. The prussic acid was liberated after 8 p.m., and three days afterwards the shed was opened at approximately the same hour, and allowed to remain open all night in order that the poisonous fumes might escape. The shed was emptied the next day, and refilled the day after. The shed appeared to be entirely satisfactory, and no damage to the tobacco was caused by the treatment adopted.

Mr. Mason considered that the fumigation was effective temporarily, but a second shed for the storage of the fumigated tobacco which he had advised was not provided, and although the building containing the fumigated tobacco has been dusted with an insecticide, a certain amount of re-infection may occur, which will possibly necessitate a second fumigation if the tobacco is not shipped within two or three months of the first fumigation.

In the experiments with the special paper used in tobacco casks and bales, clean pipe tobacco and cigarettes (American and Egyptian) were enclosed in cartons made from the paper, all folds being carefully closed with sealing wax; in no case did beetles eat through the paper. Similarly, when infected tobacco and cigarettes were placed in the cartons, the beetles and larvæ bred normally, but did not escape. Mr. Mason came to the conclusion that if the paper remains intact, it is an efficient protection for tobacco against beetle attack from outside sources.

Agricultural Possibilities of the Lands adjoining the Eastern Railway, Nigeria.—In connection with the development of the Udi coal-field (cf. this BULLETIN, 1916, **14**, 369), a railway—the Eastern Railway—has recently been constructed connecting the coal-field with the coast at Port Harcourt. The *Trade Supplement to the Nigeria Gazette* of April 30, 1917, contains an extract of a Report by the Director of Agriculture on the results of a survey of the lands adjoining this railway, which was undertaken with the object of studying the agricultural possibilities of these districts. A summary of his observations is given below.

Section between Port Harcourt and Nbwasi.—To the south of Nbwasi, the country is flat and mostly covered with thick bush interspersed with forest trees, including the oil-palm, the Fai bean tree (*Pentaclethra macrophylla*) and the Dika nut tree (*Irvingia Barteri*). This region has a large population, in some areas numbering as many as 400 per square mile. The chief crop grown by the natives is yams, and as this causes rapid exhaustion of the soil, it is cultivated on newly cleared land for only a year or two, the land being then allowed to return to bush for from 5 to 7 years to recuperate. It is considered that maize and legumes, especially ground nuts, would do well in this region. The soil and climate are well adapted for cocoa, Para rubber, kola and coconuts, but little attention has been given to such permanent crops, except near Azumini, where several Bonny chiefs and traders have been encouraged to form plantations of cocoa, Para rubber and coffee. Unfortunately, however, the enthusiasm of these people leads them to plant greater areas than they can maintain in a good condition, and consequently the crops are liable to become infested with diseases and pests. The natives are disinclined to grow crops which do not give an immediate return, and they are therefore being urged to plant maize and ground nuts, which find a ready market at the stores that are being opened by traders at the various railway stations. A small model plot has been established at Afikpo, and a nursery was started at Aba in 1914 for the propagation and distribution of such plants as cocoa, kola and Para rubber.

Section between Nbwasi and Uzuakoli.—Beyond Nbwasi, the country becomes more undulating and is covered with low bush except in the valleys and along the water-courses, where belts of forest commonly occur. This region is less densely populated than the preceding section. The oil-palm is abundant, and large quantities of palm oil are now taken to the newly opened stores at Omoahia and Uzuakoli. In addition to the common yams, the natives cultivate the coco yam (*Colocasia esculenta*) and maize. Coconut palms are grown near most of the villages, but no attempt is made to cultivate any other permanent crop. The valleys are well suited for cocoa plantations.

Section between Uzuakoli and Udi Junction.—This section consists of grass-covered hills and valleys containing patches of bushes and trees. The population is small and the villages are situated in bush-covered areas where the oil-palm is abundant. The natives do not grow yams in such large quantities as in the other two sections, but more attention is given to legumes. The country is well suited for cotton growing and also for maize and ground nuts, and the moist valleys are adapted for the cultivation of cocoa, Para rubber and kola. Cotton is grown between Udi and Abakaliki, but the industry has suffered from lack of transport. In 1914, 22,700 lb. of seed-cotton were purchased at Ngbo, but on the outbreak of war buying was suspended. Cattle, sheep and goats are common and find abundant pasture on the extensive grassy areas of the country. The chiefs are being encouraged to grow maize and cotton, and selected maize and Georgia cotton seed have been distributed amongst them. Before the war an Assistant Superintendent of Agriculture devoted most of his time to giving itinerant instruction in the Owerri and Ogoju Provinces, but as this area is too great to be worked efficiently by one man, it is now recommended that each of these Provinces should be provided with an Assistant Superintendent, who should establish and maintain model plots and nurseries, give demonstrations to the natives, and raise plants for distribution.

Reference is made in the Report to the condition of the Agricultural Stations at Onitsha and Calabar. A visit was made to the African Association's Para rubber plantation at Ikotmbo, and it was found that great progress had been made and that about 40,000 trees were nearly ready for tapping.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Food-stuffs and Fodders

Dura, or Dari.—In 1915, attention was called by the Imperial Institute to the value of Sudan dura, or dari, as a food for poultry. In the *Utility Poultry Journal* (1917–18, **3**, No. 1, p. 21) an account is given of an experiment carried out at the Harper Adams Agricultural College during the summer of 1917 on the suitability of Sudan dari and dari meal for young chickens. The results have shown that a dry mash, composed of equal parts of dari meal and bran and 10 per cent. of powdered charcoal, is not suitable for newly hatched chickens, but that if gradually introduced into the rations after the chickens are about fourteen days old, they will thrive and do well on it. The dry mash may be given in conjunction with whole dari as a grain feed.

Meat.—Attention has been directed during the last few years to the possibility of developing an export trade in frozen and preserved meat in Colombia. This country has enormous areas suitable for breeding and fattening cattle, is comparatively free from serious cattle diseases, and is conveniently situated for the transport of meat to Europe and the United States. The growing scarcity of meat at the present time has induced the Government of Colombia to encourage the establishment of this important industry. It has been enacted that a subsidy of £10,000, extended over a period of ten years, shall be paid to the first person or company establishing a complete and modern slaughter house, with refrigerating installation, on the Atlantic Coast of the Republic, on condition that the plant shall have a capacity for not less than 50,000 head of cattle and 2,000 sheep or hogs per annum, and shall be operating regularly within two years of the granting of the subsidy. The plant must include modern appliances for the conversion of the by-products into manures, glue, etc. The concessionaire must advance a sum of not less than £150,000 to cattle breeders and graziers at an interest of not more than 9 per cent. per annum and for a period of not less than five years. The enactment also applies to the erection of a packing house on the Pacific Coast. Import duties will be remitted on all materials and plant introduced for the equipment of the packing houses, and exemption of the slaughter fee will be granted for twenty years on all cattle killed for the export trade, except that the packing houses shall pay 5*d.* for each head of cattle slaughtered during this period. The Government undertake to establish bacteriological laboratories for the purpose of studying cattle diseases, of determining preventive or curative treatment, and of preparing vaccines, serums and medicines for the maintenance of health and the improvement of the stock.

Sugar.—In the *Rep. Lands and Mines Dept., British Guiana,* 1916, it is stated that an area of 77,176 acres was devoted to cane cultivation and 14,828 acres under mixed cultivation of sugar with other crops (such as rice, coconuts, plantains, rubber, cocoa, coffee and limes). The area under sugar-cane was 1,432 acres greater than that of the previous year, and that under mixed cultivation 7,893 acres greater. The rise in the price of sugar due to the war invigorated the industry, and a much greater expansion would doubtless have taken place had it not been for the shortage of labour and the uncertainty as to prices after the war. It is estimated that even with the present labour supply the area now under sugar cultivation could yield 126,000 tons of sugar per annum, and that with an ample supply of labour an average annual output of 320,000 tons could be secured in districts where the sugar-cane is already grown. Moreover, there are about a million acres of virgin Crown land on the coast lands to the west of the Pomeroon River and along the lower reaches of the rivers in the North-western District which would probably be suitable for sugar cultivation. It is evident, therefore, that if the necessary labour were available, the industry would be capable of great extension.

According to the *Rep. Dept. Agric., Burma,* 1915–1916, sugar-cane growing in that Province is a very promising industry. The crop is now grown successfully in many places, no less than 16,000 acres being devoted to it. The industry appears to be capable of almost indefinite expansion, and it is considered that sugar-cane may be a suitable crop to replace rice in the intermediate tract between the wet and dry zones where non-irrigated rice is proving unreliable. There is a large demand for jaggery in Burma, and there is no danger at present of the supply exceeding the demand. At the same time, it has been thought desirable to consider the possibility of introducing a white sugar industry, and a careful examination is therefore being made of local conditions in comparison with those of Java, which would be the most important competitor. An account is given of experiments with sugar-cane at Hmawbi, and at the Pwinbyu Station in the Môn Canals Tract.

Tea.—An account of the cultivation of tea in Nyasaland is given in the *Ann. Rep. Dept. Agric., Nyasaland*, 1916–17. The exports amounted to 420,685 lb., of local value £14,022, as compared with 288,341 lb., of value £8,585, in the previous year. The tea realises about 1*s.* per lb. in the London market and compares favourably with similar grades from Java and Sumatra. The plantations are particularly free from diseases and pests. It is anticipated that the production will continue to increase and may be considerably augmented by new tea plantations established in the higher levels to the north-west of Lake Nyasa where the conditions are very promising.

Oils and Oil Seeds

Coconuts.—In Ceylon there are over 1,000,000 coconut trees, and planting has increased considerably in recent years (*Rep. Dept. Agric., Ceylon,* 1916). In most cases the plantations are being carefully cultivated and manured, many planters finding that good results are obtained by systematic ploughing and disc-harrowing. The crops were larger in 1916 owing to good rains in the previous year, but the exports of coconut products show a decrease owing to shipping difficulties.

A leaf-eating insect has attacked coconut palms in the East Africa Protectorate (*Rep. Dept. Agric., British East Africa*, 1915–16, p. 16), but there is so far no indication that the pest will prove serious. Beetles are very prevalent, and the height of the palms and the fact that the beetles attack other trees render them difficult to deal with. Traps (*cf.* this Bulletin, 1917, **15**, 276) have been tried, and, judging by the healthy appearance of the trees and the few dead grown trees seen since their adoption, they appear to be of real value. In native plantations little attention is yet paid to pests and close planting is frequent; the use of half-ripe nuts for planting and for the production of copra and the cutting of notches on the trunk to facilitate harvesting are also common. Tapping trees for palm wine appears to be on the increase, while trees are frequently destroyed by fires made for clearing the bush.

The area under coconuts in British Guiana in 1916 amounted to 20,100 acres, an increase of 2,000 acres as compared with 1915 (*Colonial Reports—Annual*, No. 937, *British Guiana Report for* 1916 [Cd. 8434–24, 1917] p. 9). Some of the crop is exported in the form of nuts, but 2,117 cwts. of copra and 18,000 gallons of oil were also exported; most of the nuts are used locally for oil production. Large areas suitable for coconuts are available and planting is being carried on actively; it is anticipated that under good cultivation the crop will increase largely in the near future.

Coconut-planting is expected to become the most important agricultural industry in Mindanao (Southern Philippines). Several extensive plantations have already been formed and others are projected. Two large oil-pressing mills are now in operation in the Philippines, but the bulk of the copra is exported. Before the war Marseilles was the chief market, but recently San Francisco and New York have assumed greater importance (*U.S. Commerce Reps.*, 1917, No. 254, p. 409).

Experiments at Laucala in the Fiji Islands on old coconut trees which had practically ceased to yield crops owing to the attacks of the small coconut-leaf moth (*Lavuana iridescens*), have led to the conclusion that this pest cannot at present be successfully controlled on a commercial scale, and the planting of coconuts in Laucala cannot, therefore, be recommended (*Legislative Council Paper*, No. 84, M. 8195–17, *Fiji*). Spraying with arsenate of lead liquor (30 ozs. per 25 gallons) was effective in the case of trees under 20 ft. in height, but this treatment is not applicable to tall trees without using powerful pumping machinery. Small crops of nuts were obtained from plots cultivated and manured in several different ways, but the results appear to indicate that it would not pay to apply chemical manures to the trees. Where a sufficient number of trees exist, the owners are recommended to keep weeds in check and to stir the soil occasionally. The crops of nuts so obtained would probably pay for the small amount of labour expanded.

Ground Nuts.—Experiments with this crop in 1916 in the Southern Provinces, Nigeria, gave better results than in the previous year (*Rep. Dept. Agric., S. Nigeria*, 1916, p. 7). Spacing experiments showed that a distance of 3 ft. × 20 in. gave a larger yield than 4 ft. × 2 ft. Taking the average of both methods of planting for the two years 1915 and 1916, each of the six varieties tried gave yields of over 1,000 lb. of nuts per acre, the highest average yield being 1,290 lb. from the Hausa variety. The best individual result was obtained with the Gambia variety, which in 1916 gave a yield of 1,464 lb. when planted 3 ft. × 20 in.

Oil Palm.—According to the *Bulletin Econ. Indo-Chine* (1917, **20**, 258) palm kernels from trees grown in Annam contained a normal amount of oil. The results of examination of oil from fresh and from fermented fruits clearly show the superiority of fresh fruit for the production of oil of good quality, thus confirming the results obtained in West Africa (*cf.* this BULLETIN, 1913, **11**, 212).

Miscellaneous.—According to Brill (*Philippine Journ. Sci.*, A. 1917, **12**, 43) the mature kernels of *Pangium edule* yield 21 per cent. of oil containing small quantities of an optically active constituent, probably chaulmoogric acid, and the dry seeds of *Hydnocarpus Alcalae*, C. de Candolle ("Dudu-dudu" seed) yield 65·5 per cent. of solid fat, containing a large proportion of chaulmoogric acid, so that both these oils could probably be used as substitutes for chaulmoogra oil in the treatment of leprosy.

RUBBER

Balata.—The bleeding of balata trees in British Guiana was actively carried on in 1916, in consequence of the high prices obtaining, and the record quantity of 1,450,702 lb. of balata was exported (*Colonial Reports—Annual*, No. 937. *British Guiana Rep. for* 1916 [Cd. 8434–24, 1917], p. 11).

Hevea.—The exports of rubber from Ceylon during 1916 amounted to 54,698,729 lb., an increase of 17·5 per cent. over 1915 (*Rep. Dept. Agric., Ceylon*, 1916). Some estates produce as much as 650 lb. per acre, but a yield of 400 lb. per acre is more general. Of the various tapping systems, single cuts on one-half or one-third of the trunk are now being favoured, though double cuts continue to be used in several districts. Thinning out is general, and in new planting the spacing of 20 to 25 ft. apart will probably give less favourable conditions for fungoid pests. Planters appear to be fully alive to the necessity for controlling diseases.

In Southern Nigeria trees on the experimental plantation of Hevea at Agege, which were planted in 1906, have been found to be too closely planted (*Rep. Dept. Agric. S. Nigeria*, 1916, p. 8). It was decided therefore to thin out the plantation, and alternate trees were tapped in 1916 before removal. The total yield from 1,132 trees tapped was 1,400 lb. of rubber, or nearly 1¼ lb. per tree. The cost of tapping and of curing the rubber, including the erection of a curing house, was about £100, and it was estimated that the revenue would amount to over £152; a Lagos firm offered 2*s.* 3*d.* per lb. for "biscuit" and 1*s.* 9*d.* per lb. for scrap rubber. Owing to imperfect removal of stumps before planting, root diseases became rampant in the plantation ; remedial measures, however, have proved efficient in eradicating *Hymenochaete noxia*, and though attacks from *Polyporus lignosus* (*Fomes semitostus*) occur constantly they are now under control. The trees at the Agricultural Station, Calabar, are also too closely planted and will have to be thinned out. The Agricultural Department has encouraged the planting of Hevea by natives in the Calabar and Owerri provinces, and many thousands of trees exist of which a number are now ready for tapping.

Nearly 5,000 acres of land in British Guiana have been planted with Hevea, but the demand for plants from the Department of Science and Agriculture in 1916 was small, and planting did not increase appreciably (*Colonial Reports—Annual*, No. 937, *British Guiana, Rep. for* 1916 [Cd. 8434–24, 1917], p. 8). It has been proved that Para rubber does well on suitable land in this colony, and initial tappings of five- and six-year old trees have given satisfactory yields, 15,586 lb. of rubber being exported in 1916.

According to Pareivas (*Le Caoutchouc et La Gutta-percha*, 1917, **14**, 9323) the prospects of Hevea cultivation in French and Dutch Guiana are good. Rubber cultivation was commenced in Dutch Guiana about twelve years ago, and trees planted at that time recently yielded an average of 3½ lb. of rubber. Cheap transport on the rivers is available, but many estates have been abandoned owing to labour difficulties caused by the abolition of slavery ; it is stated, however, that Javanese labourers are now available.

Early attempts to cultivate Hevea in Mindanao (Philippine Islands) did not give promising results, and in consequence a large American company transferred its activities to the Dutch East Indies (*U.S. Commerce Repts.*, 1917, No. 254, p. 408). A smaller enterprise on the island of Basilan, however, proved successful, and out of 72,000 trees, 22,000 are now being tapped, yielding about 180 lb. of rubber per day. A leading rubber expert is stated to be favourably impressed with the possibilities of rubber cultivation in the island, and interest is being taken in the matter by an American company.

The results of experiments on the bark-renewal of Hevea trees of known history tapped by different methods are given by Campbell in *Bulletin* No. 33, 1917, *Dept. Agric., Ceylon*. The following conclusions were arrived at: Trees tapped daily showed poor bark-renewal compared with those tapped only on alternate days or on every third day. Good renewal of bark was given by trees tapped (1) with two cuts on one quarter, (2) with one cut sloping upwards to the left on one half, and (3) with two V-shaped cuts on one half of the tree. In the first of these methods one quarter was tapped each year; in the other two methods, tapping was transferred to the other side of the tree every six months. For a first tapping the bark-renewal may be considered good if, within three years, the renewed bark attains a thickness equal to 85 per cent. of that of untapped bark, as the former seldom attains the thickness of the latter, a difference of 1 millimetre (0·04 in.) being usual. In trees tapped on quarters, renewal of bark took place most rapidly during the year following the cessation of tapping of that quarter. On some old trees which had been severely tapped, the renewed bark was only about 5 millimetres thick (0·20 in.), *i.e.*, about one-half as thick as the untapped bark.

The results of further extensive tapping experiments are recorded by Petch (*Bulletin* No. 34, 1917, *Dept. Agric., Ceylon*). Reference should be made to the original paper for details of these experiments, but it is of interest to note that no increase in the yield is to be expected from a "change-over" system, though Campbell's results show that this system favours bark-renewal.

Experiments by Barrowcliff (*Journ. Soc. Chem. Indust.*, 1918, **37**, 48) on the spontaneous coagulation of Hevea latex mostly on lines similar to those recorded by Campbell, substantiate the latter's statement that spontaneous coagulation is due to the action of an enzyme and not to bacterial activity as supposed by Eaton and Grantham.

Fibres

Flax.—In the *Textile Institute Journal* (1916, **7**, No. 3, p. 239) an account is given by Mr. F. K. Jackson, Director of the Flax Experiment Station at Selby (*cf.* this Bulletin, 1913, **11**, 531), of the objects and work of the Station. The work carried out since 1913 when the Experiment Station was established has involved the cultivation of nearly 450 acres spread over four crops. The results have shown that the growth of flax and the manufacture of the fibre present no real obstacle with the exception of the provision of labour for harvesting. Flax grown for fibre is not cut, but is pulled from the ground by hand. This is a troublesome operation requiring a large supply of skilled labour for only three or four weeks in the year. A good worker can only pull about a quarter of an acre per day, and if the flax is not pulled at the proper time the crop may suffer serious deterioration. During recent years, efforts have been made in Canada and the United States to devise machines for effecting the pulling operation, and Mr. Jackson therefore spent the months of August and September, 1916, in

America for the purpose of studying this question. Some of the machines were found to give efficient results in trials, and it is anticipated that the difficulty will soon be overcome.

Piassava.—It is stated in *Colonial Reports—Annual*, No. 936 [Cd. 8434–23], *Gambia, Report for* 1916 that the piassava palm is abundant along the river banks of one district of the Gambia for a distance of about thirty miles. The piassava industry has been in abeyance for several years, but in 1915 the cutting and preparation of the fibre was begun by a British firm. The work had not advanced sufficiently, however, by the end of 1916 to enable exports to be made.

Paper-making Materials.—A report by Dr. C. F. Juritz, Agricultural Research Chemist, Department of Mines and Industries, Union of South Africa, on the possibilities and prospects of a paper-making industry in South Africa is given in the *South African Journal of Industries* (1917, **1**, No. 3, 271). It is pointed out that in order to establish a successful paper-making industry there must be a market for the finished product, a sufficiency of suitable raw material, abundance of pure water, a supply of efficient fuel in proximity to the mill, and easy and cheap transport for the raw materials and chemicals to the mill and for the distribution of the paper to the markets. Enquiries which have been made have led to the conclusion that the only part of South Africa in which all these conditions are likely to be met with in the immediate future is the Province of Natal and in particular the vicinity of Maritzburg. With regard to the raw material, it is stated that in the Cape Province, South of Natal, there is an abundance of grasses, including Tambookie grass which was examined at the Imperial Institute and found to give a large yield of paper of good quality (*cf.* this BULLETIN, 1916, **14**, 163). To the north of Natal there is papyrus in Zululand and a further supply of Tambookie grass in Portuguese territory. The eastern coast belt possesses numerous rivers capable of affording an abundant supply of water and in some cases offering the advantage of waterfalls from which power could be obtained. It is not practicable to establish a paper-making industry at present owing to the difficulty of procuring machinery during the war, but meanwhile further technical investigation of the raw materials and the organisation of other resources is being pursued.

Appendix I. to Dr. Juritz's report, giving a historical account of the various suggestions which have been made from time to time and of the investigations carried out in connection with paper-making possibilities in South Africa, has been published in the same *Journal* (1917, **1**, No. 4, 340).

Cotton

Egypt.—In the *Agric. Journ. of Egypt* (1917, **7**, 12), a report is given by B. G. C. Bolland, B.A., Botanist to the Ministry of Agriculture, on the "Cotton Growing Statistics obtained by the Botanical Section in 1915 from Experiments with Respect to the Improvement of Existing Varieties." It is pointed out that prior to 1915 the work of cotton breeding had been carried out solely on Mendelian principles and that the results were not so satisfactory as might have been hoped, owing to the fact that sufficient consideration had not been given to the question as to whether it would be better to attempt the improvement of the existing types or to introduce new varieties. On submitting this question to Lancashire spinners, it was found that they were unanimously in favour of improving the existing varieties rather than of breeding new strains. The work in 1915 was therefore directed to improving the existing types by the method of field selection, which has proved so satisfactory in other cotton-growing countries. The report gives particulars relating to observations of (1) the rate of growth, flowering and bolling of the different varieties, (2) the vegetative characters of the plants, and (3) the characters of the lint and seed. The object of (1) was to study the life-history of the various types in different parts of the country and to determine whether it was possible to estimate the crop several weeks before it was ready to be picked, whilst (2) and (3) were directed to ascertaining the purity of the different varieties and to select the best plants from each locality for forming the basis of a pure seed supply for these localities. From the results of this work, which are illustrated by numerous diagrams and figures, the best plants of the Ashmouni, Assili, Nubari and Sakellaridis varieties were selected for sowing in 1916. The report indicates the composition of the various types of cotton grown in Egypt and shows that the different varieties have become very mixed.

The same *Journal* (page 202) contains a note by the Editor on the four new varieties of cotton, left by Dr. W. Lawrence Balls for investigation, in comparison with other cottons grown under the same conditions. It is pointed out that in Lower Egypt there is no need for the introduction of a new brown cotton, as Sakellaridis, which is now so extensively grown, is probably the best cotton ever produced in the country in respect of strength and suitability for the present market. Moreover, the Sakellaridis variety gives a large percentage of its crop in the first picking and thus yields more clean cotton than other varieties, the later cotton being invariably more attacked by the boll-worm. It is also stated that after prolonged trials, it has been decided, with the approval of the State Domains Administration, to discontinue the propagation on a large scale of three of the four new varieties produced by Dr. Balls. The one which is being retained (No. 111) gives the largest yield per acre and the largest ginning percentage; as, however, this variety is apparently the least appreciated in the market, it is not considered likely to survive another year. Spinners' reports on the four cottons are quoted, and it is pointed out that they express rather contradictory opinions as to the comparative value of these varieties.

In a letter contributed to the *Textile Mercury* (1918, **58**, 35), Mr. John W. McConnel deprecates the abandonment of Dr. Balls' varieties and the decision to return to the old method of field selection, and asks whether the Mendelian theory should be taken as the basis of cotton breeding or whether such a scientific system should be ignored. The so-called "new strains" are all derived from cottons of the Egyptian family, and it is claimed that these varieties were obtained pure by Dr. Balls, and that if kept pure they would supply continuously cotton of a regular and trustworthy character. Mr. McConnel also asserts that to speak of Sakellaridis cotton as meeting all the requirements in Egypt constitutes a grave danger to the industry as many other cottons are required by the trade, and he expresses the opinion that efforts should be made to produce these other varieties in Egypt. As an example, reference is made to the need for a new supply of fine-stapled cotton to replace the American Sea Island variety which is gradually being reduced by the spread of the boll-weevil, and it is suggested that Balls' No. 310 was so promising for this purpose as to deserve further investigation. Exception is taken to the Editor's statement that the spinners' reports are "rather contradictory," and the difficulties encountered in examining small samples of cotton are pointed out.

Nyasaland.—In the *Ann. Rep., Dept. Agric., Nyasaland*, 1916–17, it is stated that the exports of cotton from Nyasaland during that year amounted to about 3,462,400 lb., of value £127,131, as compared with 3,065,200 lb., of value £68,585, in the preceding year. These are the largest cotton exports, both in quantity and value, hitherto recorded for any one year. The cotton realised prices from 1½*d.* to 4*d.* per lb. in advance of "middling" American. The only cotton now grown in the Protectorate in commercial quantities is of the long-stapled Nyasaland Upland type. Considerable difficulty was experienced in shipping the cotton, and the increased charges for freight, insurance, etc., greatly reduced the extra profit arising from the unusually favourable prices. It is considered that owing to the large native population and the excellent rainfall Nyasaland is well adapted for the cotton-growing industry, and it is anticipated that when direct railway communication with the coast has been established, great expansion will take place. In spite of the large demands made on the natives for carriers and askari, a satisfactory native cotton crop was produced, amounting to 944 tons of seed-cotton or about 570,800 lb. of lint.

West Indies.—Reference has been made in this BULLETIN (1917, **15**, 454) to the internal boll disease of cotton which causes the staining of the lint in green unopened bolls and the subsequent decay of the boll contents. A full account of the disease has now been given by the Mycologist of the Imperial Department of Agriculture for the West Indies, in the *West Indian Bulletin* (1917, **16**, 203). This paper gives a résumé of the literature of the subject, a review of the investigations which have been carried out in the West Indies, and a discussion of the conclusions derived from the experimental evidence and of the incidence of the disease. The disease has been found in all the British West India Islands in which cotton is grown, and it has been proved that it invariably depends on the puncture of the bolls by insects, especially the cotton stainers (*Dysdercus* spp.) and the green bug (*Nezara viridula*), and the subsequent infection of the puncture by fungi or bacteria. It is regarded as highly probable that the fungoid organisms are carried by the insects themselves. Under ordinary conditions, the infection is chiefly due to fungoid organisms, but sometimes, especially in wet seasons, bacterial infection predominates. The incidence of the disease depends, in general, on the relation between the time of planting, the length of the growing period, and the time when infestation with cotton stainers occurs. The stainers enter the cotton fields from waste lands on which their wild food-plants exist, and proximity to such areas entails earlier and more severe attack. The chief plants on which the stainers breed freely are the silk-cotton tree (*Eriodendron anfractuosum*) and the mahoe (*Thespesia populnea*), whilst they also breed to some extent on various Malvaceous herbs and shrubs (cf. this BULLETIN, 1917, **15**, 453). It is not yet known in what manner the infecting organisms are carried over from one season to another.

Belgian Congo.—An account of the efforts which have been made to establish a cotton-growing industry in the

Belgian Congo is given in the *Bulletin Agricole du Congo Belge* (1917, **8**, 33). The earliest experiments did not give satisfactory results, but in 1912 it was decided to carry out more extensive trials with the assistance of an American expert acquainted with the special needs of African agriculture. The services of Mr. Fisher, who had had experience of cotton growing in the Gold Coast, were secured, and he first conducted trials at Kitibola in the Lower Congo. These experiments did not prove very successful owing to the irregularity of the rainfall, but it was found that certain varieties of cotton yielded crops of good quality in spite of the dryness of the climate. During the year 1914–15, trials were carried out at Nyangwe in the Upper Congo, and at the end of the season Mr. Fisher expressed the opinion that the soil and climate of Nyangwe were well adapted for cotton cultivation, but it still remained to be proved which varieties were the most suitable. In the following season, about 130 acres were planted at the Government Farm with American Upland varieties and cotton of excellent quality was produced. Efforts were made to encourage cotton growing among the natives, and a cotton market was established at the Nyangwe Farm. The cotton produced by the natives was regarded very favourably in Europe, and realised prices equal to those of "middling" American. The seed produced at the Farm was distributed to the natives, and the efforts to extend the industry are being continued.

ECONOMIC MINERALS

Asbestos.—In *Mineral Resources*, No. 4, 1917, *Geol. Surv., Tasmania*, W. H. Twelvetrees gives an account of the asbestos deposits at Anderson's Creek in northern Tasmania. The rocks of the district are partly pre-Cambrian and partly Lower Palæozoic and the asbestos occurs in a serpentinised intrusion of peridotite of supposed Devonian age. A description of mining properties is given, and from this it seems that the deposits are promising. Amphibole, as well as the chrysotile variety of asbestos, occurs in the Anderson's Creek deposits.

It is estimated that the bulk of the chrysotile fibre available would range from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in length. It is expected that the yield of fibre would be from 5 to 10 per cent. of the milled rock, which is comparable to the yield of such deposits elsewhere. Assuming that a 10 per cent. extraction could be obtained, it would seem possible to produce the fibre on the spot for something like £8 or

£10 per ton. For a lower percentage of extraction the costs would be correspondingly higher. These are compared with Canadian working costs ranging from £4 to £7 per ton for rock containing 5·7 per cent. of fibre. The prices now obtainable for asbestos are such as to encourage the prospector, and it is considered likely that the Anderson's Creek deposits may ultimately become the basis of a profitable industry.

An article by Dr. P. A. Wagner in the *South African Journal of Industries* (1917, **1**, 251) deals with the asbestos deposits of South Africa. The deposits referred to include those of chrysotile asbestos in various parts of Rhodesia, and Carolina District in the Transvaal; tremolite asbestos near Pomeroy in Zululand; crocidolite in Griqualand West; and "iron-amphibole asbestos" in the northern portion of the Lydenburg district, Transvaal.

The deposits in the Lydenburg District of the Transvaal, which have been opened up during the past two years, are described as being of exceptional promise. They occur as beds in ferruginous shales of the Pretoria series, at a slightly lower horizon than that on which the Griqualand West deposits are found. The deposits appear to be extensive; the output from them is already considerable, and according to Mr. Wagner the area gives every assurance of becoming one of importance in asbestos production.

The asbestos is found in long irregular lenses up to 12 in. in thickness. These overlap in such a manner as to form practically continuous layers extending over hundreds of yards. There are proved reserves of several hundreds of thousands of tons of fibre on the farms Penge and Streatham alone, and the total tonnage available within the limits hitherto prospected must be enormous.

The conditions of occurrence are favourable to cheap and large-scale mining operations, but the locality is unfavourably situated as regards transport facilities, being sixty-five miles from Lydenburg, the nearest point on the railway. When adequate transport facilities have been provided, there should be no difficulty in meeting any demand that may reasonably be expected to arise.

The clean fibre is packed into sacks of 200 lb. and transported to Lydenburg station by ox-wagons in loads of 4 tons, about eighty wagons being constantly employed on this work. Transport costs £2 10*s*. per ton. During September 1917, 530 tons of fibre were carted to Lydenburg.

Inferior discoloured fibre is delivered f.o.r. Lydenburg at £7 10*s*. per ton, and the best grade fibre has been valued as high as £50 per ton on the London market.

Coal.—In *Colonial Reports—Annual*, No. 946, *Nigeria* [Cd. 8434–33, 1918], the Governor-General reports that work was continued through the year 1916 at the Udi Colliery, and that the advent of the railway in May gave a considerable impetus to the output. At the end of the year the output had been increased to an average of about 185 tons a day; and up to the end of 1916, 24,500 tons of coal had been won.

The Government requirements of coal average about 60,000 tons a year at Lagos, and as the average output at the date of writing had reached 300 tons a day, there was a surplus available, and this has been offered for sale at Port Harcourt at 33*s*. per ton. Larger developments of the colliery are under consideration, and a new railway siding is being constructed at a cost of £15,000 to a new and more permanent adit, known as the Iva valley workings, which will be capable of turning out coal on a large commercial scale.

Copper Ore.—In *Bulletin* No. 6, 1917, *Geol. Surv., South Australia*, R. L. Jack gives an account of the geology of the Moonta and Wallaroo mining district, which is situated in the hundred of Wallaroo, county of Daly, on the eastern shore of Spencer's Gulf. These copper mines have contributed largely to the world's copper production. Mr. Jack gives a full and detailed account of the mines, and deals also with the geology of the ore deposits.

The Moonta lodes are of pegmatitic habit, and their origin is attributed to a granite intrusion of which an exposure near Arthurton is all that is visible, but which, judging from the metamorphic aureole surrounding it, must be of considerable dimensions. With one exception, development at Moonta has shown that mining could not be carried on profitably at depths of 1,200 to 1,500 ft.; and it is considered that, in a general sense, lateral exploration is likely to be more successful than vertical.

At the Wallaroo Mines the zone of strictly pegmatitic ore deposition, such as was characteristic of the Moonta Mines, has not yet been reached, and it is probable that the lodes will carry values to much greater depths than have yet been attained.

The copper deposits of the Moonta and Wallaroo mining district were discovered fifty-seven years ago, and the mines of this district are still the principal producers in South Australia. The value of the total output of copper from this district is estimated at £19,000,000, and exceeds that of the total mineral production of the rest of the state from the date of its foundation to the present day.

Felspar and Fireclay. — In *Rev. Min. Oper., South Australia*, No. 26, *for the half-year ended* June 30, 1917, R. L. Jack gives an account of felspar deposits in the hundred of Dudley, Kangaroo Island.

The felspar occurs in a pegmatite which extends over a length of more than a thousand feet and a width of over a hundred feet.

Quartz, mica and tourmaline occur associated with the felspar. The mica plates are from ½ in. to 5 in. across, but chiefly from 1 to 2 in. The tourmaline is mainly of the schorl variety, but some of gem quality has been obtained.

Felspar is the chief ingredient of the pegmatite, and clean pieces a cubic foot in size may be seen. It is not weathered into kaolin to any great extent, but breaks up readily into granular material.

The pegmatite would probably yield from one-third to one-half of separable felspar and china-stone by hand-picking. The residue would contain too much quartz, mica and schorl to be worth picking. Of the felspar obtainable probably about half could be got in blocks of 1 lb. or more in weight, the remainder being in pieces weighing less than 1 lb.

Adjoining the area where felspar has been worked there are deposits of fireclay. The fireclay is dirty-white in colour with iron-stained patches. Ferric oxide forms the greater portion of the fluxes present in the clay, and could be largely eliminated by careful mining. The fireclay has been quarried from a pit measuring a chain square to a depth of 16 ft. There is 7 ft. of overburden. At the time of Mr. Jack's visit the pit was full of water, but the bottom and sides are stated to consist of fireclay.

The following analyses show the percentage composition of the felspar, china-stone and fireclay available :

	Felspar.	China-stone.	Fireclay.
Silica	66·10	70·20	59·80
Alumina	20·28	18·90	25·71
Ferric oxide	0·84	1·02	2·82
Magnesia	nil	nil	nil
Lime	0·12	0·08	0·52
Soda	2·58	2·58	0·07
Potash	8·76	5·74	0·81
Water at 100° C.	0·20	0·04	1·55
Water over 100° C.	0·30	0·63	8·10

A fusibility test of the fireclay showed that it resisted fusion at 1450° C.

The property on which these deposits of felspar and fireclay occur is situated at an elevation of 500 to

600 ft. above the sea, and eleven miles distant by road from the jetty at Hog Bay, which is used by coasting vessels. The road is good, and there are no heavy grades against the load. In winter the two miles of road from the claims to the main road is apt to be soft, and would require attention. It should be possible to reach the beach at Antechamber Bay in 3½ miles, all down grade, but the road, though surveyed, is not made. From the beach at this point loads are taken by boats to the coasting vessels.

The felspar and clay were worked some years ago, and a company erected works at Hog Bay for the manufacture of firebrick and pottery. Firebricks and china were produced, but the competition of imported products and other causes led to the abandonment of the works and the plant was disposed of. At present small parcels of felspar and china-stone are shipped occasionally.

Graphite.—In *Rev. Min. Oper., South Australia,* No. 26, *for the half year ended June* 30, 1917, R. L. Jack gives an account of graphite occurrences on Eyre's Peninsula, where the mineral is found over a wide area. Many of the outcrops are large, but the percentage of recoverable flake is small and the quality is poor owing to iron oxide impurity.

One instance is mentioned of an occurrence at section 66, hundred of Koppio, where a graphitic lode traverses gneiss. The lode material is soft and decomposed. The outcrop can be traced as a ferruginous capping containing spangles of graphite for at least 10 chains between walls of quartz. The lode material consists of brownish-red decomposed rock and earth with veins of kaolin, and carries flake graphite of good appearance in variable amount. Samples yielded on concentration from 9 to 12 per cent. of flake graphite containing from 80 to 86 per cent. of carbon. Material of this quality coarser than 80-mesh is valued at about £20 per ton f.o.b. Port Lincoln.

As regards the possibility of exploiting these deposits of Eyre's Peninsula, Mr. Jack points out the importance of proving a sufficiently large tonnage of workable material, and ascertaining the best method of treatment, before mills are erected.

Tantalite.—According to the *Rep. Dept. Mines, Western Australia,* 1916, 47 tons of tantalite, valued at £9,375, were exported during the year. This was raised at Wodgina in the Pilbara Field, some years ago, but was held over until a favourable opportunity arose for marketing it.

Tin Ore.—In *Colonial Reports—Annual,* No. 946, *Nigeria* [Cd. 8434–33, 1918], the Governor-General reports an output of 8,186½ tons of tin ore in the Northern Provinces during the year 1916, as compared with 6,910 tons in 1915, 6,143 tons in 1914, 5,331 tons in 1913, and 2,885 tons in 1912. In addition to this output 35·23 tons of tin ore were produced in the Calabar Province (Southern Provinces), making a total of 8,222 tons for Nigeria during 1916.

Tungsten Ore.—According to the *Report on the Administration of the Mines Department and on the mining industries in the Federated Malay States for the year* 1916, the exports of tungsten ore in that year amounted to 515·4 long tons, compared with 291·7 tons in 1915 and 261 tons in 1914. Most of this was low-grade ore, and contained less than 65 per cent. of tungstic acid. The ore consisted partly of wolframite and partly of scheelite, and the different States contributed to the output during 1916 as follows:

	Wolframite. *Tons.*	Scheelite. *Tons.*
Perak	76·0	6·4
Selangor	234·3	197·9
Pahang	0·8	—
Totals	311·1	204·3

According to the *Annual Report of the British Agent, Trengganu, for the year* 1916, exports of tungsten ore to Singapore in that year amounted to 4,554 pikuls (271 tons), or nearly double the quantity exported in the preceding year. Of this amount 4,314 pikuls (257 tons) were produced by the Dungun wolfram mine, as compared with 2,621 pikuls (156 tons) in 1915.

NOTICES OF RECENT LITERATURE

Farming and Planting in British East Africa, a description of the leading agricultural centres and an account of agricultural conditions and prospects. Compiled and edited by T. J. O'Shea. Pp. xvi + 162, with maps and illustrations, Demy 8vo. (Nairobi, B.E.A.: Newland, Tarlton & Co., Ltd., 1917.) Price 4*s.* 6*d.*; post free, United Kingdom and abroad, 4*s.* 10*d.*

This book should prove of considerable value to prospective settlers in British East Africa, as it gives in a convenient form a concise account of each of those industries that are already established in the Protectorate and also of those which experiments have shown may in future become important. Hitherto such information has not been readily accessible, and the enquirer has had to seek for it in a variety of government publications and reports.

Within the area of British East Africa both climate and soil are extremely varied and have given rise to an equally varied agriculture. For example, the coast belt is almost tropical, and produces such crops as coconuts, rubber, cotton, rice, maize and sugar-cane, whilst in the Highland zone of the interior a temperate climate obtains, the chief crops produced being coffee, flax, maize, beans, wheat, barley, wattle bark, citrus fruits and sisal hemp. The compiler has included in the book articles dealing with each of the crops mentioned, and with others of less importance; and in most cases an estimate is furnished of the cost of producing the crop and of the probable return on the outlay involved.

Following the articles dealing with crops and industries are others descriptive of the principal agricultural districts and market centres as they exist at the present time and of their possibilities and attractions from a settler's point of view.

The articles are written by men with practical experience and a knowledge of local conditions, and although they are not exhaustive, they supply general information for which there is a considerable demand at the present time in view of the opportunities which the temperate zone of British East Africa offers to intending settlers from this country.

Culture et Industrie des Plantes Aromatiques et des Plantes Médicinales de Montagne. By R.-M. Gattefossé and L. Lamotte. 4th Edition. Pp. 188, Demy 8vo. (Paris: Editions Scientifiques Françaises, 1917.)

The greater part of this book is devoted to the subject of lavender, and gives an account of the plant and its varieties, its cultivation, the pests and diseases by which it is liable to be attacked, the harvesting of the flowers and their distillation, the composition of the essential oil, the methods of submitting it to chemical examination, and its utilisation. Particulars are given of the production of oil of lavender in France in all the principal centres of the industry. Other essential oil plants are dealt with, including thyme, sage, rosemary, hyssop, camomile, the lime tree and angelica. Reference is also made to the cultivation of medicinal plants in France, and a list is given of such herbs arranged according to the month in which they should be planted.

The book is well illustrated, and the fact that it has reached its fourth edition since its first appearance in 1912 indicates that its usefulness, especially to French lavender growers and distillers, has been fully appreciated.

The Staple Trades of the Empire. By various writers. Edited by Arthur Percival Newton, M.A., D.Lit., B.Sc., Lecturer on Colonial History in the University of London, University and King's Colleges. Pp. v + 184, Crown 8vo. (London, Toronto and Paris: J. M. Dent & Sons, Ltd., 1918.) Price 2*s.* 6*d.* net; post free, United Kingdom and abroad, 2*s.* 10*d.*

This book, issued in "The Imperial Studies Series," contains a number of lectures which were delivered at the London School of Economics and Political Science in the spring of 1917. After a short introduction by the editor, the lectures are printed in the following order: Oils and Fats in the British Empire, by Sir A. D. Steel-Maitland, Bart., M.P.; the Sugar Supply of the Empire, by C. Sandbach Parker, M.A., C.B.E.; the Cotton Resources of the British Empire, by Prof. John A. Todd, B.L.; Metals as the Base of Imperial Strength, by Octavius Charles Beale; the Wheat Supplies of the British Isles, by Hugh R. Rathbone, M.A.; and the Importance of Imperial Wool, by E. P. Hitchcock, M.A.

Each lecture gives an account of the past and present conditions governing the supply of the particular class of raw materials dealt with, and indicates the steps needed to secure the control of the products in the future for the benefit of the industries of the United Kingdom and of the Empire as a whole. Emphasis is laid on the importance of developing the Imperial resources to the utmost with a view to rendering the Empire as nearly self-supporting as possible, and on the necessity of adopting a post-war policy which will enable the Empire to recover from the dislocation of industry occasioned by the war, and from the neglect and indifference which characterised the pre-war period.

The article on the sugar supply contains an instructive diagram illustrating the comparative progress of sugar production, consumption and price in the British Empire, the United States and Germany, and the lecture on oils and fats is illustrated by a reproduction of a map, showing the production of oils and fats in the British Empire, which was prepared at the Imperial Institute at the request of the War Trade Advisory Committee.

A COURSE IN FOOD ANALYSIS. By Andrew L. Winton, Ph.D. Pp. ix + 252, with numerous illustrations, Demy 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, 1917). Price 7*s*. net; post free, United Kingdom and abroad, 7*s*. 6*d*.

This book is an introduction to the methods of food analysis intended for the use of chemical students, who propose to specialise in this subject, and also for the instruction of students of agriculture, household economics, etc., to whom a knowledge of the methods of food analysis is a secondary matter. To cater for the needs of two such divergent classes of students in one book is not easy, and the difficulty of selecting material to suit both is manifest throughout this book. Thus, from the point of view of a chemical student, valuable space is wasted in several instances on unnecessary details; *e.g.* on p. 16 an illustration is given of a common laboratory desiccator, on p. 23 corkborers are illustrated, and on pp. 22 and 57 almost identical illustrations of the same fat extraction apparatus are given. The graphic formulæ given at various places for complex organic substances cannot be of use to the second class of student.

On the whole, satisfactory discrimination has been shown in the selection of the more important methods for description, and the details given are sufficient to enable students of ordinary ability to carry out the work. In the case of methods of less importance, references to the original papers or to standard works are given. Many of the standard works on food analysis are mentioned, but a notable omission is Bolton and Revis's "Fatty Foods," a comparatively recent and useful work, which should be known to the author.

The author makes a good attempt to introduce the student to the microscopy of foods, but it would probably have been better to leave this branch of the subject alone in so small a volume or at least to have referred to a first-class work on the subject, of which several are available. The instruction to place a drop of water on a slide with the finger encourages not only a bad practice, but waste of time. The section is fairly free from errors, but it is surely a libel on American importers to say that cassia bark when ground is known to the housewife as cinnamon.

It should, however, be pointed out that the book is clearly intended to be used by students undergoing courses in educational institutions. Supplemented as it will be in such cases by oral instruction and the opportunity of consulting works of reference, the book should prove useful for the purpose in view.

BOOKS RECEIVED

SEASONING OF WOOD: A Treatise on the Natural and Artificial Processes employed in the Preparation of Lumber for Manufacture, with detailed Explanations of its Uses, Characteristics and Properties. By Joseph B. Wagner. Pp. xiii + 274, Med. 8vo. (New York: D. van Nostrand Company, 1917.) Price 16*s.* net; post free, United Kingdom 16*s.* 9*d.*, abroad 16*s.* 10*d.*

CELLULOSE: An Outline of the Chemistry of the Structural Elements of Plants, with Reference to their Natural History and Industrial Uses. By C. F. Cross, E. J. Bevan and C. Beadle. New Impression, with a Supplement. Pp. xviii + 348, Extra Crown 8vo. (London: Longmans, Green & Co., 1918.) Price 14*s.* net; post free, United Kingdom 14*s.* 6*d.*, abroad 14*s.* 8*d.*

MINERAL ENTERPRISE IN CHINA. By William F. Collins, A.R.S.M., M.I.M.M., F.R.G.S. Pp. xi + 308, Demy 8vo. (London: William Heinemann, 1918.) Price 21*s.* net; post free, United Kingdom and abroad 21*s.* 6*d.*

FRONTIERS: A Study in Political Geography. By C. B. Fawcett, B.Litt., M.Sc. Pp. 107, Crown 8vo. (Oxford: Clarendon Press, 1918.) Price 3*s.* net; post free, United Kingdom and abroad 3*s.* 3*d.*

AN ELEMENTARY MŌLE GRAMMAR, with a vocabulary of over 1,000 words. For the Use of Officials in the Northern Territories of the Gold Coast. Compiled by R. S. Rattray, M.B.E. Pp. 85, Globe 8vo. (Oxford: Clarendon Press, 1918.) Price 5*s.* net; post free, United Kingdom and abroad 5*s.* 3*d.*

THE GUIDE TO SOUTH AND EAST AFRICA, for the use of Tourists, Sportsmen, Invalids and Settlers. With Coloured Maps, Plans and Diagrams. Edited annually by A. Samler Brown, F.R.M.S., and G. Gordon Brown, F.R.G.S., for the Union-Castle Mail Steamship Company, Ltd. 1918 Edition. Pp. liii + 773, Crown 8vo. (London: Sampson Low, Marston & Co., Ltd., 1918.) Price 1*s.*; post free, United Kingdom 1*s.* 6*d.*, abroad 1*s.* 7*d.*

"SOUTH AFRICA" HANDBOOKS. No. 87—CONQUERED EAST AFRICA AND ITS RESOURCES, Third Series. No. 88—SOUTH AFRICAN EXPLORATION, Sixth Series. No. 89—CONQUERED EAST AFRICA AND ITS RESOURCES, Fourth and Concluding Series. No. 90—SOUTH AFRICAN EXPLORATION, Seventh Series. Reprinted from "South

Africa." Pp. 28, Roy. 16mo. (London: "South Africa" Offices.) Price 6*d.* each; post free, United Kingdom and abroad 6½*d.*

DIRECTORY OF PAPER MAKERS OF THE UNITED KINGDOM FOR 1918. 42nd Annual Publication. Pp. 248, Imper. 8vo. (London: Marchant Singer & Co.) Price 2*s.* net; post free, United Kingdom 2*s.* 6*d.*, abroad 2*s.* 8*d.*

THE YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1918. Pp. cx + 1,154, Demy 8vo. (London: Wireless Press, Ltd.). Price 6*s.* net; post free, United Kingdom 6*s.* 9*d.*, abroad 7*s.* 2*d.*

DOD'S PARLIAMENTARY COMPANION FOR 1918. Eighty-sixth Year. Pp. 512. Imper. 32mo. (London: Sir Isaac Pitman & Sons, Ltd., 1918.) Price 6*s.* net; post free, United Kingdom and abroad 6*s.* 3*d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

SOUTH AFRICAN GRASSES FOR PAPER-MAKING

Before the war the British Empire depended to a large extent on foreign countries for supplies of paper and the wood-pulp from which paper was largely made, the chief sources of supply of the latter being Scandinavia, though some was obtained from Newfoundland and Canada. It has long been realised that the tropical countries of the Empire possess in their coarse grasses abundant raw material for the manufacture of paper, and special attention has been given in India to the problem of utilising these grasses in this way. Interest in this subject has extended to other countries of the Empire since the war began, and the scarcity of tonnage has put serious difficulties in the way of importing either paper or pulp.

In South Africa a great deal of attention has been given to the subject recently, and as a result a number of grasses have been sent to the Imperial Institute from South Africa for trial as paper-materials. A selection of the reports on these grasses is now published.

Johnson Grass

A sample of Johnson Grass (*Sorghum halepense*) was received in May 1917. It consisted of reed-like stems of pale green to straw tint, measuring from 7 to 8 ft.

in length; the stems were about ⅜ in. in diameter at the base, tapering to about ⅛ in. at the top and bearing a flowering head. The stems were hollow but had solid nodes at intervals of about 1 ft., each node bearing a sheathing leaf of pale green or straw colour, often blotched with purple; the internodes were filled with soft white pith.

The grass was submitted to chemical examination with the following results:

	Per cent.	
Moisture	10·3	
Ash	7·4	Expressed on the dry grass.
Cellulose	52·5	

The ultimate fibres were from 0·5 to 1·7 mm. in length, mostly measuring from 0·7 to 1·1 mm.

The chopped grass was treated with caustic soda solution under conditions similar to those employed for the production of paper pulp on a large scale, with the following results:

Experiment.	Caustic soda used.		Conditions of boiling.		Soda consumption.	Yield of dry pulp expressed on the grass as received.
	Parts per 100 parts of solution.	Parts per 100 parts of grass.	Time.	Temperature.		
			Hours.		*Per cent.*	*Per cent.*
A	4	12	4	140° C.	10·5	50
B	4	16	4	140° C.	11·0	48
C	4	20	4	140° C.	12·0	45

The pulp obtained in each of the three experiments shrank very considerably on drying, and yielded a tough, semi-transparent, parchment-like paper, on account of the presence of a large amount of pith in the pulp. The pulp prepared in experiment A was dark-coloured and somewhat hard to beat, and could not be bleached even with more bleaching powder than could be used economically on a large scale. The use of a larger quantity of caustic soda for boiling (16 per cent.) yielded a pulp of better colour, which was easy to beat, but which only bleached to a dark cream colour even with an excessive quantity of bleaching powder.

The more drastic conditions of Experiment C did not appreciably improve the colour or bleaching properties of the pulp.

This grass gives a good yield of pulp, but is nevertheless not very promising as a paper-making material. The pulp contains a large amount of parenchyma derived from the pith, and this causes the paper to shrink greatly in drying, and renders it parchment-like. The pulp, moreover, does not bleach well.

It might be possible to utilise the grass for the manufacture of paper in South Africa, but if used by itself the pulp would probably be troublesome to work on account of the great shrinkage on drying, and as it does not bleach easily its principal use would probably be for the manufacture of wrapping-papers. The nature of the pulp might, however, render it valuable for the production of special kinds of parchment-like papers, either by itself or in admixture with other fibrous materials.

Thatching Grass (Dek Gras)

A sample of "thatching grass," or "Dek Gras," which was identified at Kew as *Andropogon Buchananii*, Stapf, was received in June 1917.

It consisted of tapering stems, varying from 4 ft. to 5 ft. 6 in. in length, but mostly about 4 ft. 6 in., and each bearing a flowering head. The stems were $\frac{1}{16}$ in. to $\frac{3}{16}$ in. in diameter at the base, and had nodes at intervals of 10 to 15 in. throughout their length, a sheathing leaf springing from each node. The internodes were filled with soft pith.

On examination the grass was found to contain:

	Per cent.	
Moisture	10·1	
Ash	6·3	Expressed on the dry grass.
Cellulose	53·8	

Length of ultimate fibres 1·0 to 4·0 mm.; mostly 1·5 to 2·5 mm.

The grass was submitted to treatment with varying quantities of caustic soda, under conditions similar to those used for the production of paper pulp on a large scale, with the following results:

Experiment.	Caustic soda used.		Conditions of boiling.		Soda consumption.	Yield of dry pulp expressed on the grass as received.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temperature.		
			Hours.		Per cent.	Per cent.
A	10	2·5	5½	140° C.	8·0	52
B	12	3·0	4½	140° C.	8·4	51
C	16	4·0	4½	140° C.	10·0	48
D	20	4·0	4½	140° C.	11·4	46

The pulps obtained in experiments A and B were of pale brown colour. The pulp from experiment A could not be bleached, whilst that obtained in experiment B bleached only to a cream colour. In both these experiments the nodes of the grass remained somewhat hard after the treatment, and caused a little difficulty in the beating process.

The more drastic treatment employed in experiments C and D yielded pulps of paler colour and better quality. No difficulty was experienced in beating these pulps, and they bleached easily to a pale cream colour (almost white) when treated with 10 to 15 per cent. of their dry weight of bleaching powder.

In all cases the pulps furnished an opaque paper of good strength and quality, which did not shrink appreciably on drying.

This grass appears to be a promising material for the manufacture of paper in South Africa, as it gives a satisfactory yield of long-fibred pulp of good quality, suitable in the unbleached state for the manufacture of strong brown paper, or after bleaching for the manufacture of fairly good cream-coloured or white paper.

The export of the grass from South Africa would scarcely be feasible, as it would probably only have about the same value as Algerian esparto, *i.e.* £3 to £3 10*s.* per ton in the United Kingdom in normal times. It may, however, be possible to convert the grass into "half-stuff" or paper in South Africa for export.

Tambookie Grasses

According to Dr. C. F. Juritz (*South African Journal of Industries*, 1918, **1,** 516) the term "tambookie" or "mbuki" includes a large number of grasses belonging to the related genera *Cymbopogon* and *Andropogon.* In 1914 a sample of "tambookie" grass, stated to be *Cymbopogon Nardus* var. *vallidus,* was forwarded to the Imperial Institute in order to ascertain its value for paper-making (see this BULLETIN, 1916, **14**, 163). In June 1917 two further samples of distinct grasses were received, both described as tambookie grass. These samples were numbered 3 and 4. It was stated that No. 3 grows plentifully in dry open situations round Pretoria, and that No. 4 is abundant in damp situations in the same area.

Specimens of the two grasses were submitted to Kew for identification, with the result that No. 3 was pronounced to be *Andropogon Dregeanus,* Nees, and No. 4 *Andropogon auctus,* Stapf.

The two grasses were very similar in general appearance, consisting of long tapering golden-yellow stems measuring up to $\frac{3}{16}$ in. in diameter at the base, with nodes at intervals of about 10 in., the internodes being filled with soft pith. Each node bore a sheathing leaf and each stem was terminated by a long flowering head, which in sample No. 3 was mostly reddish in colour and in No. 4 greenish.

The length of the grass in sample No. 3 was 4 to 6 ft., and 5 to 7 ft. in sample No. 4.

The samples were submitted to chemical examination with the following results:

	No. 3. *Per cent.*	No. 4. *Per cent.*	
Moisture	9·2	9·1	
Ash	4·5	7·1	Expressed on the dry grass.
Cellulose	47·4	53·5	
Percentage of silica (SiO_2) in the ash	54·0	63·8	

The length of the ultimate fibres in sample No. 3 was from 0·3 to 3·8 mm., and in sample No. 4 from 0·3 to 3·9 mm., being mostly from 1 to 2 mm. in both cases.

The samples were examined as paper-making materials by treatment with varying quantities of caustic soda under conditions similar to those used in the production of paper pulp on a large scale, and the results are shown in the following table:

Experiment.	Percentage of caustic soda used; expressed on the grass as received.[1]	Boiled at 140° C. for	Yield of dry pulp expressed on grass as received.		Parts of caustic soda consumed per 100 parts of grass.	
			No. 3.	No. 4.	No. 3.	No. 4.
		Hours.	*Per cent.*	*Per cent.*		
A	10	5	50	—	8·8	—
B	12	5	—	52	—	10
C	16	4	45 (approx.)	—	11·2	—
		5	—	50	—	10
D	20	4	40	—	15	—
		5	—	42	—	11·8

[1] *In all the experiments a 4 per cent. solution of caustic soda was used.*

Sample No. 4 (*Andropogon auctus*) therefore contained more cellulose and gave a higher yield of pulp than sample No. 3 (*A. Dregeanus*). Both samples, however, gave good yields of unbleached pulp, which produced tough, strong papers of good quality. The use of about 20 per cent. of caustic soda was necessary to produce a pulp capable of being bleached to a good white colour, though pulp bleaching to a fairly good colour was obtained with only 16 per cent. of caustic soda. The pulps produced in experiments A and B were of brown colour and could not be bleached.

In the preceding experiments the entire grass was used in the preparation of the pulp, and in practically all cases the pulp contained numerous small dark specks which detracted from the appearance of the paper. The following further experiments were therefore carried out with sample No. 3 in order to ascertain if possible the reason for the presence of these specks:

Experiment.	Material used.	Percentage of caustic soda used; expressed on grass as received.[1]	Conditions of boiling.		Yield of dry pulp expressed on the air-dry material.	Caustic soda consumed per 100 parts of material.
	No. 3.		Time.	Temperature.		
			Hours.		*Per cent.*	
E	Grass with flowering heads removed .	16	5	140° C.	49	12
F	Grass with flowering heads and sheathing leaves removed	16	5	140° C.	52	11·6
G	Entire grass, with nodes crushed . .	16	5	140° C.	46	12·2

[1] *In all the experiments a 4 per cent. solution of caustic soda was used.*

The pulps produced in these experiments still contained small specks, and it would therefore appear that the specks are not due either to the inclusion of the flowering heads or leaves or to the incomplete disintegration of the nodes, but that they are accounted for by the impossibility of avoiding or removing small imperfectly beaten masses of fibre during treatment in the experimental apparatus used in the laboratory. The specks could probably be obviated in the preparation of the pulp on a manufacturing scale.

It was found that the removal of the flowering heads from the grass gives an unbleached paper of rather superior colour and character to that prepared from the entire grass, whilst the removal of both flowering heads and leaves gives a pale unbleached pulp of very good quality, bleaching to a satisfactory colour. On a commercial scale the removal of the leaves and flowers from the grass could probably be effected by chopping up the grass and winnowing out the lighter leaves and flowers.

The present samples of Tambookie grass both yielded pulp of good quality, and good brown papers could be made from them by treatment with small amounts of caustic soda (10 per cent. or probably less on a large scale). The pulps obtained with larger proportions of caustic soda could be readily bleached and used for the manufacture of white paper of good quality.

Andropogon hirtiflorus

A sample of *Andropogon hirtiflorus* grass was received in June 1917. It consisted of dark straw-coloured stems measuring up to ⅛ in. in diameter and about 3 ft. in length. The stems had nodes at intervals of about 10 to 12 in., and bore flowering heads of a reddish colour. The internodes were filled with soft pith.

Specimens of the grass were submitted to Kew for identification, with the result that the plant was pronounced to be *A. kirtiflorus* var. *semiberbis*, Stapf.

The grass was submitted to chemical examinat on with the following results :

	Per cent.	
Moisture	8·7	
Ash [1]	3·8	Expressed on the dry grass.
Cellulose	55·8	

[1] *Containing* 39·1 *per cent. of silica* (SiO_2).

Length of ultimate fibres 0·4 to 1·2 mm., mostly 0·6 to 0·7 mm.

The grass was examined as a paper-making material by treatment with varying amounts of caustic soda under conditions similar to those used on a commercial scale for the manufacture of paper pulp, and the results are shown in the following table :

Experiment.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed by 100 parts of grass.	Yield of dry pulp expressed on the grass as received.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temperature.		
			Hours.			*Per cent.*
B	12	4	6	140° C.	9·4	54
C	16	4	4½	140° C.	9·6	54
D	20	4	4½	140° C.	12·8	50

These results show that the grass gives a good yield of pulp, but the ultimate fibres are short and the paper produced is somewhat inferior in strength to that yielded by the "Dek Gras" or the Tambookie grasses dealt with on pp. 129 and 130. The unbleached pulps are inferior in colour to those obtained from the latter grasses, but they can be bleached to a good colour.

There is no doubt that this *A. hirtiflorus* grass would be quite suitable for the manufacture of paper pulp on a commercial scale.

THE WASTE PULP FROM NEW ZEALAND HEMP

In the preparation of the fibre from the leaves of the New Zealand hemp plant (*Phormium tenax*), a large amount of waste pulp is produced, which hitherto has not been put to commercial use. In order to produce 1 ton of fibre, about 7 to 8 tons of leaves are necessary, and as the production of fibre in New Zealand alone amounts on the average to over 20,000 tons each year, it will be seen that if a use could be found for the waste material it would add considerably to the success of the industry. The importance of this subject is recognised by the New Zealand Government, who have offered a bonus for a process for utilising the pulp and other waste products.

New Zealand hemp is also grown, on a smaller scale, in St. Helena, and, with a view to finding some means of utilising the waste pulp, two samples from that island were forwarded recently to the Imperial Institute. They were as follows:

A. "Rotted pulp two months in heap, temperature 110° when taken out. Dried in the sun before putting into sack." Weight, 56 lb.

The material was a coarse, dark brown powder, containing some short fibre.

B. "Fresh pulp sun-dried before placing in sack." Weight, 46 lb.

This was similar to A, but was much lighter in colour.

The two pulps were investigated: (1) as possible paper-making materials, and (2) as manures and sources of potash.

(1) *Possible Use as Paper-making Material*

The samples were submitted to a preliminary chemical examination in order to ascertain whether the material was likely to be of any value for the manufacture of paper pulp, and the following results were obtained:

	A (Rotted). *Per cent.*	B (Sun-dried). *Per cent.*
Moisture, on drying at 100° C.	8·9	8·3
Cellulose in the dried pulp	37·4	31·8

The rotted pulp therefore contained more cellulose than the sun-dried pulp, probably owing to the removal of non-cellulose constituents in the rotting process, but the percentage in both samples was low. The cellulose moreover was of poor quality, consisting largely of short, thin-walled (parenchymatous) cells which are of no value for paper-making.

This Phormium pulp in the condition of the present samples would be of no commercial value as a paper-making material. The small amount of fibre present (from 2·5 to 3 per cent.) could no doubt be utilised for the manufacture of paper pulp if separated from the pithy matter by sifting; but it seems unlikely that the yield or the value of the product would be sufficient to cover the cost of production and transport. The product would have to compete with common waste materials such as old sacking, rope, etc., which are obtained in ordinary times at low prices.

On the whole, therefore, the possibility of utilising this Phormium waste as a paper-making material does not appear promising.

(2) *Use as Manure and Source of Potash*

The composition of the pulp was investigated in order to ascertain its manurial value and the possibility of utilising it as a source of potash salts. The results are given in the following table, in comparison with corresponding figures for stable manure:

		Sample A. (Rotted.)	Sample B. (Sun-dried.)	Fresh long straw stable manure.
		Per cent.	*Per cent.*	*Per cent.*
Moisture, on drying at 100° C.		8·9	8·3	66·17
Nitrogen		1·07 [1]	1·00 [1]	0·54 [1]
Ash (total)		18·5	11·1	—
Ash soluble in cold water		—	5·2	—
Potash	K_2O	3·93 [1]	2·93 [1]	0·67 [1]
Phosphoric acid	P_2O_5	0·40 [1]	0·34 [1]	0·32 [1]

[1] *Expressed on the dry materials, the percentages of these constituents are as follows:*

Nitrogen	N	1·17	1·09	1·61
Potash	K_2O	4·31	3·19	1·99
Phosphoric acid	P_2O_5	0·44	0·37	0·94

The ash contained:

Lime	CaO	—	9·35	—
Magnesia	MgO	—	5·27	—
Potash (total)	K_2O	21·24	26·40	—
Potash soluble in cold water	K_2O	—	21·74	—
Soda	Na_2O	6·26	7·98	—
Sulphuric acid	SO_3	—	1·36	—
Chlorine	Cl	—	6·81	—
Phosphoric acid	P_2O_5	—	2·93	—
Carbon dioxide	CO_2	—	10·70	—
Total matter soluble in cold water		—	46·80	—

The soluble matter in the ash contained:

Potash	K_2O	—	46·45	—
Soda	Na_2O	—	12·93	—
Sulphuric acid	SO_3	—	3·33	—
Chlorine	Cl	—	6·47	—
Carbon dioxide	CO_2	—	24·59	—

The results of the chemical examination show that the pulp would have a considerable manurial value on account of the nitrogen, potash and phosphoric acid it contains. The amounts of nitrogen and phosphoric acid do not differ much in the samples of rotted and sun-dried pulp, but the rotted material contains a larger percentage of potash. Comparing the pulp with fresh long-straw stable manure, it will be seen that for equal weights the sun-dried or rotted pulp, as represented by these samples, contains about twice as much nitrogen as the stable manure, about as much phosphoric acid, and from 5 to 6 times as much potash. If the pulp were used in a wet condition, the percentages of the manurial constituents would of course be correspondingly reduced.

In this connection it may be mentioned that experiments were conducted some years ago at various Government Experiment Farms in New Zealand, with a view to ascertaining the value of Phormium refuse as a manure for potatoes and mangels (*Journ. Agric., New Zealand*, 1910, **1**, 276; 1913, **6**, 16). In one set of trials, on a clay soil, potatoes were manured with the refuse at the rate of 20 tons and 30 tons per acre. In both cases the plants grew more quickly than when artificial manures alone were used. The plot manured at the rate of 20 tons per acre gave a crop of good quality, but not equal to that given by 2 cwts. of superphosphate, whilst the more heavily manured plot gave better results, being quite equal to the best of those treated with artificial manures. In a second trial with potatoes, on a sandy soil, a plot manured with Phormium waste at the rate of 20 tons per acre gave an increase of 2 tons 7 cwts. per acre over an unmanured plot, the increased yield obtained by manuring with 2 cwts. superphosphate, 2 cwts. basic slag, 1¼ cwts. dried blood, and 1 cwt. muriate of potash per acre, being 2 tons 10 cwts.; the best result in this series of trials, viz. an increased yield of 4 tons 1 cwt. per acre, was obtained by using 2 cwts. superphosphate, 1½ cwts. bone-dust, ¾ cwt. sulphate of ammonia, 1 cwt. muriate of potash and 1 cwt. ferrous sulphate per acre. In a single set of experiments with mangels, Phormium refuse alone, at the rate of 56 cwts. per acre, did not give favourable results, the yield being little better than on an unmanured plot, but in combination with superphosphate, at the rate of 2½ cwts. of the latter and 28 cwts. of the waste per acre, excellent results were obtained, this plot taking second place in a trial with 22 different mixtures of artificial manures.

Instead of using the pulp itself as a manure, it could be burnt and the ash applied to the soil. On the basis of the results given on p. 136, 1 ton of the sun-dried waste represented by sample B would yield on burning 248 lb. of total ash containing 65 lb. of potash (K_2O), and 54 lb. of the potash would be soluble in water. The ash would therefore form a valuable potash manure; but, as it also contains a fairly large percentage of soda in the form of sodium carbonate, care would have to be exercised in applying it to plants particularly sensitive to the action of the latter salt.

The analysis of the portion of the ash soluble in water shows that it compares favourably in composition with commercial "potashes," but the separation of the potassium carbonate from the mixed soluble salts is not an operation which can be carried out successfully on a small scale.

With reference to the burning of the pulp for the production of the ash, it was found in small-scale trials at the Imperial Institute that the sun-dried pulp burns slowly and holds fire well, so that it could probably be burnt successfully in heaps. It might, however, be possible to burn the sun-dried pulp in the furnaces at the fibre-extracting mills if the light powdery nature of the material does not create difficulties. Experiments at the Imperial Institute showed that the heating value of the sun-dried pulp is about 45 per cent. of that of good steam coal.

ERI SILK FROM THE EAST AFRICA PROTECTORATE

Eri silk is obtained from the cocoons of an Indian moth, *Attacus ricini*, the caterpillar of which is reared for the production of silk in Assam, and to a smaller extent in certain parts of Bengal and Northern India. This silk cannot be reeled like that of the mulberry silkworm, as the thread is not continuous, and it therefore has to be spun like ordinary silk waste. Eri silk takes dyes well, and when woven into cloth far surpasses cotton in durability. For a general account of the rearing of this and other wild or semi-wild silkworms, the preparation of the cocoons for spinning or reeling and the possibilities of introducing the insects into British Colonies, see this Bulletin (1915, **13**, 87).

In June, 1917, a sample of Eri silk which was stated to have been prepared by a native by boiling the cocoons in a solution of washing soda and then teasing out the silk with the fingers was received at the Imperial Institute from the East Africa Protectorate. It was desired to ascertain whether the silk would be marketable in this form or, if not, how it should be prepared.

The sample consisted of a tangled mass of clean, soft, degummed silk, varying in colour from cream to pale brown.

The material possessed the usual appearance, lustre and strength of Eri silk. The single fibres of the silk were of normal character when viewed under the microscope; the diameter varied from 0·0003 to 0·0012 in., being mostly about 0·0008 in.

The sample was submitted for suggestions and valuation to the Silk Production Committee of the Imperial Institute, who advised that this Eri silk should not be degummed in East Africa before shipment, but that the cocoons should be exported after being turned inside out to free them from dirt, etc. A machine for reversing the cocoons, and the method of using it, are described by Lefroy and Ghosh in their monograph on Eri silk in *Memoirs of the Agricultural Department of India* (*Entomological Series*), vol. iv., p. 78, and it was suggested that the use of this machine in East Africa should be considered. The reversed and cleaned cocoons should be packed in bales for shipment, the white and brown cocoons being packed separately.

The sample was stated to be of similar quality to consignments of Eri silk recently received from Assam, and was valued as follows in the United Kingdom (March 1918):

Degummed (in the condition of the sample) . .	4*s.*	per lb.
"Reversed" cocoons	3*s.* 6*d.*	,,
Ordinary pierced cocoons	3*s.*	,,

The Silk Committee suggested that it would be advantageous if a small consignment of these cocoons, "reversed," were forwarded to the Imperial Institute so that experimental trials can be made. It would then be possible to furnish a definite report on the quality and value of the silk.

MARINE ANIMAL OILS FROM THE ANTARCTIC

In 1915 and 1916 a large number of samples of sea-leopard oil, seal oil, and penguin oil prepared in Adelie Land during the Australasian Antarctic Expedition in 1912 and 1913 were forwarded to the Imperial Institute by Sir Douglas Mawson. The results of their examination are of considerable interest and are given in the following pages. Sir Douglas Mawson considers that there is an assured future for penguin, seal and whale industries in Antarctic regions, but that any plans for development will require careful consideration before action is taken. He is of opinion that to start such industries on proper lines will require several years of preliminary work. It will also be necessary to introduce some form of protection for the animals. It is evident, therefore, that no immediate action will be possible, but that the matter may be of some commercial importance in the future.

The oils received were as follows:

Sea-Leopard Oil.—Five samples of this oil were received.

AB. "*Crude Sea-Leopard Oil,*" stated to have been extracted from the blubber by digestion in boiling water.

This was a cloudy liquid oil, with a slight fishy odour.

The cloudiness was due to the presence of a small amount of dirt. After hot filtration, the oil was of pale straw tint and remained clear and bright on cooling.

D. "*Sea-Leopard Oil.*"—This oil was similar to the crude oil described above, but was less cloudy. After filtration, the oil was clear and of pale straw colour.

E. "*Sea-Leopard Oil.*"—This consisted of a clear yellow liquid oil, with a fishy odour. A small amount of dirt was present. After filtration the oil was clear and of pale straw tint. The oil was similar to sample AB and paler than sample D.

I. "*Best Quality (thinnest) Sea-Leopard Oil, bottled June* 1913. *Adelie Land.*"—This was a clear, pale straw-coloured oil, with a fishy odour. The oil was rather lighter in colour than any of the three preceding samples.

K. "*Good Quality (not the thinnest) Sea-Leopard Oil, bottled June* 1913. *Adelie Land.*"—This sample consisted of a clear, pale straw-coloured liquid oil, with a fishy odour, and very similar to samples E and I described above.

Seal Oil.—Seven samples of seal oil were received:

F. "*Weddell Seal Oil extracted by Heat.*"—This sample was contained in six bottles—seven bottles were received, but one had been broken in transit.

F 1. The oil in five of the bottles was a golden-yellow, clear, slightly fluorescent liquid oil, with a fishy odour.

F 2. The oil in the sixth bottle differed in appearance from that in the first five bottles (F 1), and was therefore examined separately. It was cloudy owing to the presence of stearin and a small amount of dirt.

H. "*Weddell Seal Oil, 2nds extracted by Heat.*"—This sample was contained in two bottles. The oil in the two bottles differed in appearance, and the contents of each bottle were therefore examined separately.

H 1. This was a golden-yellow, slightly fluorescent liquid oil with a fishy odour.

H 2. This sample was similar to H 1, but was evidently not identical in quality, as it contained a fair amount of pale brown stearin together with some dirt and water.

J. "*Weddell Seal Oil.*"—The contents of the bottle had apparently leaked during transit and the sample received weighed only 1½ oz. It was a bright-yellow, clear liquid oil, with a fishy odour.

L. "*Thinnest Seal Oil, June* 1912, *Adelie Land.*"—This was a bright-yellow, clear liquid oil, with a fairly strong fishy odour. It was presumed to represent Weddell seal oil, though labelled only "Seal oil."

G. (*Label illegible.*)—This was a golden-yellow fluorescent oil, similar to sample F 1 of "Weddell Seal oil extracted by Heat." It was not examined.

Penguin Oil (*Sample C*).—This was a brownish-yellow cloudy viscous oil, containing a considerable amount of stearin and having a fishy odour.

The samples were examined at the Imperial Institute, with the results given in the table on the opposite page.

All the oils appeared to have been carefully prepared, as they were fairly light in colour and free from any appreciable quantities of dirt or water. The acid values are satisfactorily low and show that the oils have remained in good condition.

The following table shows the maximum, minimum and average figures given by the various samples of sea-leopard and Weddell seal oil:

Oils.		Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	Saponification value.	Iodine value. *Per cent.*	Solidifying point of fatty acids.
Sea-leopard oil	Maximum .	0·925	195·1	127·5	11·9° C.
	Minimum .	0·924	193·7	119·7	3° C. to 4° C.
	Mean .	0·9245	194·4	123·8	—
Weddell seal oil	Maximum .	0·931	201·5	147·8	19·0° C.
	Minimum .	0·924	192·0	122·1	16° C. to 17° C.
	Mean .	0·9275	195·1	134·6	—

From the above figures it is evident that sea-leopard oil and Weddell seal oil are very similar in character. There are, in fact, greater variations between the constants of the different samples of sea-leopard oil or of Weddell seal oil than between the mean values for the two kinds of oil. The iodine value of the Weddell seal oil appears on the whole to be rather higher than that of the sea-leopard oil; and the solidifying point of the fatty acids of the Weddell seal oil is distinctly higher than that of the sea-leopard oil, indicating the presence of a larger amount of "stearin" in the former oil.

Sample.	Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	Acid value.	Saponification value.	Iodine value.	Insoluble fatty acids.	Unsaponifiable matter.	Volatile Acids.		Solidifying point of fatty acids.
							Soluble.	Insoluble.	
				Per cent.	*Per cent.*	*Per cent.*			
Sea-Leopard Oil AB "crude"[1]	0·924	0·8	194·8	119·7	94·6	0·5	0·65	1·05	11·9° C.
,, ,, ,, D	0·925	1·0	194·6	123·7	—	—	—	—	—
,, ,, ,, E	0·924	1·1	195·1	121·0	—	—	—	—	—
,, ,, ,, I, "Best quality (thinnest)"	0·925	0·5	193·7	127·5	—	—	—	—	3° to 4° C.
,, ,, ,, K, "Good quality (not the thinnest)"	0·924	0·3	195·0	127·1	—	—	—	—	—
Weddell Seal Oil F 1	0·926	0·8	195·1	133·1	94·3	0·9	0·60	0·90	19·0° C.
,, ,, ,, F 2	0·924	1·1	193·1	131·0	—	—	—	—	18·5° C.
,, ,, ,, H 1 "2nds"	0·927	1·1	192·0	144·3	—	—	—	—	16° to 17° C.
,, ,, ,, H 2, "2nds"	0·928	4·2	194·4	129·5	—	—	—	—	—
,, ,, ,, J	0·929	2·7	201·5	122·1	—	—	—	—	—
,, ,, ,, L, "thinnest"	0·931	1·6	194·6	147·8	—	—	—	—	—
Penguin oil C[2]	0·932	2·3	197·5	126·9	94·7	0·5	0·65	1·0	31·4° C.

[1] *Average sample from four tins after mixing contents.*
[2] *Average sample from two bottles after mixing contents.*

With reference to the sea-leopard oils a comparison of the figures for the "crude" oils and the "thin" oils from which stearin had been removed shows that the "best quality, thinnest" oil (sample I) had a rather higher iodine value than samples AB, D and E of this oil; the solidifying point of the fatty acids is also distinctly lower. The other sample of "thin" sea-leopard oil (sample K) was too small for detailed examination, but it was evidently very similar to sample I.

In the case of the seal oils, sample L, described as "thinnest seal oil" and presumably derived from the Weddell seal, was too small for detailed examination, but the high iodine value indicates that the sample differs from the "entire" oil in having had stearin removed.

Sample H 1 of Weddell seal oil, labelled "2nds extracted by heat," appeared to be a "thin" oil, and it obviously differed from the other oil (sample H 2) bearing the same label.

The sample F 2 of "Weddell seal oil extracted by heat" differed from the bulk of the oil bearing the same label (sample F 1), in that it contained stearin, but it did not show any appreciable variation from F 1 in composition. The presence of stearin in sample F 2 may be due to the bulk of the oil not having been thoroughly mixed before transference to the bottles, F 2 representing the lower layer of the original sample, which would, of course, contain any dirt and stearin present.

The reason for the comparatively high saponification value of sample J of Weddell seal oil is not clear, but it may be due to contamination with some other oil.

The penguin oil is quite different in appearance and character from either the sea-leopard oils or the Weddell seal oils, but its chemical constants only differ materially in the case of (1) the saponification value, which is a little higher, and (2) the solidifying point of the fatty acids, which is much higher in the penguin oil than in the other oils under report, probably owing to the presence of comparatively large quantities of "stearin."

Most of the oils were submitted for valuation to a large firm of importers of similar oils, who reported that a market could easily be found for oils represented by the samples. They stated that the commercial value of the sea-leopard oils might be based upon that of Newfoundland seal oil, and that the Weddell seal oils should meet the same commercial requirements as No. 1 Whale Oil, whilst the penguin oil might be offered in competition with No. 2 Crude Whale Oil. The firm stated that all the oils submitted to them were suitable for soap-making and yielded a considerable quantity of glycerine, whilst they could also be utilised for the production of fatty acids of considerable value. They further mentioned that, when filtered, the oils would be suitable for a variety of purposes, such as burning in colliery lamps, the tempering of steel, leather dressing, etc., whilst the stearin obtained on filtering would be suitable for soap-making or for "splitting," *i.e.* for the production of glycerine and fatty acids.

The recent and pre-war prices of whale and seal oils are shown in the following table:

	Pre-war price. *Per ton.*	Recent price. *Per ton.* (Dec. 1917
No. 1 Whale oil	£23–£24	£55–£56
No. 2 Whale oil	£21–£22	£53–£54
Newfoundland seal oil—water white	£50	£100

The samples of sea-leopard and seal oils are of good quality and mostly of good colour, and consignments of similar character would evidently be readily saleable for purposes to which commercial seal and whale oils are applied. It is probable that these oils would also be suitable for conversion into solid fats by "hydrogenation," and the products might then prove to be of value for edible purposes.

The penguin oil would be of lower value than commercial seal oil, owing to its darker colour and thicker consistence.

The "thin" oils obtained after separating the stearin from the crude products would be more valuable than the "entire" oils. The separated "stearin" should be saleable as "fish stearin" or "fish tallow" for soap-making and leather currying.

CINNAMON BARK FROM THE GOLD COAST

A SAMPLE of cinnamon bark from the Gold Coast, stated to have been grown and prepared at the Tarquah Agricultural Station, was forwarded to the Imperial Institute by the Director of Agriculture in October 1917.

It consisted of pieces of rolled bark, pale brown in colour, and about 12 in. in length and 1 in. in width. The larger sticks consisted of two pieces of bark rolled together.

The aroma of the material was not so delicate as that of Ceylon cinnamon bark.

A small scale distillation trial was made with the bark at the Imperial Institute in order to determine the yield of volatile oil, and the following results were obtained :

	Per cent.
"Heavy" oil which separated from the aqueous distillate .	1·18
"Light" oil extracted with ether from the aqueous distillate	0·30
	1·48

Ceylon cinnamon bark furnishes from 0·5 to 1·0 per cent. of oil, so that the yield from the present sample of bark from the Gold Coast is extremely good. The "heavy" oil possessed a very fragrant odour.

The "heavy" oil was submitted to chemical examination with the following results, which are shown in comparison with the constants recorded by Parry (*Chemistry of Essential Oils*) for English distilled cinnamon bark oil and with the standards required by the British Pharmacopœia (1914) :

	Present sample of "heavy" oil.	Figures recorded by Parry for English distilled oil.	Requirements of the British Pharmacopœia.
Specific gravity at $\frac{15° C.}{15° C.}$ . .	1·042	0·995 to 1·040	1·000 to 1·030
Refractive index . . .	1·603	1·570 to 1·585	1·565 to 1·580
Aldehydes . . *per cent.*	86 (approx.)	58 to 70	55 to 65
Solubility in 70 per cent. alcohol	Soluble in 2·4 vols.	Soluble in 3 vols.	Soluble in 3 to 4 vols.

The results of the examination of the "heavy" oil obtained from this sample of cinnamon bark from the Gold Coast indicate that the entire oil (including both the "heavy" and "light" fractions) which would be obtained on distilling on a large scale should contain at least 68 per cent. of aldehydes.

The bark was submitted for valuation to a firm of brokers in London, who stated that the sample consisted of rather stout quills of fair quality but of poor flavour, and valued it at about 1*s.* per lb. ex wharf London (January 1918).

Samples of the bark and of the "heavy" oil prepared at the Imperial Institute were also submitted to a firm of essential oil distillers, who evinced much interest in the products and expressed a desire to obtain a few cwts. of the bark for trial distillation on a commercial scale. The firm stated that the oil was exceedingly nice and valued it at 5*s.* per oz. in London, or possibly a little more, as the market for cinnamon bark oil is very good at the present time (February 1918).

The results of this preliminary investigation indicate that cinnamon bark from the Gold Coast gives a high yield of oil of good quality, and as it seemed desirable to have a distillation carried out on a larger scale in order to obtain definite figures of the yield of oil under commercial conditions, it was suggested to the Gold Coast authorities that it would be advantageous if a consignment of a few cwts. of the bark could be forwarded to the Imperial Institute for trial by the manufacturers referred to above.

BALSAM OF COPAIBA FROM COLOMBIA

Balsam of copaiba is a semi-liquid oleo-resin obtained from various South American leguminous trees belonging to the genus *Copaifera*, the principal species being *C. Lansdorffii*, Desf., of Brazil. The balsam is obtained by making incisions in the trunk; it is at first thin and colourless, but soon becomes thicker in consistency and yellow.

A sample of balsam obtained from *C. officinalis*, Linn., in Colombia was received for examination at the Imperial Institute in September 1917.

It consisted of a clear, rather viscous, brownish-yellow liquid, which possessed the characteristic odour of balsam of copaiba and a persistent acrid and slightly bitter taste.

The balsam was found to have the following constants, which are quoted in comparison with the range of figures recorded by various observers for varieties of South American copaiba balsam:

	Present sample.	Range of figures recorded for South American copaiba balsam.
Specific gravity at $\frac{15^\circ C.}{15^\circ C}$ . .	0·961	0·915 to 1·009
Acid value	79·8	25 to 98
Ester value	11·7	0 to 33
Yield of essential oil . *per cent.*	45·5	27 to 85

The essential oil from the present sample of the balsam had a specific gravity of 0·899 and an optical rotation of $-21·65^\circ$, these figures being well within the limits recorded for the oil from South American copaiba balsam.

The balsam and the volatile oil were further examined in order to determine whether they satisfied the requirements of the British Pharmacopœia of 1914, and the following results were obtained:

Requirements of the British Pharmacopœia.	Results of tests on the present sample from Colombia.
Balsam:	
(1) Entirely soluble in absolute alcohol.	(1) Entirely soluble.
(2) Soluble in 4 times its volume of petroleum spirit, the solution yielding only a slight filmy deposit on standing.	(2) Soluble except for a small precipitate which separated on standing.
(3) Forms a transparent solution with ⅓ of its own volume of "solution of ammonia."	(3) Entirely soluble, forming a transparent solution.
(4) Gurjun balsam test.	(4) Negative result.
Volatile Oil:	
(1) Refractive index at 25° C., 1·494 to 1·500.	(1) Refractive index was 1·497.
(2) Distils between 250° C. and 270° C.	(2) Distilled between 255° C. and 270° C.
(3) Gurjun balsam test.	(3) Negative result.
(4) Optical rotation of the first 10 per cent. of oil when distilled *in vacuo* must be lower than that of the original oil	(4) Not determined, owing to the insufficient quantity of oil available.

From the above results it will be seen that the present sample of copaiba balsam from Colombia satisfies the requirements of the British Pharmacopœia and would be suitable for medicinal use.

A sample of the balsam was forwarded to a firm of brokers, who stated that, owing to the scarcity of this product at the present time, its value should be about 4*s.* 6*d.* per lb., ex warehouse London.

TOBACCO FROM CEYLON

In a previous number of this Bulletin (1912, **10**, 187), an article was published on the tobacco industry of Ceylon, including an account of the results of examination at the Imperial Institute of samples of native-grown tobacco and of cigar tobacco produced in the course of experiments carried out by the Ceylon Agricultural Society at Maha Iluppallama. In 1914 a tobacco expert was appointed to the Department of Agriculture, and experiments have since been carried out at an Experiment Station at Jaffna.

In October 1915 twenty-six samples of tobacco from the first crop grown at Jaffna were received at the Imperial Institute for examination and commercial valuation, and two years later five further samples grown at the Experiment Station were received. The results of examination of these samples are given in the present article. It will be seen that although the report on the first set of samples was not particularly favourable, the later samples of White Burley tobacco were of much better quality and quite suitable for the English market. Altogether 10 acres have been planted with White Burley tobacco at Jaffna in the 1918 season, and at a meeting of the Committee of Agricultural Experiments, Ceylon, held on May 9, 1918, it was announced that a firm of merchants had offered to purchase the 3,000 lb. of tobacco available from the 1918 crop at 1*s.* 9*d.* to 1*s.* 10*d.* per lb., delivered in London.

Samples received in 1915

No. 1. "*White Burley Flyings.*"—This sample consisted of light brown, thin leaves from 18 to 19 in. long and from 8 to 12 in. wide.

No. 2. "*White Burley Trash.*"—These leaves were about 19 in. long and from 9 to 11 in. wide. They were of a light brown colour, and rather badly torn.

No. 3. "*White Burley Lugs.*"—These leaves were fairly uniform in size, being about 22 in. long and 10½ in. wide. They were of a light brown colour and were somewhat spotted and slightly torn.

No. 4. "*White Burley Bright Leaf.*"—These leaves were medium brown in colour and were of fairly uniform size, 24 in. long by 12 in. wide. A few of the leaves were badly spotted and torn.

No. 5. "*White Burley Red Leaf.*"—These leaves were of a dull brown colour, but darker on the upper surfaces. They were about 21 in. long by 10½ in. wide.

No. 6. "*Sumatra Wrapper Leaf. American Seed.*"—These leaves were of uniform size, about 20 in. long and 12 in. wide, and varied in colour from greenish-brown to dull brown. The leaves showed a few spots and were a good deal torn. Some of the leaves were fairly thin, but others were thicker than is desirable in good wrapper leaf.

No. 7. "*Connecticut Seed Leaf Wrapper.*"—The length of these leaves varied from 20 to 23 in., and their width from 9 to 10 in. They varied in colour, but were mostly dark brown and slightly greenish in places. Most of the leaves were discoloured and many slightly torn. The veins were prominent.

No. 8. "*Connecticut Havana Wrapper. American Seed.*"—These leaves were about 20 in. long and 9 to 12 in. wide; they varied in colour, but were chiefly dark brown. The midribs were large and coarse.

No. 9. "*Dumbara Wrapper Leaf. Native Seed.*"—The leaves were fairly uniform in size, being 20 to 23 in. long and 9 to 11 in. wide. Their colour varied from dull to reddish-brown with some green patches. On the whole the leaves were coarse and rough.

No. 10. "*Samsoun.*"—The leaves measured from 8 to 10 in. in length, and from 4 to 5½ in. in width. They were of irregular colour, varying from light yellowish-brown with green patches to orange-brown. The leaves were a good deal spotted and torn.

No. 11. "*Dark Export: Germine Pryor.*"—These leaves were about 28 in. long by 15 in. wide and were of a mottled dark brown colour.

No. 12. "*Dark Export: Blue Pryor.*"—The leaves were uniform in size, being 24 in. long and from 12 to 14 in.

wide. They varied in colour, but were mostly dark reddish-brown.

No. 13. "*Dark Export: Tinnevelle.*"—These leaves were uniformly about 25 in. long by 13 in. wide and were dark greenish-brown in colour.

No. 14. "*Dark Export: Improved Yellow Mammoth.*"—The leaves varied in colour, but were mostly dark brown; they were about 22 in. long and from 12 to 14 in. wide.

No. 15. "*Dark Export: Clardy.*"—The leaves were about 24 in. long and 15 in. wide, and were mostly dark greenish-brown in colour.

No. 16. "*Dark Export: Hester.*"—The leaves were about 22 in. long by 12 to 14 in. wide, mostly with a dull dark brown colour.

No. 17. "*Dark Export: Yellow Pryor.*"—These leaves varied in colour from dull to dark reddish-brown and were 22 in. long by 11 to 14 in. wide.

No. 18. "*Dark Export: McAdoo.*"—These leaves were uniformly dark brown in colour, and measured 23 in. long by 12 in. wide.

No. 19. "*Dark Export: Madole.*"—The leaves varied in colour, but were mostly dark brown and measured about 22 in. long by 10 to 11½ in. wide.

No. 20. "*Dark Export: Jaffna.*"—These leaves varied in colour from reddish-brown to dark brown, and were about 21 in. long by 9½ to 11 in. wide.

No. 21. "*Dark Export, partially flue-cured.*"—The leaves were about 19 in. long by 11 in. wide and varied in colour from brownish-yellow to dark brownish-orange.

No. 22. "*Zimmers Spanish Cigar-filler. American Seed.*"—The colour of these leaves varied from greenish- or yellowish-brown to reddish-brown. They were uniformly about 18 in. long by 7 to 10 in. wide.

No. 23. "*Texas Cuban Cigar-filler. American Seed.*"—These leaves varied in colour from medium brown to reddish-brown, and were about 17 in. long and from 10 to 12 in. wide.

No. 24. "*Indian Cigar-filler. Indian Seed.*"—The leaves varied in colour from orange-brown to dark reddish-brown and were about 21 in. long by 7 to 11 in. wide.

No. 25. "*Dumbara Cigar-filler. Native Seed.*"—

These leaves were from 15 to 17 in. long by about 8 in. wide, and were of irregular colour, varying from dull to dark brown, some having a reddish tint.

No. 26. "*Jaffna Cigar-filler. Native Seed.*"—These leaves varied in colour from a pale brown to medium brown and were about 17 in. long by 7 to 10 in. wide.

Of the twenty-six samples submitted, nine were selected for chemical examination, and the results of this work are summarised in the table on the opposite page.

The twenty-six samples of tobacco were submitted to two firms of manufacturers for valuation. The first firm reported that none of the samples are really suitable for the English market. They added that if the types marked as cigar-wrappers and fillers could be used at all in this country, they could only be employed as common cutting tobaccos. They stated that the flavour of all the tobaccos when smoked was pungent and unpleasant. The firm quoted the following opinions and valuations regarding the samples, pointing out, however, that it might prove impossible to sell the tobaccos even at these rates.

			Value per lb.
No.	1.	Too thin-bodied	3*d.*
,,	2.	Deficient in quality when smoked	3*d.*
,,	3	Fair colour; not much body	4*d.*
,,	4.	Fair tobacco in colour and length	4*d.*
,,	5.	Fairly useful in colour and length	4½*d.*
,,	6.	Poor	2½*d*
,,	7.	Very rough and coarse	2½*d.*
,,	8.	Rather rough	3*d.*
,,	9.	Unsuitable for cigars	4*d.*
,,	10.	No aroma, resembling that of Samsoun tobacco; too short for other use	nil
,,	11.	Long but very rough and coarse	3*d.*
,,	12.	Very rough and coarse	2½*d*
,,	13.	Very rough and coarse	3*d.*
,,	14.	Clean, but rough and coarse	3*d.*
,,	15.	Heavy-bodied, rough and coarse	3*d.*
,,	16.	Poor flavour, rough and coarse	2½*d.*
,,	17.	Rough and coarse	2½*d.*
,,	18.	Rough and coarse	3*d.*
,,	19.	Very coarse	2¾*d.*
,,	20.	Narrow, rough leaf	2¾*d.*
,,	21.	Poor and brittle	1½*d.*
,,	22.	Green, unripe and poor	2*d.*
,,	23.	Short and rough	2½*d.*
,,	24.	Very narrow sandy leaf	2½*d.*
,,	25.	Unsuitable for cigars	2*d.*
,,	26.	Unsuitable for cigars	2*d.*

ANALYSES OF CEYLON TOBACCOS

		Burley.	Sumatra.	Pryor.	Tinne-velle.	Zimmers, Spanish.	Texas, Cuban.	Indian.	Dumbara.	Jaffna.
		Sample No. 3.	Sample No. 6.	Sample No. 11.	Sample No. 13.	Sample No. 22.	Sample No. 23.	Sample No. 24.	Sample No. 25.	Sample No. 26.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture[1]		14·0	14·0	14·0	14·0	14·0	14·0	14·0	14·0	14·0
Nicotine		2·1	2·7	3·8	4·0	2·9	2·2	2·5	1·7	1·8
Nitrogen		1·9	2·5	3·1	3·2	2·6	2·2	2·2	2·7	1·9
Ash		24·6	18·3	17·3	15·5	18·9	19·4	21·2	17·2	21·7
The ash contained:										
Lime	CaO	33·4	33·6	28·8	27·1	34·8	30·6	27·7	34·3	30·2
Magnesia	MgO	5·5	8·1	6·1	5·1	6·4	6·4	3·3	7·6	6·6
Potash	K_2O	16·3	16·1	22·7	18·5	16·0	9·3	11·9	10·6	6·7
Soda	Na_2O	2·8	2·8	2·9	3·2	2·7	2·1	3·3	5·0	1·9
Sulphates, expressed as sulphuric acid	SO_3	2·7	3·0	3·2	3·1	2·8	1·7	2·1	3·9	2·1
Chlorides, expressed as chlorine	Cl	15·0	13·4	9·5	9·2	14·7	12·1	9·2	10·4	7·6
Carbonates, expressed as carbon dioxide	CO_2	11·3	10·7	18·1	12·6	12·8	6·6	8·1	11·3	8·6

[1] *All the samples were "conditioned" at the Imperial Institute before examination and the quantities of moisture recorded are those found in he "conditioned" tobaccos.*

The second firm stated that the tobaccos represented by these samples are not suitable for the British market, but suggested that they might find a market in small quantities for mixing at 4*d.* to 6*d.* per lb. They added that the White Burleys, samples Nos. 1 to 5, might, with careful cultivation, be made suitable for the British market.

The results of the analysis of the nine samples of tobacco which were examined in detail show great variation in the composition of the tobacco, although the samples were all grown in the same locality and were apparently all subjected to the same treatment, viz. air-curing. The amount of nicotine is not excessive, although in Nos. 11 and 13 it is rather high, especially when the high nitrogen in these two samples is also taken into account. These, however, are both described as "dark export chewing tobaccos," and in these types high nitrogen and nicotine are less objectionable features than in smoking tobaccos.

The amount of ash present in the tobaccos shows considerable variation, but the most noteworthy point, as regards the composition of the ash, is the variation in the amount of potash, which ranges from 6·7 in sample No. 26 to 22·7 in sample No. 11. The burning quality of tobacco is largely determined by the amount of potash, and in selecting varieties for further trial in Ceylon some attention should be given to this point.

The quantities of sulphates and chlorides in tobacco are also important, as these adversely affect the burning quality. The chlorides are present in excessive amount in all these tobaccos, indicating that the soil at the Jaffna Trial Ground contains considerable quantities of chlorides. Attention has been directed to this point in previous reports on Ceylon tobacco (see "The Tobacco Industry of Ceylon," this BULLETIN, 1912, **10**, 187). Most of the Ceylon tobaccos examined at the Imperial Institute have proved to contain excessive quantities of chlorides, and this is a serious difficulty in the way of producing smoking tobacco of first-class quality, particularly cigar tobacco. There is, however, one interesting exception to this, viz. the sample grown at Talwatte from Dumbara seed, and examined at the Imperial Institute previously. The percentage of chlorides in this sample was 0·61 as compared with amounts ranging between 7·6 and 15·0 per cent. contained by the nine samples which are dealt with above.

A number of the present tobaccos were cut for the Imperial Institute by a manufacturer and their burning quality tested in the form of cigarettes. When fine cut they burned fairly well, but in no case could the burning be described as good. Still it was not bad enough to prevent the use of these tobaccos on that ground alone, since for cutting purposes it would be possible to blend them with tobaccos such as those of Nyasaland, which show particularly good burning quality. In the case of the cigar tobaccos, however, poor burning quality is a more serious defect.

It would be unsafe from the data at present available to draw final conclusions from the analyses of these tobaccos, but the following suggestions may be tentatively put forward for consideration in arranging future trials:

(1) Judging from the general tendency to coarseness shown by all these tobaccos and the rather high nitrogen and nicotine figures shown by some, the soil in this trial ground is too rich in organic matter for tobacco cultivation; this condition has probably been produced by heavy manuring with organic manures. The soil is probably rather poor in the mineral constituents necessary for plants, especially potash, though it seems to be fairly rich in lime and magnesia.

(2) The use of manures containing chlorides and sulphates should be avoided.

(3) In any further manuring of the ground manures rich in potash, such as wood ashes, should be applied.

In considering these suggestions it should be pointed out that no information was supplied with the samples as to the composition of the soil, the manurial treatment, if any, adopted, or as to the previous cultural history of the trial ground. All these factors are of great importance, and the foregoing suggestions may need correction in the light of local knowledge on these points.

It will be observed that the opinions expressed by the two firms of manufacturers to whom these samples were submitted were not favourable to the tobaccos. The samples were small, and consequently it was not possible within a reasonable time to get a wider expression of opinion from manufacturers; but the two firms selected make a great variety of manufactured tobaccos and have both shown commendable enterprise in utilising British grown tobacco from new sources in recent years; so that it may safely be assumed that they do not take unduly conservative views of the requirements of the British market.

It must, however, be borne in mind that tobacco manufacturers in the United Kingdom have for the most part established well-known brands of manufactured tobaccos, the characteristics of which they must maintain. To enter the British tobacco market it is therefore necessary that new producers should endeavour to imitate as far as possible the raw tobaccos which come on this market. The principal demand in this country for the manufacture of "Virginian" cigarette and pipe tobaccos is for bright and semi-bright tobacco, and none of the tobaccos now reported on belong to either of these categories. There is undoubtedly a large market for so-called nondescript and dark tobaccos for cutting, but this can always be met by inferior tobacco, of which a certain amount must always be available in every tobacco-growing country.

Owing to the limited capacity of the fire-curing barn at Jaffna, most of the samples had to be air-cured, and this no doubt accounts to some extent for the absence of bright and semi-bright types from the present series of samples, and this defect may be remedied in the next season. The possibility should, however, not be lost sight of that the prevalence of dark coarse tobaccos in this series of samples may be due to unsuitability of soil, and this point should be settled as soon as possible by (1) a careful investigation of the improvement possible by means of flue-curing at Jaffna next season, and (2) trials in other parts of the island.

Special mention may perhaps be made of sample No. 10, which is stated to be grown from Turkish seed.

It is almost entirely devoid of the characteristic aroma of Turkish tobacco. Its defects may be due to the use of deteriorated seed.

Samples received in 1917

(1) "*Specially selected Trash Grade, White Burley.*"—This consisted of five hands, composed of light yellowish- or orange-brown leaves 17½ to 24 in. long and from 8 to 11 in. wide. The leaves were fairly thin, but of fair strength; they all showed some stains, and many of them were badly marked.

(2) "*Specially selected Lug Grade, White Burley.*"—This sample consisted of four hands, composed of light orange-brown leaves 21 to 27 in. long and 8½ to 14 in. wide. The leaves had fair body and strength, but were slightly thinner than those of sample No. 3 (Leaf Grade). All the leaves showed stains, and some of them were badly marked.

(3) "*Specially selected Leaf Grade, White Burley.*"—This consisted of four hands composed of leaves from 21½ to 29 in. long and 8½ to 14 in. wide and of light to medium reddish-brown colour. The leaves had good substance and fair strength, and were of rather finer texture than the leaves of the bulk sample (No. 4). Most of them showed stains.

(4) "*White Burley (Bulk Sample).*"—This sample consisted of a number of unlabelled hands, composed of leaves from 22 to 30 in. long and 9 to 14 in. wide, mostly of a medium reddish-brown colour; some of the leaves were similar to those of sample No 2 (Lug Grade). The leaves were of good substance and fair strength; most of them showed some stains.

(5) "*Turkish Cigarette, Imported Seed.*"—This consisted of a bundle of leaves varying from 6½ to 10½ in. in length and from 2½ to 5½ in. in width. The colour was mainly a medium warm brown, with many dark brown discolorations principally along the midrib, whilst several leaves were of yellow or orange tint and a few greenish-yellow. The leaves were of fine texture and fairly strong, but many had been badly attacked by tobacco grubs, and many also showed stains.

The "bulk" sample (No. 4) of White Burley leaf was submitted to chemical examination with the following results, compared with those obtained for a previous sample of "White Burley Lugs" from Ceylon (see p. 153).

	Present sample of "White Burley" grown at Jaffna (1917). *Per cent.*[1]	Previous sample of "White Burley Lugs" grown at Jaffna (1914–15). *Per cent.*[1]
Moisture	14·0	14·0
Nicotine	4·6	2·1
Nitrogen	3·4	1·9
Ash	19·0	24·6

[1] *Calculated to correspond to* 14 *per cent. of moisture.*

The ash was analysed with the following results:

		Present sample. *Per cent.*	Previous sample. *Per cent.*
Lime	CaO	34·7	33·4
Magnesia	MgO	7·0	5·5
Potash	K_2O	14·4	16·3
Soda	Na_2O	2·5	2·8
Sulphates, expressed as sulphuric acid	SO_3	3·5	2·7
Chlorides, expressed as chlorine	Cl	14·2	15·0
Carbonates, expressed as carbon dioxide	CO_2	15·8	11·3

The four samples of White Burley showed very fair burning properties for this type of tobacco, but there was an almost entire absence of pleasant flavour. A mixture of the Burley tobacco with three times its weight of Nyasaland "Gold Leaf" was found to burn satisfactorily.

The sample of Turkish leaf, although of poor colour, had a fairly good flavour and "Turkish" aroma, but it did not burn well and the smoke was somewhat pungent.

Owing to the inferior appearance of the Turkish tobacco it was not submitted for valuation, but the following reports on the four samples of White Burley tobacco were obtained from three firms of manufacturers and a firm of merchants.

(1) One firm of manufacturers stated that the colour and length of the leaves were both particularly good, although the stalk appeared to be rather heavy in proportion to the leaf, which would cause a heavy loss in stripping. They considered that the tobaccos would be useful for blending, and stated that at the present time there would be a good market for them, as this description of leaf is very scarce and much wanted. The value in

London of tobacco similar to these samples at the time they were examined (January 1918) was from 1*s.* to 1*s.* 4*d.* per lb., according to colour.

(2) Another firm of manufacturers reported that the colour of the tobacco was very good and the "body" a good average for Burley tobacco. They considered that the current American prices for tobacco represented by the samples would be as follows :

Trash Grade	7*d.* per lb.
Lug Grade	9*d.* ,,
Leaf Grade	10*d.* ,,
Bulk sample	1*s.* ,,

(3) The third firm of manufacturers were of opinion that the tobaccos would not be very suitable for use in the United Kingdom owing to the woody stalks and the lack of flavour. The firm could not assign a value to the samples under present conditions, but they stated that in normal times the tobaccos might be worth 3*d.* or 4*d.* per lb. for their purposes.

(4) The merchants reported that the tobaccos were well grown and handled, and quite suitable for the United Kingdom market. They valued them as follows :

Trash Grade	7*d.* per lb.
Lug Grade	9*d.* ,,
Leaf Grade	11*d.* ,,
Bulk sample	1*s.* ,,

The chemical examination of the tobaccos shows that they contain a high percentage of chlorides and are deficient in potash, which would adversely affect the burning properties. The amounts of nicotine and nitrogen in the present samples are also unduly high. The results indicate that the samples were grown in soil containing sufficient nitrogenous manure and an excess of chlorides, but deficient in potash. The effect of these soil conditions on the character of the tobacco produced has already been discussed on p. 154 of this report.

On the whole, however, the present samples of White Burley tobacco are of good appearance and of much better quality than those previously received from Ceylon, the leaves being larger and superior in substance and texture. The burning properties were fair.

SPECIAL ARTICLE

THE MAINTENANCE OF THE QUALITY OF EGYPTIAN COTTON

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Egyptian cotton holds its high position in the world's markets by reason of the combined qualities of fineness, strength and length, which its staple possesses in comparison with that of cotton from other parts of the world.

The climatic and cultural conditions found in Egypt afford the country unique advantages, as far as it is at present known, with respect to the production of the particular kinds of cotton possessing the above-mentioned valuable qualities.

Experiments have been conducted in India and Arizona in order to establish similar varieties there, but up to the present it has been found that Egyptian kinds grown in these new localities are less prolific and more susceptible to disease and rapid deterioration in quality than is the case in their country of origin.

Had this not been so, it is highly probable that the United States at least would have been able to put an Egyptian type of cotton on the market in competition with Egypt. In point of fact the efforts which have been made by the Department of Agriculture in the United States since 1900, in Arizona and California, to establish a pure type of Egyptian cotton there, have resulted in the isolation of three pure kinds of cotton, which, although bearing many of the characters of the cotton varieties of Egypt, are somewhat different from those grown there. The best of these three varieties is said to resemble Egyptian Nubari. The following figures showing the yields per acre obtained from the American-grown Egyptian cottons on carefully controlled farms unaffected by insect pests, give some idea of the cropping possibilities of these varieties :

	Area. Acres.	Yield per Acre. lb.
1912	480	388
1913	3,800	278
1914	12,000	255

Such yields, in view of the expensive labour system in operation in the United States, may not seem to Egyptian growers to promise great success for that country in competition with Egypt; but it is unlikely that the Department of Agriculture at Washington will be deterred from a continuance of its efforts in view of a temporary failure to attain an equality with Egyptian results. Moreover the final year's yield given above is over 50 lb. per acre in excess of the average for the whole of the cotton area in the United States, and in view of the greater value of the Egyptian type in comparison with American Upland, which constitutes the standard, and of which the majority of the country's crop is composed, the results may reasonably be regarded as hopeful in America.

The foregoing remarks are intended as a warning with respect to possible competition from the outside, and as introductory to the point to be made with regard to the necessity, on behalf of the cultivating as well as of the ginning class in Egypt, of combining to preserve the superior position which Egyptian cotton has hitherto maintained.

To any one who has watched the development of Egyptian cotton it is evident that the life of any variety of cotton in Egypt extends for a few years only. This life is determined by the length of time occupied in its becoming so impure that its characteristic advantages are no longer apparent. The loss of purity, which proceeds more rapidly, or is perhaps more readily conspicuous in some varieties than in others, causes a depreciation in value which has frequently rendered the position of the Egyptian cotton industry precarious. It is true that on every occasion when the danger has become imminent, the situation has been fortuitously saved by the introduction of a new variety showing improved qualities in comparison with the variety which has declined, and which it is destined to replace. These new varieties in their turn, for want of proper control, proceed to deteriorate in the same manner as soon as their cultivation becomes extensive. The reason for this deterioration of varieties is explained below, but it must be borne in mind that it is quite distinct from *degeneration of the*

Egyptian type, which is in fact non-existent, although frequently confused with varietal decline. As far as is known, in the case of every variety which has obtained commercial acknowledgment, the origin has been a single plant chosen for the different botanical characters exhibited in comparison with other plants in the field, and for the special advantages with regard to its lint and cultural features. Out of many plants selected in this way, the seeds of a few have been found to produce plants altogether true to the parent type, and these only have been permitted to become established. There appears to be the strongest evidence that most, if not all, of the commercially known varieties have such an origin, and that they are not splitting forms which it is impossible to retain long in a uniform condition. The phenomenon of discontinuity in variation which the behaviour of certain commercially established Egyptian varieties has exemplified, was noted by Bateson towards the end of the last century, and it was then suggested by him that such may have played an important part in the production of species. In 1901–3, Hugo de Vries, a Dutch botanist, emphasised Bateson's point of view, and gave the name of "mutations" to such variations. Mutation in plants may be defined then as a type of variation which manifests itself as a sudden appearance of a distinctly different individual, whose characters are identically reproduced in its descendants originating from self-pollination or pollination with individuals of the same parentage. Mutants are not spontaneous or chance forms, but are developed in accordance with some natural law which is as yet undetermined. It has been suggested that mutants result from the mating of two forms, each of which is of an extremely complex constitution; this is a common condition with regard to Egyptian cotton. The fusion of these two forms results in the suppression of some of the characters and the emphasis of others; these differences are then constantly inherited as long as the strain is inbred. Mr. Balls, in his work entitled *The Cotton Plant in Egypt*, 1912, p. 97, dismisses the theory of the origin of our varieties from mutants in the following manner: ". . . mutations in

Gossypium ought not to be mentioned until we know much more about natural crossing and heredity than we are likely to acquire for several years to come." Again, in a later work entitled *The Development of Raw Cotton*, 1915, on page 14, the same author remarks : " The proof of its occurrence demands most careful experimentation, and, as we mentioned formerly, it will be years before such proof can be obtained clearly in the particular case of the cotton plant, although it may well be still taking place." Mr. Balls, when in Egypt, paid particular attention to the establishment of pure strains of cotton according to the Mendelian principle of plant-breeding, but it has been found by experience that it is more satisfactory from the point of view of the cultivator, as well as of the spinner, to concentrate attention upon the retention of purity of the existing appreciated varieties, than to evolve new varieties which may not be suitable when ready. The purification of the existing varieties has been advocated by the author ever since he formed the Agricultural Department in Egypt, and, at the present time, a satisfactory and apparently pure-breeding nucleus has been obtained of each of the four most important commercial strains.

Although, as already shown, Mr. Balls refused to attach immediate importance to the theory of the mutative origin of Egyptian cotton, this may have been partly due to the fact that the acceptance of the same would have been opposed to the continuance of the Mendelian plant-breeding methods, on which he placed so much reliance. Scientific cotton breeders in the United States adopted the selection system for obtaining pure varieties of Egyptian cotton there in preference to attempting to evolve new cottons by artificial pollination, and, although they have experienced great difficulties, the enunciation of the mutative capability of Egyptian cotton must be credited to them.

In reviewing the work done in Arizona, previously referred to, with regard to the efforts to establish pure types of Egyptian cotton, Mr. T. H. Kearney shows that with respect to the four distinct varieties obtained there, it may be concluded that all were of mutational origin.

In his paper entitled "Mutation in Egyptian Cotton" (*Journ. Agric. Research*, 1914, **2**, 290), he states that the first "mutant" appeared in 1908 after about eight years of discouraging results from unproductive late-maturing descendants of the Mit Afifi which was imported from Egypt. In fact two "mutants" appeared in the progeny rows in the same year, but one was discarded by reason of its late maturity and excessive development of vegetative branches. Two other varieties, which are also believed to be of mutational origin, have since been developed in the same region.

Speaking of all the commercial Egyptian cotton varieties produced in Egypt itself, the same author says: "The conclusion that these varieties originated by mutation is supported by the following facts: (1) The derivation of each from a single plant discovered in a field of very different cotton; (2) the distinctness of their botanical characters, especially in the recently developed Nubari and Sakellaridis varieties; and (3) *their tendency to remain uniform, which is, however, finally nullified by the ample opportunities afforded in Egypt for cross-pollination with other types, and for the mixing of seeds at the gins.*" The last portion of this quotation, which has been italicised, is so very important that it deserves the most particular attention. To these causes alone is due the deterioration of the Egyptian commercial varieties. They are not unstable and degenerate splitting-forms which they have frequently been supposed to be, but are, or were, "mutants" breeding pure *inter se*, and might have been retained pure had precautions been taken to prevent cross-fertilisation with impure neighbours and mixing of seed in the ginneries.

The production of a commercial variety of Egyptian cotton is usually the work of some one interested entirely in the financial aspect of the case. A single plant exhibiting specially good qualities having been discovered in a field of cotton, the seed from the plant is carefully collected and sown in the next year in an isolated position. If the plants obtained from the seed breed true to type in the subsequent generations, arrangements are made with cultivators to grow the cotton for the owner, the latter undertaking to purchase the whole crop of seed-cotton, or the seed alone, at a favourable price. This is repeated each year until the seed is so increased in quantity that the operator cannot finance the control of it. He then sells at a high price the seed he has collected, and the planting of the variety gets out of control and at once begins to hybridise with other neighbouring cotton, and is mixed in the ginneries. The decline then starts, and proceeds with increasing rapidity.

Although purified strains of commercial kinds have been obtained by careful selection and inbreeding, and are represented by small quantities grown under Government control on specially appointed seed-farms, these in the present circumstances must become impure when they become widely diffused, owing to the fact that the Government at present has no power to dictate to the cultivator regarding the variety of cotton he shall sow on his land. When the cultivator realises the danger of not taking sufficient precautions with regard to the maintenance of purity of his seed, he may ask for the intervention of Government in the matter, and, by genuine co-operation, it should be easily possible to guarantee the life of any suitable variety of cotton for a prolonged period, if not permanently.

If the Government were asked to assume this authority, the particular areas in which each variety of cotton might be grown, as well as the group of ginneries in which the variety might be ginned, would have to be determined. All new varieties of cotton would necessarily be examined and approved by the Government before their producers were allowed to distribute them on a dangerous scale. If considered satisfactory and advantageous for commercial introduction, they would have a locality assigned for their cultivation. The control of the distribution of any particular variety of seed could be easily arranged, in view of the fact that the sole distributors of cotton-seed would be the Government and its specially appointed agents.

Let us now examine some examples in existence at the present time, where the lack of those necessary precautions, mentioned above, is militating against the retention of commercial cottons in a satisfactorily pure condition.

In Upper Egypt, practically all the cotton grown has for many years belonged to one type, *i.e.* Ashmouni. This variety is the oldest of our commercial cottons, having been first established in Lower Egypt more than fifty years ago. During the last two decades it has been confined almost entirely to Upper Egypt, and has retained its characters well, due to the fact that it has not been associated to any large extent with other kinds of cotton.

Recently some lots have shown more impurity than hitherto, owing to the fact that perhaps 3–5 per cent. of the cotton grown in its vicinity has, in the last few years, consisted of experimental plantings of Sakellaridis and some newly isolated kinds. The inducement to plant Sakellaridis has arisen owing to the very high prices which were recently obtainable for this kind, and this in spite of the fact that smaller yields were to be expected from it in Upper Egypt than from Ashmouni. The resultant cotton did not compare in quality with that of the same variety grown in Lower Egypt, but the temporary advantage with respect to price was sufficient to encourage some planters to grow it for more than one season. The result of this introduction, as well as of that of another light-linted cotton, the seed of which is now being extensively distributed despite the fact that by many it is not considered desirable as a substitute for Ashmouni, is that a mixture of foreign seed with that of Ashmouni occurs in the ginneries, and cross-fertilisation follows in the fields.

The Ministry of Agriculture has, with great pains, succeeded in isolating a purified type of Ashmouni which, on three farms aggregating 30 feddans (1 feddan = 1·038 acres) has yielded in the last year from 6½–9½ kantars per feddan (620–906 lb. of ginned cotton per acre). The lint from this type has been pronounced by experts in Alexandria to be of excellent quality.

If, however, when the time comes for this seed to be distributed upon an extensive scale, there co-exists in the same localities where it is to be planted a distinct variety of cotton, the result must be contamination. It may be necessary to mention here that the proximity of a finer quality of cotton, instead of, as might be imagined, improving the Ashmouni by crossing with it, could do nothing but harm, by the formation of undesirable and irregular hybrids. This, then, is the menace that awaits the laborious efforts of the Ministry to isolate a pure cotton. Of course the establishment of a purer strain may be forced on the country by the process which is at present being adopted of purifying the nucleus in each year's cultivation and eliminating the progressively contaminated strains when these get beyond control. But this is an endless work, and very easily dislocated by the accident of breaking the continuity of the original scheme. It may be contended that, after all, Ashmouni is an inferior cotton to those grown in Lower Egypt, and that any attempt therefore to establish another cotton in its place should not be regarded as a disadvantage. But it must be remembered that not only is Ashmouni particularly suited to Upper Egypt conditions, but that there is a special market for this cotton which Egypt at present holds, and that, if this were lost, spinners would have to substitute one from somewhere else, which might entail alterations in machinery. All mills cannot of course spin fine cotton, nor is fine cotton suitable for all fabrics. Once this market is lost, Egypt may never be able to recover her position of supremacy in it.

Although Ashmouni is specifically the cotton for Upper Egypt, it should in its turn be excluded from Lower Egypt, where a different kind of cotton is almost entirely grown; but, by an unfortunate circumstance, Ashmouni gives a larger crop than the ordinary Lower Egyptian kinds in certain localities in the vicinity of the desert. For this reason, the inhabitants of these localities prefer to grow it. They are encouraged in this by certain unscrupulous ginners in Lower Egypt, who eagerly buy this Ashmouni cotton for the express purpose of using it to adulterate the Nubari kinds. Not only is the cotton produced by the mixture of the two kinds extremely unsuitable from the spinner's point of view, but also, by reason of the difference in the staple, Ashmouni does not take dyes, especially black, in the same way as Nubari or other kinds: this detracts from the value of the yarn.

From the standpoint of seed-mixture, it is clear that no greater harm could be done to the standard of quality grown than that caused by ginning together two totally different kinds of cotton, in the manner adopted by the ginners who practise the fraud.

It was on account of the mixing of Ashmouni cotton from Upper Egypt with Lower Egyptian varieties becoming an extensive mal-practice in Damanhour and other places, that, at the instigation of the Alexandria General Produce Association, the Department of Agriculture, some years ago, procured the enactment of a law to compel growers of Ashmouni cotton in Upper Egypt to gin their crops to the south of a line which formed the northern boundary of the proper Ashmouni zone. At that time it was not considered likely that any cultivators in Lower Egypt would find it expedient to grow Ashmouni within the fine-cotton zone there, though it was recognised that, if this were done, there were ginners whose lack of foresight or interest with regard to the future of Egyptian cotton might lead them to encourage such an evasion of the object of the law, to enable them to carry on the adulteration without hindrance.

Ashmouni has been grown in Lower Egypt during the past year, and has been openly ginned with Nubari for a fraudulent purpose, and the resultant seed is doubtless available for sowing in the coming season with the worst possible prospects for the neighbouring cotton crops. Applications have recently been received by the Ministry of Agriculture from growers resident in parts of the Qualiubia Province for permission to buy Ashmouni seed from the Fayoum for planting in their fields.

These examples, if carefully considered by all who have the prosperity of Egyptian cotton at heart, will, it is hoped, lead the intelligent class of cultivators to call upon the Government to assume authority, in order to preserve their most remunerative industry from future injury. The matter is one which appears to demand energetic control, and it can scarcely be conceived that, if brought to public notice, it would be viewed with apathy by cultivators and ginners.

Summary

(1) Egypt has, so far as at present determined, unique advantages for the production of a special kind of cotton of high value. Attempts are being made in India and Arizona to emulate Egypt's success in this respect, and attention is drawn to the progress made in America, to be regarded as a warning of what may happen, if steps be not taken to maintain the purity of the existing Egyptian commercial varieties in this country.

(2) The period of life of an Egyptian commercial variety is not long, owing to the fact that the characteristic qualities, which constitute its value, are usually rapidly broken down by cross-fertilisation in the field and by careless mixture of seed in the ginneries.

(3) The origin of all Egyptian commercial varieties appears to have been a single plant in each case. These plants may be assumed to have been " mutant " strains, the nature of which, so long as they are each inbred, is to breed true to the parent type. The theory of the commercial varieties being ever-splitting hybrids is therefore apparently untenable. The assumption of the mutational origin of Egyptian commercial varieties is supported by what has been found to occur in experimental breeding from Egyptian seed in Arizona.

(4) The inducement for certain cultivators to select single and remarkable plants, in order to propagate new varieties, has arisen from a desire for money-making, but this advantage is only coincident with the retention of a monopoly of the seed. The impracticability of keeping this has resulted in the deterioration of the variety as soon as control was lost. The Government's attempts to fix and maintain the purity of existing types are faced with the same fate when the purified seed becomes widely distributed. The necessity of cultivators asking for the co-operation of Government in prolonging the life of pure commercial types, should be brought to public notice. The measures which the Government would have to enforce, if control were to be exercised in this matter, are stated.

(5) Examples are given of the introduction of locally

undesirable types of cotton into areas otherwise confined to the cultivation of one special kind ; and of the injurious irregularity introduced into the seed for sowing by the fraudulent admixture of two totally different varieties of cotton in the operation of ginning. A statement is made of the success which has attended the efforts of the Ministry of Agriculture in the isolation of a purified type of cotton, which has yielded from 6½–9½ kantars per feddan (620–906 lb. of ginned cotton per acre) in the last year, and of which samples have been pronounced by buying-experts in Alexandria to be of excellent quality. Attention is drawn to the fact that, in the process of the dissemination of the seed descendant from the purified type, it must, under present circumstances, become impure, necessitating the incessant selection each year of a new nucleus, in order to overcome the establishment of the inevitably deteriorated descendants. This difficulty would disappear if the majority of the cultivators, as well as the ginners, could be brought to understand the position thoroughly and combine in an appeal to the Government to assist them.

GENERAL ARTICLE

INDIAN HIDES AND SKINS

Hides and skins, raw and tanned, form one of the largest groups of exports from India. In the last year of normal trade, 1913–14, they figured in the returns of the seaborne trade of British India to the extent of 1,900,000 cwts. valued at £10,600,000, the only groups which exceeded them in value being textile materials and manufactures, cereals, and oil seeds. The chief constituents of this trade in hides and skins are cow-hides, the exports of which, raw and tanned, were valued in 1913–14 at nearly £5,000,000, goat-skins (over £3,000,000), and buffalo-hides (over £1,500,000). Cow-hides, buffalo-hides and goat-skins together accounted in 1913–14 for over 90 per cent. of the total both by weight and by value, the balance consisting principally of sheep-skins (£800,000) and calf-skins.

Most of the hides and skins exported from India before the war found a market in countries outside the

British Empire. In the year 1913–14, for which the returns are fairly typical of pre-war conditions in this branch of trade, the exports of hides and skins, raw and tanned, from India to British countries, formed 20 per cent. of the whole by weight, and were consigned principally to the United Kingdom (19 per cent.). The exports to the United States were 28 per cent., and to all Allied countries 38 per cent., while the exports to Germany were 21 per cent., and to all enemy countries 36 per cent. By value the position of the inter-Empire trade in Indian hides and skins was a little more favourable, the proportion exported to British countries being 27 per cent. of the whole (26 per cent. to the United Kingdom). This difference between the percentage distribution of the trade by weight and by value has an important significance. It is due to the fact that the exports to British countries comprised nearly all the tanned or dressed hides (98·5 per cent.), and the great bulk of the tanned or dressed skins (80 per cent.), but only a small portion of the raw hides (5 per cent.) and raw skins (9 per cent.). The major part (59 per cent.) of the raw hides were exported to enemy countries (Germany 35 per cent., Austria-Hungary 21 per cent.), while about three-fourths (76 per cent.) of the raw skins were exported to the United States. The tanned and dressed hides and skins are classed in the Indian trade returns as leather, and though this leather is not a finished product, the tanning being only partial, especially in the case of hides, a higher value naturally attaches to the manufactured or partially manufactured article than to the raw product. In 1913–14 tanned hides and skins formed by weight (304,621 cwts.) only 16 per cent. of the total exports of hides and skins from India, but by value (£2,817,166) they formed 27 per cent. of the total. To sum up, the United Kingdom before the war controlled the trade in tanned hides and skins from India, but had little share in the trade in raw hides and skins, which was much the more important of the two, both in quantity and in total value.

The trade with enemy countries before the war was mainly in raw Indian cow-hides (kips). These were by far the largest item in the exports of hides and skins from India. In 1913–14 the exports of raw kips amounted to nearly 750,000 cwts. valued at nearly £4,000,000, or nearly two-fifths, both by weight and by value, of the total exports of hides and skins, raw and tanned. Over two-thirds of these kips went to enemy countries, principally Germany and Austria-Hungary. The war has directed particular attention to this trade, and that not merely because of the difficulty of finding new buyers for the large quantities of kips suddenly shut off from their regular market. When converted into finished leather, kips are very suitable for use in making the uppers of stout boots, and they have been largely employed in Germany and Austria in the manufacture of army boots. At one time they were largely exported to the United Kingdom, but in the last two or three decades before the war the trade had passed into German hands. In India itself the merchant side of the business was controlled by German or quasi-German firms, who constituted a strong " ring." Ways and means of recapturing this trade, not only during the war but after the war, have been under careful consideration by an influential committee of the Imperial Institute, including representatives of British tanners and of Indian firms interested in the subject. A report was submitted by the Committee to the Secretary of State for India in March 1917. Important questions connected with the future development of other branches of the Indian trade in hides and skins have also been under consideration by this Committee.

The following article brings together statistical and other data relating to the subject in all its main branches. As a preliminary, an attempt is made to estimate the livestock resources of India, on which the supplies of hides and skins depend. The conditions and distribution of the trade are then discussed in detail, in relation both to the position existing before the war and developments during the war. One of the most notable features in this last connection is the development of the tanning industry in India. As already pointed out, in 1913–14 tanned hides and skins formed 16 per cent. of the total exports of hides and skins by weight, and 27 per cent. by value. In 1917–18 they formed 32 per cent. by weight and 45 per cent. by value. In view of the marked differences between the British and foreign purchases of tanned and raw hides and skins before the war, it is obvious that the development of the tanning industry in India may have an important bearing on the future course of the trade.

Livestock Resources of India

British India.—Statistics of the livestock in British India are based mainly on provincial censuses. In some provinces livestock censuses are taken annually, in others only once in five years, and then not in the same year in all cases, though efforts are being made to secure greater uniformity in this respect. Meanwhile such totals as are available combine the returns for different years, and obviously no useful comparisons can be drawn from year to year. In Bengal no livestock census was taken till 1912–13, and then it covered only cattle and buffaloes. The latest figures for British India are given in *Agricultural Statistics*, 1916–17 (Calcutta, 1918; No. 583). The following table summarises the livestock returns :

Province.	Bulls and Cows.	Buffalo Bulls and Cows.	Calves and Buffalo Calves.	Sheep.	Goats.	Horses, Mules, Donkeys, Camels.
Bengal (1912–13)	15,998,100	942,656	8,383,168	—	—	—
Madras (1914–15)	12,130,209	3,751,386	5,878,807	10,765,543	7,426,828	188,623
Bombay (1915–16)	5,158,708	1,304,761	2,742,641	1,699,196	2,338,478	211,971
Sind (1915–16) .	1,324,493	289,016	565,468	514,463	1,101,487	318,906
United Provinces (1914–15) .	17,467,254	4,670,486	9,603,089	2,794,605	9,881,611	845,617
Bihar and Orissa (1913–14) .	12,338,528	2,280,703	5,479,237	1,168,709	5,372,656	203,127
Punjab (1913–14)	8,258,150	3,189,683	4,041,250	4,676,899	4,431,837	1,472,015
Burma (1916–17)	3,801,142	856,597	1,641,292	38,777	198,303	110,686
Central Provinces (1916–17) .	5,884,995	1,119,072	2,719,650	268,752	980,974	140,193
Berar (1916–17)	1,375,788	265,887	528,890	137,128	369,545	48,437
Assam (1914–15)	2,142,476	347,320	1,086,380	11,650	509,742	15,004
N.W. Frontier Prov. (1913–14)	795,087	175,015	300,958	604,004	543,308	211,176
Ajmer-Merwara (1916–17) .	202,020	44,400	52,002	234,094	184,570	9,895
Delhi (1914–15) .	70,755	21,863	55,013	9,504	22,129	12,944
Coorg (1914–15)	81,200	19,677	33,147	110	3,929	291
Manipur (1916–17)	4,150	1,225	1,226	24	995	109
Total .	87,033,055	19,279,747	43,112,218	22,923,458	33,366,392	3,788,994

Of the total of 87,000,000 cattle shown in the preceding table, the greater part, 49,400,000 (57 per cent.), were bulls and bullocks, and 37,600,000 (43 per cent.) were cows. On the other hand, of the 19,300,000 buffaloes, only 5,600,000 (29 per cent.) were bulls, while 13,700,000 (71 per cent.) were cows.[1] The numbers of calves and buffalo calves are not given separately in *Agricultural Statistics of India.* If it may be assumed that they are in proportion to the numbers of full-grown cattle and buffaloes, then the total of 43,100,000 calves and buffalo calves would comprise about 35,300,000 calves and 7,800,000 buffalo calves. On this basis the total number of cattle in British India would be over 122,000,000 and of buffaloes over 27,000,000.

The chief cattle provinces are the United Provinces (20 per cent. of the full-grown animals), Bengal (18 per cent.), Bihar and Orissa (14 per cent.), Madras (14 per cent.), and the Punjab (9 per cent.), these five provinces containing three-fourths of the total. The chief buffalo provinces are the United Provinces (24 per cent.), Madras (19 per cent.), Punjab (17 per cent.), and Bihar and Orissa (12 per cent.), these four provinces containing nearly three-fourths of the whole. Bengal, which is the second largest cattle province, comes seventh in the list of provinces arranged according to numbers of buffaloes.

No figures are available as to the numbers of the smaller classes of livestock in Bengal. Among the other provinces of British India, Madras easily leads in respect of sheep, containing nearly half the recorded total. With those of Madras, the flocks of the Punjab and the United Provinces form nearly four-fifths of the total. In respect of goats, as of cattle and buffaloes, the United Provinces take first place with nearly one-third (30 per cent.) of the recorded total, while Madras, Bihar and Orissa, and the Punjab together account for more than half the total.

The 3,789,000 horses, mules, donkeys and camels consist mostly of horses and ponies (1,681,000) and donkeys (1,537,000). There are 500,000 camels, and 71,000 mules. Of the horses and ponies, well over half are found in the United Provinces (515,697), and the Punjab

[1] Buffalo bulls are apt to be dangerous, and Sir George Watt in his *Commercial Products of India* (Murray, 1908), notes on p. 736 that they are not often reared, but are either purposely starved or killed.

(427,515). In the same provinces are found nearly two-thirds of the donkeys, and nearly three-fourths of the mules. The Punjab alone has over three-fifths of the camels, most of the remainder being found in Sind and the N.W. Frontier Province.

Native States.—Livestock returns are made by eighteen Native States, with a total area of 165,000 sq. miles (about one-sixth of British India), and a population of 20,000,000 (about one-twelfth of that of British India). The number of livestock recorded in these States (22·7 millions) is about one-tenth of the number in British India (209·5 millions, exclusive of sheep, goats, etc., in Bengal). The following table gives the latest figures for the reporting States, as recorded in *Agricultural Statistics of India*, 1914–15, vol. ii.

State (1914–15).	Bulls and Cows.	Buffalo Bulls and Cows.	Calves and Buffalo Calves.	Sheep.	Goats.	Horses, Mules, Donkeys, Camels.
Mysore	3,213,212	564,240	1,238,368	2,738,199	1,762,036	79,778
Central India:						
Gwalior	1,777,816	394,756	1,124,101	202,948	533,165	101,558
Indore	622,370	139,465	233,010	42,142	167,615	25,814
Bhopal	446,161	114,348	9,131	14,634	18,899	22,149
Rajputana:						
Bikaner	199,243	26,821	90,048	664,590	104,840	38,954
Marwar	209,305	27,784	109,905	477,061	272,866	15,787
Jaipur	265,165	80,291	92,960	203,967	249,869	23,027
Alwar	283,800	85,726	161,573	253,704 [2] (Sheep and Goats)		22,590
Bharatpur	202,332	85,033	148,455	41,682	125,426	23,564
Tonk	170,405	35,173	66,710	35,019	46,299	9,818
Kotah	420,471	92,746	259,756	40,098	205,351	25,925
Others [1]	500,741	129,643	253,725	227,479 [3] (Sheep and Goats)		21,052
Total	8,311,021	1,776,026	3,787,742	8,427,889 [4] (Sheep and Goats)		410,016

[1] *Seven—namely, Rajgarh, Narsingarh, Barwani and Nagod in Central India; Kishangarh and Jhalawar in Rajputana; and Cochin.*

[2] *About* 200,000 *goats.* [3] *About* 144,000 *goats.*

[4] *About* 4,597,000 *sheep and* 3,831,000 *goats.*

The total in the last column is composed of 180,445 horses and ponies, over one-third of which are in Gwalior; 171,391 mules and donkeys, of which over one-third are in Mysore; and 58,180 camels, of which 35,000 are in Bikaner.

There is not much difference between the recorded numbers of bulls and bullocks (4,002,000) on the one hand and of cows (4,309,000) on the other; but the excess of buffalo cows (1,528,500) over buffalo bulls (247,500) is very marked, the proportion being six to one. If the numbers of calves and buffalo calves are in the same proportion as the numbers of the adult animals in their respective classes, the young stock would comprise about 3,121,000 calves and 667,000 buffalo calves. On this basis the total number of cattle in the reporting Native States would be 11,432,000 and the total number of buffaloes 2,443,000.

Estimated Totals.—The reporting Native States comprise 21 per cent. of the total area of the Native States in India, and 27·5 per cent. of the total population. If the remaining States carried livestock on the same scale in proportion to area, the number of cattle in the Native States as a whole would be in round figures 54,500,000, the number of buffaloes 11,500,000, the number of sheep 22,000,000, the number of goats 18,250,000, the number of horses and ponies 850,000, and the number of mules and donkeys 800,000. On this basis the total numbers of the livestock in India as a whole (exclusive of sheep, goats, etc., in Bengal) would be: cattle, 177,000,000; buffaloes, 39,000,000; sheep, 45,000,000; goats, 52,000,000; horses and ponies, 2,500,000; mules and donkeys, 2,400,000.

Obviously there is room for a considerable margin of error in these estimated totals. As the non-reporting Native States are more sparsely populated than the reporting States, it may be that the former do not carry all classes of livestock on the same scale, in relation to area, as the latter. Proportionately, cattle may be fewer and sheep and goats more numerous, owing to the larger areas for grazing by flocks. In any case it is probable that the returns supplied by the reporting States are incomplete. In the crop-reporting Native States, which are much more numerous than the States which furnish livestock returns, statistics are available for less than half the total area. It is not stated in *Agricultural Statistics of India* what, if any, is the degree of incompleteness in the livestock returns from reporting Native States. The omissions, however, may easily balance any over-estimation in the above totals. For example, an independent estimate of the number of sheep in India puts the total at between 50,000,000 and 55,000,000. If this be correct, the figure given above (45,000,000 outside of Bengal) is under rather than over the mark.

In the next table the calculated totals for India are shown, with the official returns for other leading countries. These official returns, like the official returns for India, are probably incomplete in some cases; but two things stand out clearly—that India has the largest number of livestock, and that British and Allied countries largely control the world's supply.

Country.	Millions of							
	Cattle.	Buffaloes.	Sheep.	Goats.	Horses.	Mules and Donkeys.	Pigs.	Total.
India	177·0	39·0	45·0	52·0	2·5	2·4	—	318
Australia (1916)	10·0	—	72·9	—	2·4	—	0·9	86
S. African Union (1911)	5·8	—	33·5 [1]	11·8 [1]	0·7	0·4	1·1	53
New Zealand (1917)	2·6	—	25·3	—	0·4	—	0·3	29
Canada (1917)	7·9	—	2·4	—	3·4	—	3·6	17
United Kingdom (1917)	12·3	—	27·8	—	1·9 [2]	—	3·0	45
United States (1918) [3]	66·8	—	48·9	—	21·6	4·8 [4]	71·4	213
Russian Empire (1914)	52·1	—	72·3	—	35·0	—	15·0	174
Brazil (1916)	29·0		7·2	6·9	6·1	3·2	17·3	70
Uruguay (1908)	8·2 [5]	—	26·3	—	0·6	—	0·2	35
France (1917) [6]	12·4	—	10·6	—	2·3	0·5	4·2	30
Italy (1914)	6·6		13·8		2·2		2·7	25
Argentina (1914)	25·9	—	43·2 [7]	4·3	8·3	0·8	2·9	85
Spain (1916)	3·1	—	16·0	3·2	0·5	1·8	2·8	27
Germany (1915)	20·3 [8]	—	5·1 [8]	3·4	3·3 [9]	—	17·3 [8]	49
Austria-Hungary [10]	17·8		12·4	3·1	4·3	0·7	14·9	53

[1] *At the end of* 1916 *the number of sheep in the Union of South Africa was returned as* 31,980,705 *and the number of goats as* 8,961,696.

[2] *Horses for agriculture, mares for breeding, and unbroken horses.*

[3] *Farm animals. In addition, at the census of* 1910, *animals not on farms numbered over* 7,000,000, *nearly half of them horses.*

[4] *Mules.*

[5] *In* 1916 *the number of cattle in Uruguay was returned as* 7,800,000.

[6] *Farm animals. Exclusive of invaded area.*

[7] *Census returns. At the previous census* (1908) *the number of sheep in Argentina was returned as* 67,384,000, *and at the end of* 1913 *an official estimate put the number at* 81,485,000.

[8] *In* 1917 *the number of cattle in Germany was returned as* 21,462,071, *of sheep as* 6,167,469, *and of swine as* 2,763,610.

[9] *Exclusive of army horses.*

[10] *Returns for years ranging from* 1910 *to* 1913 *for different parts of the Austro-Hungarian Empire.*

Numbers are not the only criterion of importance. The economic value of the livestock in India is limited by the small size of the animals, and the aversion of the

Hindus from taking life. The hides are not only light in weight, but are mostly taken from old and worn animals which have died a natural death. These and other fundamental considerations are opposed to the development of the livestock industry in India along the lines pursued by other countries. A certain amount of improvement in the stock is being effected by the efforts of the Veterinary Department, and, apart from this, it may be possible even under present conditions to remedy some of the worst defects in the preparation of the hides and skins for export. The subject is dealt with more fully in subsequent sections, under the heads of the several branches of the export trade. First, however, a brief survey may be taken of the import trade.

Imports of Hides and Skins into India

Though not commensurate with the exports, the imports of hides and skins into India amount to a considerable total. Including the imports across the land frontier, they attained in 1913–14 to a value of £635,000.

Sea-borne Trade.—Imports by sea provided less than one-third of the value of the total imports in 1913–14, (£203,556). The sea-borne trade had been increasing in value for some years before the war, and though there was a falling-off in 1914–15 (£144,859) and 1915–16 (£180,484), the pre-war value was exceeded both in 1916–17 (£246,281), and in 1917–18 (£254,273). In quantity the imports in the four war years were respectively 27,462 cwts., 32,692 cwts., 43,816 cwts. and 35,351 cwts. Prior to the war they amounted to between 30,000 cwts. and 40,000 cwts. annually, with a tendency to increase. In the five years 1909–10 to 1913–14, the average annual imports were 34,414 cwts. The value of these imports before the war was divided almost equally between raw hides and skins (£101,066 in 1913–14) and tanned hides and skins (£102,490 in 1913–14). It follows that the bulk of the trade by weight was in raw hides and skins; these provided imports to the amount of 32,906 cwts. in 1913–14, compared with imports of tanned hides and skins to the amount of 4,776 cwts., the total imports for the year being 37,682 cwts.

The greater part of the imports of raw hides and skins are drawn from countries in the British Empire (chiefly Aden, Ceylon, and the Straits Settlements), with Persia as the chief source of supply among foreign countries. The imports of tanned hides and skins are received almost exclusively from British countries, chiefly the United Kingdom. The great bulk of the raw imports, as regards both weight and value, consists of skins. The weight of the tanned imports is more evenly divided between hides and skins, though here again the skins predominate in value. In 1913–14 the figures were as follows :

Sea-borne Imports of Hides and Skins into India in 1913–14

Imports.	Quantity.			Value.
	British.	Foreign.	Total.	
	Cwts.	*Cwts.*	*Cwts.*	£
Raw hides	2,146	1,875	4,021	10,935
Raw skins	15,754	13,131	28,885	90,131
Total Raw . . .	17,900	15,006	32,906	101,066
Tanned hides	2,164	54	2,218	24,078
Tanned skins	2,256	302	2,558	78,412
Total Tanned . . .	4,420	356	4,776	102,490
Total Raw and Tanned .	22,320	15,362	37,682	203,556

There were no re-exports of raw hides and skins in 1913–14, and the re-exports of tanned hides and skins amounted to only 8 cwts.

Transfrontier Trade.—In the Indian transfrontier trade in hides and skins the relation between imports and exports is the reverse of that which obtains in the sea-borne trade. By sea, the imports are only a small fraction (less than 2 per cent.) of the exports, whereas by land the exports are a small fraction of the imports. As previously stated, the exports by sea, with a pre-war value of over £10,000,000 sterling, are the outstanding factor in the total trade in hides and skins ; but imports by land in 1913–14 formed a substantial item, valued at £431,980. At some of the Customs stations along the frontier quantities are reported by weight, and at others by numbers of hides and skins. In 1913–14 the imports recorded by weight amounted to 87,657 cwts., and those recorded by number to 528,158. By far the greater part of the total, both in quantity and in value, consists of hides; they furnished over 80 per cent. of the total value in 1913–14.

Both in 1914–15 and again in 1915–16 the trans-frontier trade in hides declined considerably, but showed little further alteration in 1916–17. The transfrontier imports of skins, during the first three years of the war, were well maintained. The specification of the imports in the land trade returns is a little different from that in the returns of sea-borne trade. Imports by land are described as "Hides of Cattle" and "Skins of Sheep, Goats, and Small Animals," without its being definitely stated that they are raw hides and skins. There is no separate category under the heading "Leather"—as in the sea-borne trade returns—for tanned hides and skins, and if any imports of this description are included in the category "Unmanufactured Leather" they must be very small, the total imports so described in 1913–14 amounting in value to only £200.

In the returns of the "Trade by Land of British India with Foreign Countries" are included the imports from and the exports to a number of border States and territories within the international frontier of India, such as the Shan States (Burma), Swat and Waziristan (N.W. Frontier Province), Las Bela and Kalat (Baluchistan), and Sikkim. Some of this trade consists of goods in transit from remoter countries. In the report on the trans-frontier trade of Burma, for example, it is stated that this is the case in regard to the Shan States, etc. At present Customs stations are established only on the Indian border of these States; eventually it is hoped to establish stations on the outer or international border. Meanwhile it is impossible to give precise returns of the trade of British India with foreign countries only, as distinct from Indian Native States. The existing returns give the closest approximation possible under present conditions. With regard to the imports of hides, the chief source of supply is Nepal (nearly 40 per cent. of the total value in 1913–14). In the same year Dir, Swat, and Bajaur, on the Afghan border, were credited with supplying nearly 21 per cent. of the total value, the Shan States 18 per cent., and Western China nearly 11 per cent. In other words, these four sources supplied 90 per cent. of the value of the hides imported into India by land in the latest year of normal trade. Of the skins imported by land, nearly 30 per cent. by value were received from Nepal, and over 50 per cent. from Afghanistan and bordering territories in the North-West Frontier Province.

Analysis of Export Trade

The exports of hides and skins from India by land are comparatively small (value £15,256 in 1913–14), and need not be considered in detail. This and following sections are concerned with the exports by sea.

The contributions made by the different classes of livestock to the Indian export trade in hides and skins are not equally related to their numbers. The number of grown cattle (cows and bulls) in India may be estimated from the data given in the section of this article relating to Livestock Resources at about 127,000,000. The number of raw and tanned cow-hides exported in 1912–13 was 13,214,430, and in 1913–14 it was 10,974,375; that is, the number of cow-hides exported before the war was from 8 to 10 per cent. of the estimated number of grown cattle in India. Similarly the total number of buffalo cows and bulls may be estimated at about 28,000,000, and before the war raw and tanned buffalo hides were exported to the extent of about 8 per cent. of this total—2,223,797 hides being exported in 1912–13 and 2,217,622 in 1913–14. Very much larger proportions of goat-skins and sheep-skins are exported. As already estimated, there are about 52,000,000 goats in India. The number of goat-skins exported annually before the war was as high as 55 per cent. of this total, amounting to 28,713,590 skins in 1912–13 and 28,266,207 skins in 1913–14. Of sheep it has been estimated that there are about 45,000,000; and about 25 per cent. of this number of sheep-skins were exported—11,999,181 in 1912–13, and 10,492,327 in 1913–14.

Altogether, between 50,000,000 and 60,000,000 hides and skins are exported annually from India under normal trade conditions. Of these nearly two-thirds are raw, and the rest tanned. About half the total number are goat-skins, while most of the remainder are divided fairly evenly, as regards number, between cow-hides and sheep-skins. In 1916–17 the total number of hides and skins exported was nearly 67,000,000.

Weights and values afford a better basis than numbers for testing the relative importance of the different classes of hides and skins exported from India. The following table gives the returns for five years:

Exports of Hides and Skins in Cwts.

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
RAW HIDES:					
Cow	831,200	743,037	480,513	689,113	581,645
Buffalo	345,037	345,864	211,745	162,887	261,099
Calf	29,640	26,116	21,158	29,761	50,933
Other	3,172	730	510	124	351
Total quantity *cwts.*	1,209,049	1,115,747	713,926	881,885	894,028
,, value	£5,372,407	5,530,638	3,500,693	4,523,590	4,994,675
RAW SKINS:					
Goat	520,954	453,356	382,060	399,951	521,808
Sheep	31,668	33,067	26,295	32,517	45,134
Other	2,649	140	93	229	104
Total quantity *cwts.*	555,271	486,563	408,448	432,697	567,046
,, value	£2,447,576	2,260,244	1,695,583	1,995,184	4,603,416
TANNED HIDES:					
Cow	215,429	158,383	191,565	247,380	286,210
Buffalo	17,004	15,545	25,261	24,234	32,178
Other	830	100	194	388	4,002
Total quantity *cwts.*	233,263	174,028	217,020	272,002	322,390
,, value	£1,363,278	1,058,575	1,606,649	2,041,582	2,980,822
TANNED SKINS:					
Goat	61,741	74,126	61,288	70,773	83,861
Sheep	60,355	49,652	45,978	49,345	66,254
Others	8,311	6,815	10,139	7,204	12,804
Total quantity *cwts.*	130,407	130,593	117,405	127,322	162,919
,, value	£1,705,055	1,758,591	1,552,269	1,699,177	3,231,056
HIDES AND SKINS:					
Raw	1,764,320	1,602,310	1,122,374	1,314,582	1,461,074
Tanned	363,670	304,621	334,425	399,324	485,309
Total	2,127,990	1,906,931	1,456,799	1,713,906	1,946,383
RAW AND TANNED:					
Hides	1,442,312	1,289,775	930,946	1,153,887	1,216,418
Skins	685,678	617,156	525,853	560,019	729,965
Total quantity *cwts.*	2,127,990	1,906,931	1,456,799	1,713,906	1,946,383
,, value	£10,888,316	10,608,048	8,355,194	10,259,533	15,809,969

During the period covered by the above table, about two-thirds of the raw hides by weight consisted of cow-hides in each year except 1915–16, when the proportion jumped up to 78 per cent. All but 2 or 3 per cent. of the remaining raw hides consisted of buffalo-hides in each year except 1916–17, when calf-skins formed 6 per cent. of the total. The percentage value of the raw cow-hides was a few units higher than their percentage weight.

Of the raw skins, goat-skins formed in each year from 92 to 94 per cent. of the total, and sheep-skins practically the whole of the remainder. The percentage values were about the same as the percentage weights.

Of the tanned hides, cow-hides formed from 88 to 92 per cent. of the total and buffalo-hides practically the whole of the remainder. The percentage value of the cow-hides was slightly higher than the percentage weight.

Of the tanned skins, goat-skins formed from 47 to 57 per cent. of the total, and sheep-skins from 38 to 46 per cent., leaving from 5 to 9 per cent. for "other kinds." The percentage value of the goat-skins (51 to 61 per cent.) was higher than their percentage weight.

The changes produced by the war assumed a more radical character in the year 1917–18. In the United Kingdom a proclamation dated February 23rd, 1917, prohibited as from that date the importation, except under licence, of numerous classes of goods, including wet and dry hides and dressed and undressed leather. In India the Government stopped the issue of licences for the export of cow-hides to the United Kingdom on private account. The tanning of goat and sheep-skins in the Madras and Bombay Presidencies was also prohibited (May 1917), so as to concentrate effort on the tanning of hides for War Office requirements, and to conserve for that purpose the supplies of suitable tanning bark. As a result, the exports of tanned cow-hides from India in 1917–18 increased to 342,806 cwts., while the exports of tanned goat-skins and tanned sheep-skins dropped sharply to 15,303 cwts. and 15,895 cwts. respectively.

The exports of raw cow-hides likewise declined to 317,588 cwts., so that for the first time the exports of tanned kips exceeded the weight of the raw kips exported. Raw buffalo hides dropped to 84,900 cwts. The exports of raw goat-skins were less affected, amounting to 392,034 cwts. The total exports of hides and skins were 1,245,923 cwts., valued at £9,450,067—the lowest quantity, but not the lowest value, recorded during the war. The total was composed of 846,931 cwts. of raw hides and skins, and 398,992 cwts. of tanned hides and skins; or, otherwise grouped, 779,577 cwts. of raw and tanned hides, and 466,346 cwts. of raw and tanned skins. The significance of these figures, in relation to those of earlier years, will be apparent from the following tables of percentages.

The percentage relation of hides and skins by weight in the export trade is shown in the following table:

Percentage Exports, Hides and Skins, by Weight

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.	1917–18.
Raw hides . .	69	70	64	67	61	49
,, skins . .	31	30	36	33	39	51
	100	100	100	100	100	100
Tanned hides .	64	57	65	68	66	91
,, skins .	36	43	35	32	34	9
	100	100	100	100	100	100
Total hides . .	68	68	64	67	62·5	63
,, skins . .	32	32	36	33	37·5	37
	100	100	100	100	100	100

The proportion of hides to skins is usually about the same in the raw and in the tanned exports, and consequently in the total export trade. The weight of hides exported is about twice the weight of skins, and this proportion was not greatly affected in the case of the totals even in 1917–18, when the decrease in the percentage weight of raw hides was counterbalanced by the increase in the percentage weight of tanned hides. It is instructive to contrast with the above the percentage relation of hides and skins by value:

Percentage Exports, Hides and Skins, by Value

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.	1917–18
Raw hides . .	69	71	67	69	52	39
,, skins . .	31	29	33	31	48	61
	100	100	100	100	100	100
Tanned hides .	44	38	51	55	48	77
,, skins .	56	62	49	45	52	23
	100	100	100	100	100	100
Total hides . .	62	62	61	64	50·4	56
,, skins . .	38	38	39	36	49·6	44
	100	100	100	100	100	100

The percentage values were not much different from the percentage weights in the case of raw hides and skins, except in 1916–17 and 1917–18, when the percentage value of raw skins was considerably greater than their percentage weight. In other words, raw hides and raw skins, as valued for export purposes, are normally about the same price per cwt., but in 1916–17 and 1917–18 raw skins fetched a much higher price than raw hides. On the other hand, the percentage value of the tanned skins was much higher than their percentage weight in each of the six years covered by the table; so much so that while the tanned skins usually amounted, in weight, to little more than half the tanned hides, their value was greater than that of the tanned hides in three years out of the six. Analysis of the percentage relation between the raw and tanned exports is also instructive:

Percentage Exports, Raw and Tanned Products, by Weight

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.	1917–18.
Raw hides . .	84	86·5	77	76	73·5	54
Tanned hides .	16	13·5	23	24	26·5	46
	100	100	100	100	100	100
Raw skins . .	81	79	78	77	78	92
Tanned skins .	19	21	22	23	22	8
	100	100	100	100	100	100
Total, Raw, .	83	84	77	77	75	68
,, Tanned .	17	16	23	23	25	32
	100	100	100	100	100	100

Before the war tanned hides constituted, by weight, about one-sixth or one-seventh of the total hides exported, and tanned skins about one-fifth of the total skins exported. In the five years, 1912–13 to 1916–17, the proportion of tanned skins among the skins exported did not greatly increase (from 19 to 22 per cent.), and in 1917–18 it dropped to 8 per cent., owing to the Government restrictions already noted. Among the hides, on the other hand, the proportion of the tanned hides increased during the six years from 16 to 46 per cent., the rise being especially marked in 1917–18, due to the Government measures to promote the output of tanned kips. Among hides and skins combined, the tanned goods increased during the period covered by the table from 17 to 32 per cent. of the total. Except in 1916–17, the actual exports of tanned hides and skins as a whole were not greatly in excess of the pre-war figures, and the percentage increase has been chiefly due to the decline in the exports of raw hides and skins, more particularly raw hides. This decline is directly due to the war, and from the standpoint of Indian industry the question is whether after the war the exports of raw hides will expand again at the expense of trade in the tanned product.

The following table shows the percentage values of the raw and tanned exports :

Percentage Exports, Raw and Tanned Products, by Value

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.	1917–18.
Raw hides . .	80	84	69	69	63	39
Tanned hides .	20	16	31	31	37	61
	100	100	100	100	100	100
Raw skins . .	59	56	52	54	59	76
Tanned skins .	41	44	48	46	41	24
	100	100	100	100	100	100
Total, Raw . .	72	73	62	64	61	55
,, Tanned .	28	27	38	36	39	45
	100	100	100	100	100	100

Among the exports of hides, the percentage value of the tanned products, like the percentage weight, has increased considerably during the war. The percentage value of the tanned hides, naturally, is greater than the percentage weight, and has tended to increase more rapidly; in 1912–13 the percentage value was one-fourth greater than the percentage weight, while in 1917–18 it was one-third greater. On the other hand the percentage value of the tanned skins, though showing little increase or decrease till the abnormal drop in 1917–18, was about double the percentage weight of the tanned skins till the last-named year, when it was three times as great. After allowance has been made for abnormal conditions of supply and demand, it remains generally true that tanning in India increases the value of skins by weight very much more, relatively, than it does the value of hides. The explanation is not so much that the skins are tanned more completely than the hides, but, as will be seen later, that they lose relatively more in weight—at any rate as compared with kips. The increase in value per skin, as a result of tanning, is much more commensurate with the increase in value per hide than might be thought from a comparison of their respective increases in value by weight.

To recapitulate: By weight, in the normal course of trade, the exports of raw hides consist almost entirely of cow-hides and buffalo-hides, in the proportion of two to one; of the tanned hides exported, nine-tenths are cow-hides. Over nine-tenths of the raw skins exported are goat-skins, which also provide between half and three-fifths of the tanned skins exported; the remainder of both the raw and the tanned skins are chiefly sheep-skins. The weight of hides exported from India is about twice the weight of skins, as regards both raw and tanned products. Raw hides before the war were about the same price per cwt. as raw skins, but tanned skins fetched much higher prices per cwt. than tanned hides, with the result that the proportion of the total exports of hides to the total exports of skins by value was little more than three to two. In 1916–17 the two classes of exports were about equal in value, and in 1917–18 the proportion was about five to four. The weight of raw hides exported before the war was 5 or 6 times the weight of tanned hides; and the weight of raw skins about four times the weight of tanned skins. Among the exports of skins the proportion was not greatly affected by the war till 1917–18, when it rose to about eleven to one; as regards hides, on the contrary, the proportion was steadily reduced till in 1917–18 the exports of raw hides were to the exports of tanned hides as about six to five, the weight of the tanned kips being actually greater than that of the raw kips.

So far the exports of hides and skins from India have been considered in their group relations. The following table shows, for the latest year of normal trade, the importance of the principal kinds of hides and skins exported, considered in relation to the whole:

Exports of Hides and Skins in 1913–14

	Quantity.		Value.	
	Cwts.	*Per cent.*	£	*Per cent.*
Cow-hides:				
Raw	743,037	39·0	3,937,007	37·1
Tanned	158,383	8·3	982,654	9·3
Total	901,420	47·3	4,919,661	46·4
Buffalo-hides:				
Raw	345,864	18·1	1,469,113	13·8
Tanned	15,545	0·8	75,127	0·7
Total	361,409	18·9	1,544,240	14·5
Goat-skins:				
Raw	453,356	23·8	2,085,132	19·7
Tanned	74,126	3·9	1,073,767	10·1
Total	527,482	27·7	3,158,899	29·8
Sheep-skins:				
Raw	33,067	1·7	173,999	1·7
Tanned	49,652	2·6	639,000	6·0
Total	82,719	4·3	812,999	7·7
Other hides and skins:				
Raw [1]	26,986	1·4	125,631	1·2
Tanned [2]	6,915	0·4	46,618	0·4
Total	33,901	1·8	172,249	1·6
Total hides and skins	1,906,931	100·0	10,608,048	100·0
Hides, raw	1,115,747	58·5	5,530,638	52·1
Hides, tanned	174,028	9·1	1,058,575	10·0
Skins, raw	486,563	25·5	2,260,244	21·3
Skins, tanned	130,593	6·9	1,758,591	16·6
Total hides and skins	1,906,931	100·0	10,608,048	100·0

[1] *Chiefly hides (calf-skins).* [2] *Chiefly skins.*

The great bulk of the trade consisted of cow-hides, buffalo-hides and goat-skins, which together constituted 94 per cent. of the total by weight and 91 per cent. by value. Cow-hides alone furnished nearly half the total both by weight and by value, goat-skins over one-fourth, and buffalo-hides nearly one-fifth by weight (one-seventh by value). Of the cow-hides over one-sixth were tanned, and of the goat-skins one-seventh, but of the buffalo-hides only about 4 per cent.

The relatively small contribution which sheep-skins make to the total is noteworthy, seeing that the estimated number of sheep in India is not greatly different from the number of goats. The numbers are roughly in the proportion of nine sheep to ten goats, but the exports of sheep-skins are only about one-sixth of the exports of goat-skins by weight. This statement is true not only for 1913–14, but for each of the five years ending 1916–17. During that period the proportion showed a slight tendency to increase, but in 1917–18 it dropped to one-eighth. The disparity is partly due to the fact that the average sheep-skin exported is of lighter weight than the average goat-skin; but, even on the basis of numbers, between two or three times as many goat-skins as sheep-skins are annually exported from India. The position occupied by sheep-skins is further noteworthy in that, ordinarily, well over half the exports of this class of skins are tanned, whereas among the exports of cow-hides, buffalo-hides, calf-skins, and goat-skins, the raw product greatly preponderates in every case.

A small addition to the trade is furnished by cuttings of raw hides and skins, which in 1913–14 were exported to the amount of 29,488 cwts., valued at £24,394. Of these cuttings 90 per cent. were despatched from Bengal. The great bulk of them went to the United States. During the war the trade in cuttings has declined, the exports in 1917–18 amounting to only 5,661 cwts., valued at £4,488.

The distribution of the exports by groups and as a whole is shown in the following tables. The italicised figures bracketed with the chief items denote percentages.

Exports of Raw Hides

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	1,209,049	1,115,747	713,926	881,885	894,028
„ value .	£5,372,407	5,530,638	3,500,693	4,523,590	4,994,675
To British Countries:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom	83,799 *6·9*	42,365 *3·8*	132,322 *18·5*	99,290 *11·3*	145,140 *16·2*
Canada . .	5,302	9,021	2,261	11,079	12,848
Others[1] . .	5,367	5,805	1,114	5,656	4,470
Total . .	94,468 *7·8*	57,191 *5·1*	135,697 *19·0*	116,025 *13·2*	162,458 *18·2*
To Allied Countries:					
United States .	228,281 *18·9*	155,372 *13·9*	189,173 *26·5*	312,965 *35·5*	461,167 *51·6*
Italy . .	133,164 *11·0*	106,805 *9·6*	72,199 *10·1*	383,360 *43·5*	172,871 *19·3*
France . .	25,584 —	17,885 —	8,619 —	21,924 —	37,562 *4·2*
Belgium . .	21,417	21,888	6,852	—	—
Others[2] . .	3,793	3,503	4,722	614	4,105
Total . .	412,239 *34·1*	305,453 *27·4*	281,565 *39·5*	718,863 *81·5*	675,705 *75·6*
To Enemy Countries:					
Germany .	389,429 *32·2*	388,409 *34·8*	146,575 *20·5*	— —	— —
Austria-Hungary	173,772 *14·4*	237,829 *21·3*	60,143 *8·4*	— —	— —
Turkey . .	24,609	33,095	10,849	—	—
Bulgaria . .	5,649	2,663	4,690	—	—
Total . .	593,459 *49·1*	661,996 *59·3*	222,257 *31·1*	— —	— —
To Neutral Countries:					
Spain . .	65,946 *5·5*	49,375 *4·4*	47,011 *6·6*	29,552 *3·4*	41,317 *4·6*
Holland . .	42,624 *3·5*	41,564 *3·7*	5,518 *0·8*	— —	— —
Sweden . .	—	—	19,526	6,564	—
Norway . .	125	83	2,243	10,353	13,861
Others . .	188	85	109	528	687
Total . .	108,883 *9·0*	91,107 *8·2*	74,407 *10·4*	46,997 *5·3*	55,865 *6·2*

Chiefly Ceylon and Straits Settlements. [2] *Chiefly Rumania and Greece.*

The total exports of raw hides in 1917–18 amounted to 417,903 cwts., valued at £2,057,092. No returns of the distribution of the trade in hides and skins in that year are available for publication.

There has been a considerable increase in the exports of raw hides to the United Kingdom during the war. Germany and Austria-Hungary were the chief customers before the war, and were followed by the United States and Italy. During the war the last two countries have absorbed some of the supplies which would have gone normally to enemy countries, but the loss of enemy markets has been attended by a heavy falling off in the total exports, due in part to the shortage of shipping and the restrictions on trade.

Before the war nearly 80 per cent. of the exports of raw hides were shipped from Bengal ports, the remainder being despatched almost entirely from the ports of Sind (9 per cent.) and Burma (10 per cent.). In 1916–17 the share of Bengal had dropped to 63 per cent., and that of the Sind ports had risen to 21 per cent., while 7 per cent. were shipped from Bombay ports; the share of Burma remaining fairly normal at 9 per cent. In 1917–18, however, Bengal's share was up again to 73 per cent., that of Sind being 10 per cent., of Bombay 6 per cent., and of Burma 10 per cent.

Exports of Raw Skins

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	555,271	486,563	408,448	432,697	567,046
,, value	£2,147,576	2,260,244	1,695,583	1,995,184	4,603,416
To British Countries:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom	57,598 *10·4*	41,993 *8·6*	39,722 *9·7*	33,993 *7·9*	40,719 *7·2*
Others [1]	6,937	3,389	3,168	5,557	7,526
Total	64,535 *11·6*	45,382 *9·3*	42,890 *10·5*	39,550 *9·1*	48,245 *8·5*
To Allied Countries:					
United States	411,415 *74·1*	371,270 *76·3*	325,358 *79·7*	385,401 *89·1*	495,855 *87·4*
France	35,944 *6·5*	22,802 *4·7*	8,685 *2·1*	7,573 *1·75*	21,893 *3·9*
Others [2]	6,186	9,088	9,902	173	1,053
Total	453,545 *81·7*	403,160 *82·9*	343,945 *84·2*	393,147 *90·9*	518,801 *91·5*
To Enemy Countries:					
Total [3]	14,954 *2·7*	14,179 *2·9*	7,957 *2·0*	—	—
To Neutral Countries:					
Total [4]	22,237 *4·0*	23,842 *4·9*	13,656 *3·3*	— —	— —

[1] *Chiefly Australia.* [2] *Chiefly Belgium, up to and including* 1914–15
[3] *Chiefly Germany.* [4] *Chiefly Holland.*

In 1917–18 the total exports of raw skins amounted to 429,028 cwts., valued at £3,163,716.

The British share of the trade in raw skins, as in raw hides, is small, though the United Kingdom is the largest buyer after the United States. The latter country is the dominating power in this branch of Indian trade, taking three-fourths of the exports before the war and nearly nine-tenths both in 1915–16 and in 1916–17.

The shipping of skins is more evenly divided among the provinces of India than the shipping of hides, but shows the same war tendency, namely the declining importance of Bengal ports, and the transference of trade to the ports of Bombay and Sind, up to and including 1916–17, with partial recovery on the part of Bengal in 1917–18. In 1916–17 the shipments of raw skins from Bengal ports were 26 per cent. against 43 per cent. in 1913–14; from Bombay ports they were 35 per cent. against 28 per cent.; and from Sind ports, 34 per cent. against 23 per cent. In 1917–18 the percentages were: Bengal, 35; Bombay, 33; Sind, 25. The rest (5 or 6 per cent.) of the raw skins are despatched almost entirely from Madras ports.

Exports of Tanned Hides

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	233,263	174,028	217,020	272,002	322,390
,, value	£1,363,278	1,058,575	1,606,649	2,041,582	2,980,822
To British Countries:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom	229,075	169,687	214,115	270,648	321,121
	98·2	*97·5*	*98·7*	*99·5*	*99·6*
Others . .	3,145	1,646	784	1,354	1,250
Total . .	232,220	171,333	214,899	272,002	322,371
	99·5	*98·5*	*99·0*	*100*	*100*
To Foreign Countries:	1,043	2,695	2,121	—	19

In 1917–18 the total exports of tanned hides were 361,674 cwts., valued at £3,246,588.

Tanned hides were exported exclusively to British countries in 1915–16, and all but so in 1916–17, the great bulk going to the United Kingdom. The position was little different before the war, only 0·5 per cent. of the total being exported to foreign countries in 1912–13, and

1·5 per cent. in 1913–14. Normally, four-fifths of the total are despatched from Madras ports, and practically all the remainder from Bombay ports.

Exports of Tanned Skins

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	130,407	130,593	117,405	127,322	162,919
„ value	£1,705,055	1,758,591	1,552,269	1,699,177	3,231,056
TO BRITISH COUNTRIES:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom	99,879 *76·6*	102,442 *78·4*	92,698 *79·0*	83,575 *65·6*	107,451 *66·0*
Straits Settlements	2,490	1,719	1,766	1,775	1,746
Others . .	350	606	378	594	426
Total . .	102,719 *78·8*	104,767 *80·2*	94,842 *80·8*	85,944 *67·5*	109,623 *67·3*
TO ALLIED COUNTRIES:					
United States .	16,032 *12·3*	16,211 *12·4*	13,135 *11·2*	35,452 *27·8*	46,139 *28·3*
Japan . .	9,146 *7·0*	7,491 *5·7*	8,612 *7·3*	5,840 *4·6*	6,537 *4·0*
Others [1] . .	92	329	91	65	616
Total . .	25,270 *19·4*	24,031 *18·4*	21,838 *18·6*	41,357 *32·5*	53,292 *32·7*
TO GERMANY:	2,380 *1·8*	1,785 *1·4*	718 *0·6*	—	—
TO OTHER FOREIGN COUNTRIES [2] .	38	10	7	21	4

[1] *France, Belgium, Siam.*

[2] *Holland, Sumatra, and other foreign countries not specified.*

The total exports of tanned skins in 1917–18 amounted to only 37,318 cwts., valued at £982,671.

Tanned skins are not exported to British countries to the same extent as tanned hides ; but before the war the United Kingdom received over three-fourths of the total exports of tanned skins, and British countries as a whole about four-fifths of the total. Most of the remainder went to the United States and Japan, the more important customer being the United States. In 1915–16 and 1916–17 the British proportion of the trade declined to about two-thirds, though the actual exports to British countries in 1916–17 were larger than in any other year of the quinquennium. The percentage decline of the British trade was due to the large increase in the exports of tanned skins to foreign countries, the dominating factor being the exports to the United States, which increased from 16,000 cwts. in 1913–14 to 46,000 cwts. in 1916–17. As in the case of tanned hides, most of the trade in tanned skins is done from Madras, over four-fifths of the exports being despatched ordinarily from the ports of that presidency, and the rest mainly from Bombay ports.

The following table shows the distribution of the total exports of hides and skins in 1913–14:

Exports of Hides and Skins, Raw and Tanned, in 1913–14

	Quantity.		Value.	
	Cwts.	*Per cent.*	£	*Per cent.*
To British Countries:				
United Kingdom	356,487	18·7	2,749,734	25·9
Other British countries	22,186	1·2	122,307	1·2
Total	378,673	19·9	2,872,041	27·1
To Allied Countries:				
U.S.A.	542,853	28·5	2,569,047	24·2
Italy	106,943	5·6	564,260	5·3
Other countries	81,983	4·3	441,402	4·2
Total	731,779	38·4	3,574,709	33·7
To Enemy Countries:				
Germany	402,988	21·1	2,151,887	20·3
Austria-Hungary	239,214	12·5	1,241,469	11·7
Other countries	35,758	1·9	95,531	0·9
Total	677,960	35·5	3,488,887	32·9
To other Foreign Countries:	118,519	6·2	672,411	6·3
British	378,673	19·9	2,872,041	27·1
Allied	731,779	38·4	3,574,709	33·7
Enemy	677,960	35·5	3,488,887	22·9
Neutral	118,519	6·2	672,411	6·3
Total	1,906,931	100	10,608,048	100·0

Both Allied and enemy countries were much larger buyers of Indian hides and skins of all kinds before the war than were British countries. The largest individual share of the trade, however, in respect of value, was that taken by the United Kingdom (over one-fourth), though in respect of quantity both the United States (over one-fourth) and Germany (over one-fifth) were ahead of the United Kingdom (under one-fifth). The next largest buyer, Austria-Hungary, had about one-eighth of the trade. Between them these four countries took about four-fifths of the total exports, both by quantity and by value.

These comparisons do not take account of the re-export trade of the receiving countries. In the case of the United Kingdom, the re-export trade is of large dimensions, as the following returns show:

Trade of the United Kingdom in Indian Hides and Skins

	1912.	1913.	1914.	1915.	1916.
		RAW HIDES.			
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
Gross Imports .	148,212	100,019	92,033	160,491	141,004
Net Imports . .	81,819	48,131	56,667	84,545	74,948
		UNDRESSED GOAT-SKINS.			
	Number.	Number.	Number.	Number.	Number.
Gross Imports .	5,499,192	5,933,071	3,648,301	4,988,277	5,926,264
Net Imports . .	1,217,481	1,149,836	710,055	1,437,680	511,662
		OTHER UNDRESSED SKINS.			
	£	£	£	£	£
Gross Imports .	15,997	36,575	32,664	30,798	90,352
Net Imports . .	7,052	7,796	10,132	6,678	11,247
		LEATHER (MOSTLY ROUGH-TANNED HIDES AND SKINS)			
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
Gross Imports .	344,507	309,527	272,724	371,339	401,056
Net Imports .	261,832	220,290	206,806	326,145	304,938

Of the raw hides imported into the United Kingdom from India before the war, about one-half were retained; of the raw goat-skins, about one-fifth; of the other raw skins—a comparatively small item—nearly half in 1912 and a fifth in 1913; of the tanned hides and skins, about three-fourths. During the war, up to and including 1916, the proportion retained was subject to little alteration in the case of either raw hides or leather, but fluctuated considerably in the case of raw skins (see p. 226).

INDIAN TANNING INDUSTRY

Before dealing with the chief kinds of hides and skins separately, it will be useful to state the present position with regard to a question which affects the trade in all of them—the development of the tanning industry in India.

Factory Statistics.—In the factory statistics of India a distinction is drawn between tanneries and leather works. Both are tabulated under "Processes connected with skins and hides," and most if not all of the leather works appear to comprise tanneries. A certain amount of tanning is done by individuals in almost every town and village in India, but factories of any considerable size devoted to this industry are not numerous. In the *Commercial Products of India* (Murray, 1908), Sir George Watt says that in 1902–3 there were 202 tanneries with 6,200 employees; and of these tanneries 183 were small concerns, located in the Madras Presidency and engaged chiefly in the dressing of skins. The statistics now issued relate mainly to factories employing 50 persons or more. The returns distinguish not only between tanneries and leather works, but between those worked by mechanical or electrical power and those not so worked. In each category the number of employees as well as the number of works is given. During the decade ending 1915 (the latest year for which returns are available), the total number of works engaged in processes connected with hides and skins, including an occasional entry under "miscellaneous," increased in every year but one, and advanced from 19 in 1906 to 40 in 1915. The total number of employees fluctuated considerably, and was slightly less in 1915 (6,787) than in 1906 (6,930); in the interval it fell to a minimum in 1909 (5,862) and reached a maximum in 1914 (10,397). In each year the number of tanneries (16 to 28) was considerably in excess of the number of leather works (3 to 13), but the latter employed the larger number of persons prior to 1912, when tanneries claimed 6,175 employees against 2,488 employees in leather works. Tanneries continued to employ the larger number of persons both in 1913 and in 1914; but in 1915 leather works again took the lead, with 4,262 employees against 2,397 in tanneries. This preponderance of employees in leather works is due to the outstanding position of the Cawnpore works, run by mechanical power, which in 1915 had 3,649 employees (2,938 in Messrs. Cooper, Allen & Co.'s Army Boot and Equipment Factory), or over 53 per cent. of the total published number of employees in private leather works and tanneries throughout India. When account is further taken of the employees in other leather works run by mechanical power, as well as in tanneries run by power, a very large proportion of the total number of employees is found to be absorbed by establishments of this description. In 1915 as many as 5,722 persons out of a total of 6,787 were employed in power works, and though the proportion was not always so large, in no year during the decade was it less than two-thirds. The number of establishments worked by power increased from 7 in 1906 to 17 in 1912, dropped to 14 in the following year, rose to 23 in 1914, and dropped again to 18 in 1915. The number of establishments not worked by mechanical or electrical power ranged during the decade between 16 and 22, and constituted a majority in each year except 1914. In other words, up to 1915, non-power establishments for the tanning and working of hides and skins were ordinarily the more numerous, but power establishments employed, both on average and as a whole, a much larger number of persons.

Not included in the returns just given is the Government Harness and Saddlery Factory at Cawnpore. Up to 1915 this was the only leather works or tannery under public ownership in India. The average number of persons employed there increased from 1,682 in the year before the war to 2,552 in 1915. Thus the total number of persons employed in India in 1915 on processes connected with hides and skins, so far as returns are available, was 9,339, and the number of works employing them was 41. It may be repeated that these are only the larger establishments of their kind, and that tanneries especially are very much more numerous. For instance, the returns which have been quoted include only one hides and skins factory for Mysore—a tannery at Bangalore employing 112 persons. But a report issued by the Mysore Department of Industries and Commerce on the foreign rail-borne trade of that State in 1916–17 gives the number of tanneries as 52; and an official statement issued in Madras towards the end of 1917 mentioned incidentally that there are several hundreds of tanneries in the Madras Presidency, Mysore, and Hyderabad.

The Madras Industry.—The majority of the larger tanneries in India before the war—as distinct from leather works, in which tanneries (where they exist) are associated with leather manufactures—were in the Madras Presidency. In 1908, out of 23 tanneries employing 3,813 persons, Madras contained 19, employing 2,200 persons. In 1913, out of 22 tanneries employing 2,622 persons, Madras contained 15, employing 1,396 persons. In 1915, however, out of 26 tanneries employing 2,397 persons, Madras had only 9, employing 900 persons; Bengal had a larger number (12), but they employed only 540 persons.

As already seen from the trade returns, Madras provides the great bulk of the exports of both tanned hides and tanned skins from India. Next to seeds, the most valuable exports from the Presidency are hides and skins, raw and tanned, and in the five years ending 1912–13, over 88 per cent. of the value of these exports was provided by tanned hides and skins. Though classed as leather, the tanned hides and skins exported are not the finished product, ready for manufacture. Sir George Watt states (*Commercial Products of India*, 1908, p. 637), that "protracted immersion [of hides and skins in process of being tanned] has for many years past been admitted as impossible in India." This may explain, in part, the "half process" employed by native tanners connected with the export trade, though the nature of the tanning materials in use is also an important factor. In the Madras *Handbook of Commercial Information* (Madras, 1916), by Mr. M. E. Couchman, I.C.S., Director of Industries, the exports of tanned hides and skins are described as "tanned (unfinished)," and in Flemming's *Practical Tanning* (Philadelphia, 1910) it is stated that India-tanned sheep-skins and goat-skins, as received from India, "are imperfectly tanned, of a dark colour and quite hard. In order to complete the tanning and to improve the quality of the leather by making it softer and better adapted for fancy colours, it is necessary to remove from it some of the original tanning material, and to replace it with one that makes soft and light-coloured leather." Flemming recognises, however, the excellent quality of these skins, which "have considerable firmness and durability and yet are soft and pliable, and, when coloured and finished, cannot be excelled by any other leather." This bears out the opinion of the Madras Government Expert, who is quoted by Mr. Couchman as stating, with reference to the provincial industry of tanning for export, that "the methods employed by the export tanners, when carried out under the best conditions as regards water, bark, and myrobalams, and careful supervision, turn out a class of leather that is of very high quality, very suitable for European and American leather dressers, and although several tanners have at different times tried to modernise the processes used for these skins, they have always returned to the old native methods."

Pre-war Changes.—True as the foregoing may be, changing conditions in the world's markets had considerably affected the Madras tanning industry even before the war. European methods of tanning were introduced in the first half of the nineteenth century, and at one time almost all the hides and skins exported from the Presidency were tanned. This continued to be the case as regards hides, as will be seen from the following table, which shows the course of trade up to the outbreak of war:

Exports of Hides from Madras Presidency

Hides:	Average Annual Exports in Cwts.			
	Quinquennium 1895–6 to 1899–1900.	Quinquennium 1900–1 to 1904–5.	Quinquennium 1905–6 to 1909–10.	Four Years 1910–11 to 1913–14.
Raw . . .	96	1,068	714	2,083
Tanned . .	124,593	128,713	157,060	152,322
Total . .	124,689	129,781	157,774	154,405

Throughout the period covered by the above table the exports of tanned hides from Madras formed between 80 and 90 per cent. of the total exports of tanned hides from India. Though subject to large fluctuations from year to year, in its general trend the trade in tanned hides followed a fairly normal course of development, agreeing in this respect with the total exports of raw hides from India, in which Madras has quite an insignificant share. The figures for India as a whole are shown in the following table:

Exports of Hides from India

Hides:	Average Annual Exports in Cwts.			
	Quinquennium 1895–6 to 1899–1900.	Quinquennium 1900–1 to 1904–5.	Quinquennium 1905–6 to 1909–10.	Four Years. 1910–11 to 1913–14.
Raw . . .	786,544	802,698	863,449	1,030,445
Tanned . .	144,724	144,580	180,769	183,745
Total . .	931,268	947,278	1,044,218	1,214,190

The course of the export trade in skins, during the two decades immediately prior to the war, was of a very different character, as regards both the Madras Presidency and India as a whole. While the exports of raw skins went up by leaps and bounds, the exports of tanned skins declined. In the Presidency, both tendencies received a check before the war, but in India as a whole they continued to operate up to the last year of normal trade. The following are the figures for Madras:

Exports of Skins from Madras Presidency

Skins:	Average Annual Exports in Cwts.			
	Quinquennium 1895–6 to 1899–1900.	Quinquennium 1900–1 to 1904–5.	Quinquennium 1905–6 to 1909–10.	Four Years 1910–11 to 1913–14.
Raw . . .	5,979 [1]	42,557	67,832	36,524
Tanned . .	156,107	122,206	107,694	115,523
Total . .	162,086	164,763	175,526	152,047

[1] *The annual exports yielding this average were* 1,071 *cwts.,* 524 *cwts.,* 276 *cwts.,* 6,535 *cwts., and* 21,470 *cwts.*

Though not dominating the trade quite to the same extent as in the case of tanned hides, the exports of tanned skins from Madras form the great bulk of such exports from India (over three-fourths during the last twenty years before the war). On the other hand, the raw skins exported from Madras are only a small part of the total trade. The following are the total figures for India :

Exports of Skins from India

Skins:	Average Annual Exports in Cwts.			
	Quinquennium 1895–6 to 1899–1900.	Quinquennium 1900–1 to 1904–5.	Quinquennium 1905–6 to 1909–10.	Four Years 1910–11 to 1913–14.
Raw . . .	120,139	266,723	480,649	531,240
Tanned . . .	194,693	159,545	142,787	139,181
Total . .	314,832	426,268	623,436	670,421

Chrome Tanneries in Madras.—The growth in the exports of raw skins at the expense of the trade in tanned skins is due to the development abroad of chrome tanning, especially as practised in the United States for the production of glacé kid. The bulk of the raw skins exported before the war were consigned to the United States. Efforts to establish tanneries employing the chrome process in the Madras Presidency have attained some success in the last few years, though hitherto their influence on the export trade has not been great. The first experiments, in the early years of the present century, were not a commercial success, but those interested in the industry persevered, and two companies were established : the Chrome Leather Company, Madras, and the Mysore Tannery, Ltd., with works near Bangalore. After the early difficulties had been overcome, both companies made considerable and steady progress, and during the war a third chrome tannery has been established with local capital at Berhampur, near the extreme north-east corner of the Presidency. The Chrome Leather Company, Madras, which in 1916 employed a capital of about 9 lakhs (£60,000), has built a new tannery and factory at Pallavaram, a few miles south of Madras. Pallavaram was formerly the home of several tanneries which fell into decay with the development of the chrome tanning industry in the United States. About 1,000 men were engaged in 1916 in the Chrome Leather Company's new works. Apart from the production of chrome leather—comprising both sole and upper leathers, as well as belting—bark-tanned sole leather of superior quality is turned out in considerable quantities. All classes of manufactured leather goods are produced, and large quantities of footwear and accoutrements have been supplied to the Government of India. When the *Madras Handbook of Commercial Information* was issued in 1916 considerable extensions were being made to the works with a view to the export of chrome-tanned upper and sole leathers on a large scale. The Mysore Tannery has been concentrating on the production of chrome-tanned black box sides for export, and the same class of goods is being produced by the Berhampur tannery for export via Calcutta.

Normally large quantities of raw hides and skins are bought in other parts of India and brought into Madras to be tanned, not only for export but for the home market. The best hides reach Madras from November to April. Skins are in the best condition from January to May, and buying stops to a large extent in the latter part of the hot weather, as the skins from animals killed at that time of the year are thin and unsuitable for the best class of work. Owing to the prejudice against killing cattle, most of the hides are from animals which have died of old age or disease, whereas skins are from goats and sheep slaughtered for food, and Indian skins therefore occupy a better relative position in the world's markets than Indian hides. It is only in a few large towns or military cantonments that hides from slaughtered animals are available in any quantity. Normally the tanned hides and skins are exported chiefly to the United Kingdom, because most other countries offering a market for Indian hides and skins have arranged their tariffs so as to encourage the importation rather of the raw than of the tanned product.

Effects of the War.—The Madras trade both in tanned hides and in tanned skins has been considerably affected by the war, but the changes have not operated in the same way in the two cases. The *Review of the Sea-Borne Trade of the Madras Presidency* for 1915–16 states that after the loss of enemy markets the Madras tanners bought large quantities of the stocks of raw hides which accumulated in Calcutta, Agra, Cawnpore, and other northern hide-producing centres. These hides were tanned in Madras; shippers bought them freely, and sent heavy consignments to the United Kingdom. It was only to the United Kingdom, Ceylon, and the Straits Settlements that the export of tanned hides was allowed. For a time the supplies despatched to the United Kingdom were equal to the demand, and prices lagged after an initial rise; but subsequent to 1915–16, with the continued growth of military requirements and the adaptation of the leather-dressing industry in this country to war conditions, not only did the exports from Madras continue to expand, but prices again advanced, up to 50 per cent. on average above pre-war figures. As regards the exports of tanned goat-skins, trade with the United States increased over four-fold in 1915–16 and 1916–17, compared with 1913–14, but trade with the United Kingdom declined. Formerly German buyers purchased the bulk of the skins sold in the London market for their trade in finished leather goods. After war broke out many difficulties stood in the way of any determined efforts by British manufacturers to capture the trade. The opportunity was seized by American firms, who made arrangements for shipments direct to the United States instead of via London. In December 1916, however, the exportation of tanned skins from India was prohibited to all destinations except the United Kingdom, while by a Notice issued in Madras and Bombay in May 1917, as already stated, it was forbidden to put goat or sheep skins into tannage except by express permission. Later in the year licences were granted to renew the trade with the United States to a limited extent; the American Consul in Madras reported on October 4th, 1917, that the first consignment of tanned skins to the United States since the prohibition came into force was expected to be forwarded shortly (*Commerce Reports*, 1917, 285). But, with the restrictions imposed on the tanning of skins, supplies were naturally much reduced, and the trade returns for 1917–18 already quoted show how marked was the decline in the exports.

Much attention is being given by the Government of India, as well as by private firms, to the improvement and extension of the tanning industry in India. As announced by H. E. the Viceroy in his address at the opening meeting of the Imperial Legislative Council's autumn session at Simla in September 1917, tanners in India have been given orders on a scale which has encouraged them to reform their methods, and by having to work regularly to a rigid standard of high quality a striking improvement in their work has already taken place. The Munitions Board, with the generous consent of a group of Central Indian States, has taken over the tannery at Maihar to test new tan stuffs, new combinations of known materials, new processes, and the manufacture of concentrated tanning extracts. The results are being tested on a commercial scale at the Allahabad tannery, which has been purchased for the purpose. In co-operation with the Forest Department the Munitions Board has organised the collection of promising materials, and has arranged with the railway companies for their distribution at uniform and low rates of freight. Students are being taken as apprentices, and it is hoped to form at Allahabad an institute in which the scientific aspects of tanning will be taught in conjunction with practical work on a commercial scale.

An important factor in the reputation acquired by Madras in connection with the tanning industry is that Avaram or Tarwad bark (*Cassia auriculata*) is found chiefly in the Madras and Bombay Presidencies, also in Mysore and Hyderabad States. This is one of the most useful materials for the production of soft leather by unskilled labour, but it is comparatively expensive. According to a *communiqué* issued by the Madras Government in April, 1918, the tanneries in North India, which have an advantage over the Madras tanneries in respect of the supplies of raw hides, have been trying to discover a tanning mixture equal to Avaram bark, and though they have not achieved complete success they have gone a long way towards it, and have produced some very cheap mixtures. To compete with these the price of Avaram bark must be greatly reduced. At present supplies are obtained by collecting the wild product, and are limited, but it is believed that they might be greatly increased, with consequent reduction in price, if the shrub were cultivated. Land grants for this purpose are being offered to cultivators by the Madras Government on favourable terms.

Cow-hides (Kips)

From an economic standpoint, cattle in India play much the same part as draught-horses in England. Bulls and bullocks are the ordinary beasts of burden. They do the work on the farms—ploughing and other agricultural operations. They are the commonest means of transport: loads are hauled in bullock-wagons in the country districts and through the streets of cities; travellers are conveyed in bullock-carts where no railways run. Cows are of some economic value as milk-producers. But cattle breeding and rearing for meat supply are almost unknown in India. The religious scruples of the Hindus against taking life, and the special sanctity attaching in their eyes to the cow, combine to ensure a natural death to the vast majority of the cattle in India. It follows that there are large numbers of old and worn animals, which fall a specially easy prey to outbreaks of virulent diseases and to the scarcity of famine years. At such times the rate of mortality among cattle is greatly increased, and the exports of hides go up with a bound.

These conditions affect not only the quantity but the quality of the hides exported. Beasts that have dragged out a lingering existence will not supply hides of the same quality as slaughtered prime cattle. Apart, however, from this fundamental characteristic of the trade in Indian hides, the cattle of India are, in general, not of a high grade. There are various breeds both of heavy draught cattle and of cattle for quick road work, as well as certain good milking strains, which are maintained by the observance of sound principles of cattle-breeding. But as regards the great mass of the cattle no attention is paid to such matters. Good grazing lands are limited. Stock farming is not general. The possession of cattle is a circumstance attendant on the pursuit of agriculture. Breeding is little regulated, and the animals are badly fed. In the rice tracts the diet consists largely of rice straw, and the cattle are often miserably weak. But perhaps the chief distinguishing feature of Indian cow-hides is their small size and weight. Indian cattle are very much smaller than English, the average weight of the raw hides being only 9 lb. in a dried state, equivalent to 24 lb. wet. The various breeds, however, differ considerably in size. Judged by the hides which enter into the export trade, the smallest cattle are found in the north-east (where Dacca is the centre for the collection of hides), south-east and south-west districts; the largest in Sind, Rajputana, and the Punjab; and intermediate sizes in the Central Provinces. Size is not a criterion of value from the leather merchant's point of view, for some of the largest hides are the worst in quality, coming from badly fed animals which yield a flat skin with a humpy shoulder. In comparisons of weights, account must also be taken of the method of curing the raw hides. A great change has taken place in this respect during the past half-century. Formerly practically all the hides were cured by the use of lime, salt, and earth, and the creation of false weight was a native science. Now the great bulk of the hides exported are dried out in the sun or under cover, and treated with an arsenical solution. Arsenicated and dry-salted hides may range in weight from a maximum of 24 lb., for bulls, down to $\frac{3}{4}$ lb. for calf-skins; wet-salted hides may weigh as much as 36 lb. Practically all, however, are unsuitable for the manufacture of sole leather, and their chief use is for making upper shoe leather. In the early stages of the war the raw hides considered by the War Office to have military value were arsenicated hides weighing 6 lb. or over, and dry-salted hides weighing 9 lb. or over. In March 1917, however, all hides weighing over 4 lb. arsenicated, 7 lb. dry-salted, and 12 lb. wet-salted, including rejections and double rejections, were reserved by the Government of India for export on Government account.

Defects of Preparation.—Dry-salting is still extensively practised in the case of hides exported from Dacca, and wet-salting in the case of some of the hides exported from Burma. In both cases the hides have an unfavourable reputation in Europe, owing not so much to the use as to the abuse of the methods employed. Hides lightly salted after being thoroughly fleshed are excellent for tanning. Those exported from Dacca, however, are not only heavily weighted with salt earth, but are often disfigured by butcher-cuts made during flaying, and have adhering to them a large amount of flesh, which sets up putrefaction. Intrinsically Dacca kips constitute a good class of hides, being generally of good pattern and fairly well grown ; but they are largely spoiled in their treatment, which in the opinion of one leading firm of importers is worse to-day than it was fifty years ago. The hides exported from Burma vary greatly both in growth and quality. Rangoon is the outlet for hides not only from all over Burma, but from the trans-frontier districts of China and Annam, though as regards the supplies from across the Chinese frontier a competing route which is beginning to make its influence felt is that afforded by the French railway connecting Yunnan-fu with Haiphong (Tongking). Some of the hides exported from Rangoon are intrinsically very fine, and the trade, which has already grown considerably in the last few decades, is capable of much further expansion. Yet the condition in which the hides are exported has led to the assertion that no hide-producing country under British control is so far behind the times as Burma. The southern supply consists of sun-dried and arsenicated hides, but in the northern coastal districts in particular the hides are heavily cured and adulterated and very badly flayed, and in Rangoon itself the practice has grown up of wet-salting hides which have already been dried.

Most of these criticisms do not apply to the main supplies of raw Indian cow-hides. Those from the north-west parts of India are for the most part well prepared and flayed. In general, however, the flaying of hides in India is not of a high standard. The flaying of city-slaughtered cattle is done by Mohammedans, who also do the slaughtering. Cattle which die a natural death are usually flayed by low-caste Hindus. A suggestion that the quality of the work might be improved by a system of bonuses for well-flayed hides finds strong support in the results of a recent experiment in Bombay. About 200 cattle are killed daily in the Bandra slaughter-house, which is under the Bombay municipality. Formerly only about a third of the hides could be used for Army purposes: the rest had to be rejected because of butcher-cuts. The Market Superintendent granted the workmen an extension of time for slaughtering, and the buyer for the Government Tannery was authorised to pay the skinners a bonus of two annas for every well-flayed hide. As a result, according to a Government *communiqué* dated October 1st, 1917, less than 5 per cent. of the hides have since been rejected for faulty flaying.

Unfortunately, this gain in efficiency has not been general. In May, 1918, the Indian Munitions Board issued a statement to the Calcutta dealers in raw hides, regretting that no improvement had been effected in the cure and fleshing of dry-salted hides, and giving notice that on and after July 15th, 1918, Government would refuse to purchase any raw hides which were not cleanly-fleshed or which bore more cure than was necessary for the preservation of the hide. The style of cure laid down as a standard is that of the original cure of "real Meherpore" hides.

Another defect in the hides which greatly limits their value for tanning purposes is due to the native methods of branding cattle. Sometimes the brand consists of double semi-circular lines covering the butt part of the hide and even extending to the shoulder. It has been estimated that as a result of this practice there is a reduction of between one and three rupees in the value of each hide. In some districts nearly half the hides are spoiled for Army purposes by branding. The Indian Munitions Board has brought the matter to the attention of Local Governments in the hope that native owners of cattle may be induced to adopt the use of smaller brands.

The religious customs of the natives play their part in the branding of cattle, as in other matters affecting the trade in Indian hides. Veterinary methods are also an important factor. Suggestions for obviating the difficulty are now under consideration. If they can be carried out, and if at the same time means can be devised for securing better workmanship in the flaying and curing of the hides, the reputation of East Indian kips will be greatly benefited, with corresponding advantage to the prices they command.

Exports of Raw Kips.—The following table shows the number, the total weight and value, and the average weight and value, of the raw cow-hides exported from India in each year for which returns are available. The year 1912–13 was the first in which these exports were separately recorded in the Indian trade returns :

Exports of Raw Cow-hides from India

Year.	Quantity.		Value.	Average weight.	Average export value per lb.
	Number.	Weight. *Cwts.*	£	*lb.*	*d.*
1912–13	10,277,990	831,200	3,969,754	9·1	10·2
1913–14	8,967,518	743,037	3,937,007	9·3	11·4
1914–15	5,947,080	480,513	2,477,553	9·0	11·0
1915–16	8,180,599	689,113	3,743,928	9·4	11·6
1916–17	6,410,937	581,645	3,335,926	10·2	12·3
1917–18	—	317,588	1,546,798	—	10·4

During the war, up to and including the year 1917–18, the exports of raw cow-hides fell off considerably in quantity, and prices did not greatly increase ; in 1917–18, indeed, the average export value per lb. was less than in the year before the war. In percentages of the exports in 1913–14, the exports in the four following years were : in 1914–15, weight 65, value 63 ; in 1915–16, weight 93, value 95 ; in 1916–17, weight 78, value 85 ; in 1917–18, weight 43, value 39.

The following table shows the dominant position occupied by the ports of Bengal in the export trade in raw cow-hides, and also the growing importance of the Sind ports (Karachi) during the first three years of war :

Exports of Raw Cow-hides by Provinces

Provinces.	Percentages of weight.				
	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Bengal	77·8	76·0	72·9	73·2	56·5
Sind	10·5	9·5	12·2	16·8	22·6
Burma	9·9	12·6	12·5	10·0	11·7
Others [1]	1·8	1·9	2·4	—	9·2
Total	100·0	100·0	100·0	100·0	100·0

[1] *Almost wholly Bombay.*

The distribution of the raw cow-hides exported, as given in the Indian trade returns, is shown in the following table. The italicised figures denote percentages.

Exports of Raw Cow-hides: Distribution

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	831,200	743,037	480,513	689,113	581,645
,, value	£3,969,754	3,937,007	2,477,553	3,743,928	3,335,926
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
To British Countries:					
United Kingdom	35,076	14,919	77,923	56,298	106,099
	4·2	*2·0*	*16·2*	*8·2*	*18·2*
Canada . .	5,247	8,978	2,261	11,006	12,848
Others . .	757	166	156	4,581	2,300
Total . .	41,080	24,063	80,340	71,885	121,247
	4·9	*3·2*	*16·7*	*10·4*	*20·9*
To Allied Countries:					
Italy . .	116,095	92,662	66,211	358,718	163,721
	14·0	*12·5*	*13·8*	*52·1*	*28·1*
France . .	17,844	14,283	6,867	21,679	37,308
	2·1	*1·9*	*1·4*	*3·1*	*6·4*
Belgium . .	18,850	20,435	6,565	—	—
	2·3	*2·8*	*1·4*		
United States .	69,434	36,820	73,884	191,657	208,604
	8·4	*5·0*	*15·4*	*27·8*	*35·9*
Others . .	2,397	2,127	736	9	2,310
Total . .	224,620	166,327	154,263	572,063	411,943
	27·0	*22·4*	*32·1*	*83·0*	*70·8*
To Enemy Countries:					
Germany .	365,874	356,195	137,655	—	—
	44·0	*47·9*	*28·6*		
Austria-Hungary	113,620	141,537	38,865	—	—
	13·7	*19·0*	*8·1*		
Turkey . .	8,924	2,961	572	—	—
Bulgaria .	2,683	1,422	1,995	—	—
Total . .	491,101	502,115	179,087	—	—
	59·1	*67·6*	*37·3*		
To Neutral Countries:					
Spain . .	57,793	41,865	41,890	28,135	34,341
	7·0	*5·6*	*8·7*	*4·1*	*5·9*
Holland . .	16,252	7,771	2,046	—	—
Norway . .	125	83	2,243	9,862	13,531
Sweden . .	—	—	19,526	6,564	—
Others . .	229	813	1,118	604	583
Total . .	74,399	50,532	66,823	45,165	48,455
	9·0	*6·8*	*13·9*	*6·6*	*8·3*

In the year before the war over two-thirds of the exports of raw cow-hides from India were consigned to enemy countries (Germany, nearly half), and between one-fifth and one-fourth to Allied countries. Exports to the United Kingdom were only 2 per cent. of the total and to all British countries only 3·2 per cent. During the war the United States and Italy have taken the bulk of the exports. According to a statement issued by the Government of India and published in the *Indian Trade Journal* (1917, **44**, 206), in the pre-war cow-hide trade from Calcutta the hides taken by Germany and Austria averaged about 9½ lb. in weight; it is believed that the heaviest were used exclusively for the Scandinavian market. The hides taken by Italy and Spain averaged from 5½ lb. to 6 lb. The war made no change in this respect in the Spanish trade, but Italy's takings, which in 1915–16 especially were very greatly increased, went up in average weight to 7½ lb. Heavier classes of hides have been taken by the United States (11½ lb.) and the United Kingdom (12 lb.).

In Europe the chief centre of the pre-war trade in raw Indian cow-hides was Hamburg, and in India the collection and export of the hides had passed into the hands of firms consisting of Germans, or naturalised persons of German origin, who formed an effective ring. One or two English firms had attempted occasionally to enter the trade, but failed to break the ring, and in the case of an Indian firm which made the attempt the ring adopted, with some success, a policy of boycott. During the war steps have been taken not only to cut off supplies from enemy markets, but to bring the trade at its source under British control. Proposals for dealing with the post-war trade problem were made by the Imperial Institute Committee on Hides and Tanning Materials, after consultation with the United Tanners' Federation of Great Britain and Ireland, and with representatives of British firms in India, who were ready to enter the trade under certain conditions. Lecturing before the Indian Section of the Royal Society of Arts on the Indian Hide and Leather Trade on February 14th, 1918, Sir Henry Ledgard, a member of the Committee and lately President of the Upper India Chamber of Commerce, stated (*Journal R.S.A.*, 1918, **46**, 281) that the Tanners' Federation were prepared to handle increasing quantities of kips up to 4,000,000 in the third year after the conclusion of the war, subject to:

1. The imposition in India of an export duty on raw

hides, to be remitted in the case of hides tanned within the Empire.

2. The elimination of firms with German or Austrian connections from the trade.

3. The granting, where necessary and advisable, of financial assistance to tanners adapting their yards or building tanneries to deal with East Indian hides.

Sir Henry Ledgard added that in their report the Committee of the Imperial Institute "also laid stress on the importance of the fullest development possible of the tanning of kips in India which shall involve the employment of Indian labour and capital in the manufacture of leather goods from Indian tanned leather."

Recent developments in the tanning of kips in India will be seen from the next section.

Tanned Cow-hides.—The exports of tanned cow-hides from India in each year for which returns are available are shown in the following table:

Exports of Tanned Cow-hides from India

Year.	Quantity.		Value.	Average weight.	Average export value per lb.
	Number.	Weight.			
		Cwts.	£	*lb.*	*d.*
1912–13 .	2,936,440	215,429	1,278,000	8·2	12·7
1913–14 .	2,006,857	158,383	982,654	8·8	13·3
1914–15 .	2,480,225	191,565	1,447,126	8·7	16·2
1915–16 .	3,273,820	247,380	1,892,594	8·5	16·4
1916–17 [1] .	3,867,418	286,210	2,687,622	8·3	20·1
1917–18 [2] .	—	342,806	3,115,887	—	19·5

[1] *Including* 140,869 *cwts. valued at* £1,274,432 *on Government account (average value per lb.,* 19·4*d.*).

[2] *All but* 909 *cwts., valued at* £9,567, *on Government account.*

The average weight of the tanned hides exported is slightly (under 1 lb.) less than that of the raw hides. Before the war the difference between the average prices (export value) of the raw and tanned hides was from 2*d.* to 2½*d.* per lb.; in the first two years of the war it rose to 5*d.* per lb., in 1916–17 to nearly 8*d.* per lb., and in 1917–18 to 9*d.* per lb., this being due to the increase in value of the tanned hides. The total quantity exported has also increased. In percentages of the exports in 1913–14, the exports in the four following years were: in 1914–15, weight 121, value 147; in 1915–16, weight 156, value 193; in 1916–17, weight 181, value 274; in 1917–18, weight 216, value 317. Coincident with this increase in the exports of tanned cow-hides there was, as already noted, a large decrease in the exports of raw cow-hides. Consequently during the war the proportion of tanned to raw hides has greatly increased. In 1912–13 the proportion by weight was a little over 1 to 4, and in 1913–14 a little over 1 to 5, whereas in 1916–17 it was nearly 1 to 2, and in 1917–18 the weight of tanned hides exported was actually a little in excess of the weight of raw hides.

About 80 per cent. of the exports of tanned cow-hides from India are despatched ordinarily from Madras ports (nearly all from the port of Madras), and the rest almost wholly from Bombay ports. The Madras *Handbook of Commercial Information* states that tanned (unfinished) cow-hides are exported from that presidency in pressed, gunnied, roped bales, each containing from 650 lb. to 675 lb., or sometimes 700 lb. These tanned hides are available for export all the year round, and are sold on standards, of which each firm has its own. They are mostly described by names of localities: *i.e.* Coasts, Bangalores (Best and Ordinary), Pallavarams, Hyderabads, Cocanada Coasts. Light Cocanada Coasts weigh about 7½ lb. and light Bangalores 8 lb. to 8½ lb. (minimum in both classes, 3 lb.; maximum, 14 lb.). "Heavies" in both classes usually weigh from 14½ lb. to 16 lb. (minimum, 12 lb.; maximum, 20 lb.). All but one or two per cent. of the total exports of tanned cow-hides from India are consigned ordinarily to the United Kingdom, and it is believed that they are mostly absorbed into the industry of this country. The precise figures given in the Indian trade returns are:

Tanned Kips: Distribution of Exports from India

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	215,429	158,383	191,565	247,380	286,210
,, value	£1,278,000	982,654	1,447,126	1,892,594	2,687,622
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
To British Countries:					
United Kingdom	213,673 *99·2*	155,550 *98·2*	189,551 *98·9*	246,366 *99·6*	285,330 *99·7*
Others . .	1,179	799	572	1,014	863
Total . .	214,852	156,349	190,123	247,380	286,193
To Foreign Countries	577	2,034	1,442	—	17

One reason why foreign countries take so small a proportion of the tanned kips is that most countries, while admitting raw hides free, impose a tariff on tanned hides. So long as that condition continues, and subject to whatever limit there may be to the ability of British industry to absorb the tanned kips, it would seem that, apart from any other action which might be taken, the British share in the total trade in Indian cow-hides might be increased by extending the tanning of these hides in India before export.

Although the United Kingdom has always been the chief market for Indian tanned cow-hides, leather of this description was so little appreciated for the uppers of British Army boots before the war that War Office contracts ruled out East India kips in favour of heavy ox-hides (Sir Henry Ledgard, *opus cit.*). During the war there has been a great change. The *Pioneer Mail* of January 25th, 1918, quoting the Controller of Hides and Wool in India, stated that at least three-fifths of the upper leather used in the United Kingdom in the manufacture of boots for the Allied Armies was supplied from East India kips. The magnitude of the demand may be appreciated from the further statement that the minimum requirements of Army upper leather for the year 1917 were estimated at 80,000,000 feet. Nor are the export returns the only measure of the increased output of tanned kips in India. There has been a great development in the Indian manufacture of leather accoutrements and boots to meet the needs of the Army in India and the Indian Expeditionary Forces. In this connection, according to the *Pioneer Mail*, the Indian Munitions Board arranged to supply 35,000 kips monthly to the boot factories in Cawnpore, and 8,000 kips monthly to the Government Harness and Saddlery Factory in Cawnpore.

Buffalo-hides

Buffaloes are used in India for the same purposes as other cattle—the bulls for tillage and road work, the cows for the supply of milk. They are not so numerous as ordinary cattle, but are larger and more powerful. There are considerable differences between the different breeds, and generalised statements can only be made with reserve; but the buffaloes of southern India are mostly smaller and less valuable than those found in the northern provinces and Burma. Little attention is given to breeding. As a rule, bull buffaloes can be bought very cheaply, and except in specially good grazing districts it does not pay to make a business of rearing them. Both bulls and cows are slaughtered in large numbers, notably at Agra, Aligarh, and Sekundra, for the dried meat export trade to Burma. In 1915–16 Burma's imports of this commodity from other provinces were valued at £150,000.

Raw Buffalo-hides.—The Indian export trade in buffalo-hides, raw and tanned, amounts in weight to about one-third of the export trade in cow-hides. Separate returns were first published in 1912–13. The following table shows the number, total weight and value, and average weight and value of the raw buffalo-hides exported in that and subsequent years:

Exports of Raw Buffalo-hides

Year.	Quantity.		Value.	Average weight.	Average value per lb.
	Number.	Weight. *Cwts.*	£	*lb.*	*d.*
1912–13 .	2,055,678	345,037	1,266,071	18·8	7·9
1913–14 .	1,967,018	345,864	1,469,113	19·7	9·1
1914–15 .	1,213,113	211,745	921,993	19·5	9·3
1915–16 .	970,742	162,887	621,837	18·8	8·2
1916–17 .	1,495,046	261,099	1,351,626	19·6	11·1
1917–18 .	—	84,900	425,112	—	10·7

The average weight of the raw buffalo-hides exported is about double that of the raw cow-hides. The average export value of buffalo-hides before the war was about 2*d.* per lb. less than that of cow-hides, and in 1915–16 the difference increased to nearly 3½*d.* per lb.; but in 1917–18 buffalo-hides commanded a slightly higher price than cow-hides. During the war there has been a marked decrease in the exports of raw buffalo-hides, and in 1917–18 the drop was especially great. In percentages of the exports in 1913–14 the exports in the next four years were: in 1914–15, weight 61, value 63; in 1915–16, weight 47, value 42; in 1916–17, weight 75, value 92; in 1917–18, weight 25, value 29.

Bengal is the outlet for about four-fifths of the exports of raw buffalo-hides; Burma provides from 10 to 15 per cent. (only 5 per cent. in 1916–17); and most of the remainder are despatched from Sind. The hides from Bengal were mostly exported, before the war, to Austria and the United States, the average weights taken by those two countries being about the general mean—19 to 20 lb. The hides from Burma are much heavier. They used to be exported chiefly to the United Kingdom and Turkey, which took weights of from 40 to 60 lb. (*Indian Trade Journal*, 1917, **44**, 206). The distribution of the total exports, before and during the war, is shown in the following table, the italicised figures denoting percentages:

Raw Buffalo-hides: Distribution of Exports

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	345,037	345,864	211,745	162,887	261,099
,, value	£1,266,071	1,469,113	921,993	621,837	1,351,626
TO BRITISH COUNTRIES:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom .	46,551 *13·5*	26,254 *7·6*	52,062 *24·6*	41,711 *25·6*	37,426 *14·3*
Others . . .	4,576	5,639	957	1,109	2,152
Total . .	51,127 *14·8*	31,893 *9·2*	53,019 *25·0*	42,820 *26·3*	39,578 *15·2*
TO ALLIED COUNTRIES:					
United States .	143,766 *41·7*	114,476 *33·1*	107,074 *50·6*	108,495 *66·6*	215,718 *82·6*
Italy . . .	10,921 *3·2*	7,150 *2·1*	1,322 *0·6*	10,251 *6·3*	2,233 *0·9*
France . .	6,646 *1·9*	3,232 *0·9*	1,368 *0·6*	55	230
Others . .	3,612	1,928	788	14	1,783
Total . .	164,945 *47·8*	126,786 *36·7*	110,552 *52·2*	118,815 *72·9*	219,964 *84·2*
TO ENEMY COUNTRIES:					
Austria-Hungary	58,276 *16·9*	91,736 *26·5*	20,799 *9·8*	—	—
Germany . .	22,148 *6·4*	30,785 *8·9*	7,744 *3·7*	—	—
Turkey . .	15,685 *4·5*	30,134 *8·7*	10,277 *4·9*	—	—
Bulgaria . .	2,966	1,241	2,684	—	—
German East Africa	4	—	—	—	—
Total . .	99,079 *28·7*	153,896 *44·5*	41,504 *19·6*	—	—
TO NEUTRAL COUNTRIES:					
Holland . .	25,966 *7·5*	32,485 *9·4*	3,097 *1·5*	—	—
Others . .	3,920	804	3,573	1,252	1,557
Total . .	29,886 *8·7*	33,289 *9·6*	6,670 *3·2*	1,252 *0·8*	1,557 *0·6*

As in the case of raw cow-hides, only a minor part of the exports of raw buffalo-hides from India before the war was consigned to countries within the British Empire, though in 1912–13 the United Kingdom stood third in the list among individual countries. Foreign countries took 85 per cent. of the total in 1912–13, and over 90 per cent. in 1913–14. But whereas the largest buyer of kips was Germany, the largest buyer of buffalo-hides was the United States, which took two-fifths of the total in 1912–13 and a third of the total in 1913–14. The next largest share of the pre-war exports was taken by Austria-Hungary—one-sixth in 1912–13, and one-fourth in 1913–14. It is interesting to compare the exports to all Allied countries and all Enemy countries in the two years before the war. The total exports in those two years were practically the same. In 1912–13 Allied countries took 47·8 per cent. of the total, against 28·7 per cent. consigned to Enemy countries. In 1913–14 the positions were reversed, Enemy countries taking 44·5 per cent. of the total against 36·7 per cent. consigned to Allied countries. In the first two years of the war the United States strengthened the dominating position it occupied in this trade, taking half the total exports of raw buffalo-hides in 1914–15 and two-thirds of the total in 1915–16; but this increase in the United States percentage share of the trade was entirely due to the shrinkage of the total exports, for neither in 1914–15 nor in 1915–16 were the actual exports to the United States so large as either in 1912–13 or in 1913–14. In 1916–17, however, not only did the proportion of the exports consigned to the United States increase to over four-fifths, but the quantity was 50 per cent. greater than in 1912–13, the previous highest on record. The United Kingdom's share in the trade increased during the first two years of the war to one-fourth of the total, but declined again in 1916–17 to 14·3 per cent.; the actual exports to the United Kingdom, during the quinquennium for which returns are available, reached their minimum in 1913–14 (26,000 cwts.) and their maximum in 1914–15 (52,000 cwts.).

Tanned Buffalo-hides.—Very few buffalo-hides, comparatively, were tanned for export before the war, but the character of the trade in buffalo-hides has undergone a marked change in this respect during the war. The number, total weight and value, and average weight and value of the tanned hides exported are shown in the following table for 1912–13 (the first year for which separate returns are available) and subsequent years.

Exports of Tanned Buffalo-hides

Year.	Quantity.		Value.	Average weight.	Average value per lb.
	Number.	Weight. *Cwts.*	£	*lb.*	*d.*
1912–13 . .	168,119	17,004	78,612	11·3	9·9
1913–14 . .	160,604	15,545	75,127	10·8	10·4
1914–15 . .	263,040	25,261	157,520	10·8	13·4
1915–16 . .	270,137	24,234	145,102	10·0	12·8
1916–17 . .	339,038	32,178	239,483	10·6	15·9
1917–18 .	—	18,552	126,733	—	14·6

The average weight of the tanned buffalo-hides exported is not much more than half that of the raw hides. Before the war the average value of the tanned hides was only from 1*d.* to 2*d.* per lb. more than that of the raw, but the difference increased during the war till in 1916–17 it was nearly 5*d.* per lb., although in the interval the raw hides had themselves increased considerably in value. In 1917–18 the average export values per lb. of both raw and tanned buffalo-hides declined, and the difference between them was reduced to just under 4*d.* per lb. The total weight as well as the value of the tanned buffalo-hides entering into the export trade increased during the first three years of the war, but dropped again to little more than the pre-war figure in 1917–18. In percentages of the exports in 1913–14, the exports in succeeding years were: in 1914–15, weight 163, value 210; in 1915–16, weight 156, value 193; in 1916–17, weight 207, value 319; in 1917–18, weight 119, value 169. As this increase in the weight of the tanned hides exported was accompanied by a decrease in the export of raw hides, the ratio of raw and tanned hides underwent a striking change during these years. Before the war the trade in tanned buffalo-hides was remarkable for the smallness of its proportion to the trade in raw hides; the proportion of raw to tanned was 20 : 1 in 1912–13 and 22 : 1 in 1913–14. The change on the outbreak of war was immediate. In 1914–15 the proportion was 8 : 1 ; in the next two years there was little further change ; in 1917–18 the proportion was 4·5 : 1.

Nine-tenths of the Indian export trade in tanned buffalo-hides is done from Madras (86 per cent. in 1912–13, 90 per cent. in 1913–14, 88 per cent. in 1914–15, 97 per cent. in 1915–16, 94 per cent. in 1916–17). The remaining exports of this class practically all find an outlet through Bombay. The Madras *Handbook of Commercial Information* states that the tanned hides are available all the year round, and are packed in pressed bales, wrapped in gunnies and roped, each containing from 650 lb. to 675 lb. Cold-weather hides are slightly better than hot-weather. They are usually sold on standards, and the average weight is given as 12–13½ lb.

The distribution of the exports, as shown by the Indian trade returns, was almost entirely to British countries, even before the war. The following are the figures, with percentages added in italics :

Tanned Buffalo-hides : Distribution of Exports

		1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity	*cwts.*	17,004	15,545	25,261	24,234	32,178
„ value		£78,612	75,127	157,520	145,102	239,483
To British Countries :		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom		14,704 *86·5*	14,047 *90·4*	24,371 *96·5*	23,894 *98·6*	31,789 *98·8*
Egypt		1,655 *9·7*	710 *4·6*	161	340	387
Others		179	127	50	—	—
Total		16,538 *97·3*	14,884 *95·7*	24,582 *97·3*	24,234 *100·0*	32,176 *100·0*
To Foreign Countries [1]		466	661	679	—	2

[1] *Mostly to Turkey.*

As in the case of kips, a question for consideration is whether the British share in the total trade in buffalo-hides could not be increased by extending the tanning of these hides in India before export. It is believed that a far larger quantity of buffalo-hides could be absorbed by British industry than is at present the case. The partially tanned hides hitherto taken by the United Kingdom are admirably adapted for dressing, and might command a larger sale, especially if the medium and heavy hides could be tanned with materials which would produce a more solid leather. Medium weights could be used for in-soling and other purposes for which shoulders are employed, and heavy weights for soles. "Heavies," if chrome tanned, might also be used for picking bands, or in the raw state for pickers. Light weights are suitable for use as upper leather.

Calf-skins

Calf-skins form the smallest class of hides and skins separately recorded in the returns of the export trade of India. It is only for raw calf-skins that separate figures are given, and as these are recorded as one of the groups under the heading "Raw Hides," it is to be inferred that tanned calf-skins are included among "Other Hides" under the heading "Hides, Tanned or Dressed." In that case the exports of tanned calf-skins are very small, for the total of "Other Hides, Tanned or Dressed," in the four years 1912–13 to 1915–16 ranged only from 100 cwts. to 830 cwts., and though the total rose to 4,002 cwts. in 1916–17, it was down again to 316 cwts. in 1917–18. The exports of raw calf-skins were first recorded separately in 1912–13, and the figures for that and following years are shown in the following table, with the calculated average weights and values:

Exports of Raw Calf-skins

Year.	Quantity.		Value.	Average weight.	Average value. per lb.
	Number.	Weights. *Cwts.*	£	*lb.*	*d.*
1912–13 .	1,099,200	29,640	126,652	3·0	9·2
1913–14 .	809,550	26,116	122,039	3·6	10·0
1914–15 .	589,433	21,158	99,161	4·0	10·0
1915–16 .	858,639	29,761	157,367	3·9	11·3
1916–17 .	1,490,141	50,933	306,401	3·8	12·9
1917–18 .	—	15,415	85,182	—	11·8

Judged by pre-war standards, the most noticeable features of the subsequent trade in raw calf-skins have been the big increase in the exports in 1916–17 and the big decline in 1917–18. Before the war from 80 to 90 per cent. of the exports were despatched from Bengal ports, the remainder going through Sind. In the first three years of the war the share of Bengal declined to 39 per cent., while that of Sind increased to 60 per cent.

The distribution of the exports is shown in the following table, the italicised figures denoting percentages :

Raw Calf-skins : Distribution of Exports

		1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity .	*cwts.*	29,640	26,116	21,158	29,761	50,933
„ value .	. £	126,652	122,039	99,161	157,367	306,401
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
To British Countries[1]		1,483 *5·0*	956 *3·7*	2,044 *9·7*	1,196 *4·0*	1,282 *2·5*
To Allied Countries :						
United States . .		14,921 *50·3*	4,076 *15·6*	8,092 *38·2*	12,813 *43·1*	36,845 *72·3*
Italy . . .		5,890 *19·9*	6,822 *26·1*	4,666 *22·5*	14,391 *48·4*	6,917 *13·6*
Others[2] . . .		720	342	384	190	24
Total . . .		21,531 *72·6*	11,240 *43·0*	13,142 *62·1*	27,394 *92·1*	43,786 *86·0*
To Enemy Countries :						
Germany . . .		404 *1·4*	1,213 *4·6*	1,083 *5·1*	—	—
Austria-Hungary .		1,516 *5·1*	4,556 *17·5*	479 *2·3*	—	—
Total . . .		1,920 *6·5*	5,769 *22·1*	1,562 *7·4*	—	—
To Neutral Countries :						
Spain . . .		4,292 *14·5*	6,843 *26·2*	4,023 *19·0*	1,171 *3·9*	5,749 *11·3*
Others[3] . . .		414	1,308	387	—	116
Total . . .		4,706 *15·9*	8,151 *31·2*	4,410 *20·8*	1,171 *3·9*	5,865 *11·5*

[1] *Practically all to the United Kingdom.*
[2] *Chiefly France.* [3] *Chiefly Holland.*

There are very few exports of raw calf-skins from India to British countries except the United Kingdom, and its share in the trade is only small. The great bulk of the exports before the war were taken by four countries —the United States, Italy, Spain, and Austria-Hungary. These four countries took 90 per cent. of the total in 1912–13 and 85 per cent. in 1913–14. In the first three years of the war most of the exports went to the United States and Italy, Spain making a good third except in 1915–16, when Italy's share was unusually large. In general, the United States has been the principal factor in the trade ; in three out of the five years under review, it provided the largest market for India's raw calf-skins.

Goat-skins

Goats are found all over India, and range from the large, well-proportioned, long-haired breeds of the Himalayas to the nondescript but hardy varieties in the south of the peninsula. In the economic life of India they are primarily of importance as a source of milk and meat supply; though the Himalayan breeds are also kept for the sake of their hair. In general, breeding is subject to little control, and the varieties are as numerous as they are ill-defined. The female produces two or three kids at a birth, often twice a year. In the fine weather season the professional shepherds wander over Peninsular India with their sheep and goats, letting them graze by day and at night folding them on arable land, which they fertilise with their droppings, a service regarded as sufficiently valuable to command payment from the cultivators.

Both in weight and in value goat-skins are the second most important constituent of the Indian trade in hides and skins, ranking next to kips. Normally they provide, in raw and tanned skins, exports amounting to over 500,000 cwts., with an export value of over £3,000,000. As in the trade in hides, the great bulk of the exports consist of the raw product. The skins from the male animals are characterised by a strong smell, which does not disappear even from some finishes of the leather; but if the males have been castrated their skins are said to be free from this drawback, and to command a higher price in consequence (*Leather World*, 1918, **10**, 419).

Raw Goat-skins.—The following table shows the exports of raw goat-skins for six years:

Exports of Raw Goat-skins from India

Year.	Quantity.		Value.	Average weight.	Average value per lb.
	Number.	Weight.			
		Cwts.	£	*lb.*	*d.*
1912–13 .	21,716,896	520,954	2,278,616	2·7	9·4
1913–14 .	19,690,958	453,356	2,085,132	2·6	9·9
1914–15 .	16,409,829	382,060	1,561,018	2·6	8·8
1915–16 .	19,618,894	399,951	1,836,543	2·3	9·8
1916–17 .	27,866,563	521,808	4,275,888	2·1	17·6
1917–18 .	—	392,034	2,913,719	—	15·9

The first result of the war was to reduce the exports, but in 1916–17 they were again fully normal in quantity, while the average price, which until then had shown little variation from the pre-war figure, increased nearly 80 per cent. In 1917–18 there was again a considerable reduction in the quantity exported, and a slight reduction in the average price, which, however, remained much above the pre-war figure. In percentages of the exports in 1913–14, the exports in the four following years were: in 1914–15, weight 84, value 75; in 1915–16, weight 88, value 88; in 1916–17, weight 115, value 205; in 1917–18, weight 86, value 140.

The average price per lb. (export value) before the war was slightly less than that of raw cow-hides and slightly more than that of raw buffalo-hides. The average weight is about 2½ lb. The average weight of any particular consignment, however, may differ from this considerably, being determined not only by the size of the skins but by the way in which they are cured. The following particulars from the Madras *Handbook of Commercial Information* will serve to indicate the different methods of treating the skins, though in so far as the statements about these methods are comparative, it must be remembered that the trade of Madras in raw goat-skins forms only a small fraction of the whole. In Madras the skins are mostly dry-salted with the hair on, but sometimes they are flint-dried (air-dried; hard) and very occasionally are wet-salted in the hair, or unhaired and then pickled in a solution of alum and salt. Each skin varies from the rest, and they are very difficult to grade. Firms have their own standards for sorting into firsts and seconds, the substance and condition of the skins being the chief factors taken into account. Supplies are available all the year round, though as a rule cold-weather skins are better than hot-weather skins. Pickled skins are exported in casks, the others in pressed bales packed in mats and gunnies, each containing about 756 lb. net.

Neither the Indian nor the United Kingdom trade returns distinguish between the different classes of raw goat-skins exported or imported; but the United States trade returns distinguish between "dry" and "green or pickled" skins. In 1913–14 the number of dry goat-skins imported into the United States from India was over six times the number of pickled skins imported, and their value was over six times as great; but the weight of the dry skins was only three times that of the pickled skins. That is to say, a pickled skin weighs on average twice as much as a dry skin, but only fetches the same price. The additional weight imparted to the skin by the pickling process does not add to the value of the skin, and must add to the transport charges. Already most of the raw goat-skins are exported in a dry state, and it would seem to be desirable that the dry method of preservation should be adopted still more widely, unless there is a definite demand for pickled skins for special purposes.

The Indian export trade in raw goat-skins is distributed among the provinces more evenly than the trade in raw hides, but the largest share of the skins, as of the hides, falls to Bengal in normal times. During the first three years of war the ports of Bombay and Sind improved their positions, relatively, at the expense of Bengal. The following table shows the chief percentage shares of the provinces of shipment for five years. (From Burma there are occasional exports of raw goat-skins, but only to the extent of a fraction of 1 per cent. of the total.)

Exports of Raw Goat-skins by Provinces

Provinces.	Percentages (weight).				
	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Bengal	45·6	45·3	41·7	40·0	27·7
Bombay	29·1	30·2	33·4	31·3	36·1
Sind	15·7	18·5	20·6	22·3	30·5
Madras	9·4	5·9	4·3	6·4	5·7
	99·8	99·9	100·0	100·0	100·0

The distribution of these exports overseas, as given in the Indian trade returns, is shown in the following table;

Exports of Raw Goat-skins: Distribution

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	520,954	453,356	382,060	399,951	521,808
„ value . .	£2,278,616	2,085,132	1,561,018	1,836,543	4,275,888
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
To British Countries:					
United Kingdom	56,287 *10·8*	40,259 *8·9*	39,305 *10·3*	33,424 *8·4*	40,559 *7·8*
Others [1] . .	6,885	3,044	3,023	4,943	6,903
Total . .	63,172 *12·1*	43,303 *9·6*	42,328 *11·1*	38,367 *9·6*	47,462 *9·1*
To Allied Countries:					
United States .	381,266 *73·2*	342,452 *75·5*	300,676 *78·7*	353,997 *88·5*	452,151 *86·7*
France . .	35,659 *6·8*	22,717 *5·0*	8,667 *2·3*	7,573 *1·9*	21,893 *4·2*
Others [2] . .	5,668	8,953	9,764	14	302
Total . .	422,593 *81·1*	374,122 *82·5*	319,107 *83·5*	361,584 *90·4*	474,346 *90·9*
To Enemy Countries:					
Germany . .	12,504 *2·4*	11,118 *2·5*	7,003 *1·8*	—	—
Austria-Hungary	1,295	1,262	56	—	—
Total . .	13,799 *2·7*	12,380 *2·7*	7,059 *1·8*	—	—
To Neutral Countries:					
Holland . .	21,390 *4·1*	23,551 *5·2*	13,547 *3·5*	—	—
Others . .	—	—	19	—	—
Total . .	21,390 *4·1*	23,551 *5·2*	13,566 *3·6*	—	—

[1] *Chiefly Australia.*
[2] *Chiefly Belgium, up to and including* 1914–15.

Three-fourths of the exports of raw goat-skins from India before the war were taken by the United States, whose predominant interests in this trade are attributed to American specialisation in the manufacture of glacé kid. Not only is the total production in the United States many times the production in the United Kingdom, but individual American firms turn out glacé kid in quantities far in excess of the output of any British firm. A few years ago this branch of American industry was suffering from over-production, but it enjoyed a revival of prosperity in the early stages of the war. In 1916–17 the exports of raw goat-skins from India to the United States formed nearly 87 per cent. of the total, and the actual quantity was greater than before the war. India's next best customers used to be the United Kingdom, France, Holland and Germany. For some years before the war these four countries, with the United States, took over 97 per cent. of the total. The proportion taken by Germany, though small, was increasing (from 1·5 per cent. in 1910–11 to 2·5 per cent. in 1913–14), and so was the proportion taken by Holland (from 3·4 per cent. in 1910–11 to 5·2 per cent. in 1913–14). On the other hand the proportion taken by France was only 5 per cent. in 1913–14 against 7·4 per cent. in 1910–11. Among countries not listed separately in the preceding table, Australia took the bulk of the exports to British countries other than that of the United Kingdom. Before the war the trade was declining; exports to Australia dropped from 9,386 cwts. in 1910–11 to 1,964 cwts. in 1913–14; but both in 1914–15 and in 1915–16 there was some recovery. Practically all the exports to Allied countries other than the United States and France went to Belgium, and the rapid increase of trade in this direction before the war is apparent from the table.

Though a long way behind the United States, the United Kingdom took the next largest share of the exports of raw goat-skins from India. There is, however, a large re-export trade in these skins from the United Kingdom. According to the United Kingdom trade returns, only about one-fifth of the undressed goat-skins imported from India were retained before the war; in 1915 the proportion rose to between one-third and one-fourth, but in 1916 it dropped to less than one-eleventh. The figures have already been given in conjunction with other returns of the United Kingdom trade in Indian hides and skins (see p. 195), but it will be convenient to repeat them here.

United Kingdom Imports of Raw Indian Goat-skins

	1912.	1913.	1914.	1915.	1916.
Number imported	5,499,192	5,933,071	3,648,301	4,988,277	5,926,264
Number retained	1,217,481	1,149,836	710,055	1,437,680	511,662

With these figures may be contrasted the following, taken from the Indian trade returns :

Number of Raw Goat-skins exported from India to the United Kingdom

1911–12.	1912–13.	1913–14.	1914–15.	1915–16.
1,406,162	2,109,517	1,412,071	1,275,858	1,289,301

Exact comparison of the Indian export returns with the United Kingdom import returns is impossible, not only because of the difference in the trade years for which statistics are given (calendar years in the case of the United Kingdom, and years ending March 31st in the case of India), but because of the time allowance necessary for transport. In general, however, it will be seen that the Indian export returns are intermediate between the United Kingdom gross and net import returns, though much nearer the net than the gross returns. The two periods of five years covered by the tables differ at each end by nine months, less the time allowance for transport. During the one period (1912–16), according to the United Kingdom trade returns, the gross imports of undressed goat-skins from India amounted to nearly 26,000,000 skins, and the net imports to just over 5,000,000 skins ; while in the other period (1911–12 to 1915–16), according to the Indian trade returns, the exports of raw goat-skins to the United Kingdom amounted to 7,500,000 skins. The Indian trade returns aim at giving as nearly as possible the exports to countries of final destination ; and in the case of the trade in raw goat-skins with the United Kingdom it would appear that the Indian returns have gone a long way in this direction, but that some further reduction is still necessary.

Incidentally it may be calculated from the Indian trade returns, in regard to the exports of raw goat-skins to the United Kingdom, that their percentage of the whole by weight is greater than their percentage by number ; in other words, the skins exported to the United Kingdom are heavier than the average. But the outstanding fact, clearly revealed by the United Kingdom returns, is that the British trade in raw Indian goat-skins is largely a merchant trade : the skins are imported not for the use of British industry, but for sale to foreign buyers. The returns do not show the destinations of the

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re-exports of Indian skins, considered separately; but the distribution of the total re-exports of undressed goat-skins from the United Kingdom show that the Indian skins have been going chiefly to the United States. Normally between one-third and one-half of the gross imports of undressed goat-skins into the United Kingdom come from India (British countries as a whole supply about four-fifths of the total). Of these total imports from all sources about two-thirds (including four-fifths of the Indian skins) are re-exported. During the four years ending 1914 between 75 and 85 per cent. of these re-exports were consigned to the United States; in 1915 the percentage consigned to that country was 96, and in 1916 it was nearly 90. Before the war the next largest share of the re-exports of undressed goat-skins from the United Kingdom was taken by Germany, whose purchases were rapidly increasing—in 1911, 598,245 skins (nearly 8 per cent. of the total); in 1912, 930,291 skins (nearly 11 per cent.); in 1913, 1,121,994 skins (13 per cent.). During the war the largest share of the re-exports of undressed goat-skins from the United Kingdom, next to that of the United States, has been taken by France (in 1916, 847,230 skins, forming nearly 10 per cent. of the total).

While thus re-exporting to the United States more than half the undressed goat-skins shipped to this country, the United Kingdom takes from the United States large quantities of glacé kid, valued in each of the three years 1913–15 at about one and a half millions sterling, and in 1916 at two and a half millions. Thus there exists a state of affairs in which the raw material of a large and valuable industry is brought into this country, and then sent across the Atlantic for manufacture into an article of which large quantities cross the Atlantic in the reverse direction for sale in this country.

Tanned Goat-skins.—Analysis of the returns of the trade in tanned Indian goat-skins shows that that trade also, so far as the United Kingdom is concerned, is largely a merchant trade. During the last six years for which statistics are available, the total exports of tanned goat-skins from India were:

Exports of Tanned Goat-skins from India

Year.	Quantity. Number.	Quantity. Weight. Cwts.	Value. £	Average weight. lb.	Average value per lb. d.
1912–13 .	6,996,694	61,741	871,905	0·99	30·3
1913–14 .	8,575,249	74,126	1,073,767	0·97	31·0
1914–15 .	7,407,944	61,288	882,965	0·93	30·9
1915–16 .	8,402,764	70,773	986,999	0·94	29·9
1916–17 .	10,416,825	83,861	1,697,796	0·90	43·4
1917–18 .	—	15,303	468,734	—	65·6

In percentages of the exports in 1913–14 the exports of tanned goat-skins in the next four years were: in 1914–15, weight 83, value 82; in 1915–16, weight 95, value 92; in 1916–17, weight 113, value 158; in 1917–18, weight 21, value 44. The abnormal decline in the exports in 1917–18 and the great advance in their average value per lb. must both be considered in the light of government restrictions on industry and trade, including, it will be remembered, the prohibition of the tanning of skins in Madras and Bombay except by special permission. Unlike the Indian hides (both cow-hides and buffalo-hides), which gain comparatively little in export value per lb. by tanning, the average export value of tanned goat-skins per lb. is normally more than three times that of the raw skins (about 30*d.* per lb. tanned against 9*d.* to 10*d.* per lb. raw). This is true of each of the first four years in the last table. In 1916–17, when the prices of both raw and tanned goat-skins rose abnormally, the relation of the tanned to the raw skins in respect of average export value was about 5 : 2 (43·4*d.* per lb. against 17·6*d.* per lb.; and in 1917–18, when the average price of tanned skins continued to rise sharply, while that of raw skins declined a little, the proportion was as much as 4 : 1 (65·6*d.* per lb. against 15·9*d.* per lb.). On the other hand the big difference between the average weights of the raw and the tanned skins is noteworthy—the tanned skins averaging just under 1 lb. against about 2½ lb. in the case of the raw skins. The difference would seem to be largely due to the proportion of the raw skins which are exported in the " green " or " pickled " state. Those imported into the United States in this condition have an average weight of between 3 lb. and 4 lb., whereas the " dry " skins imported into the States average only from 1¼ lb. to 1¾ lb. If the average value per skin and not the average value per lb. be taken as the standard of comparison, the difference between the values of the raw and the tanned product is not nearly so great. Thus in 1913–14 the average value per skin of the raw goat-skins exported was 25·4*d.* and of the tanned skins 30·1*d.*

From three-fourths to four-fifths of the exports of tanned goat-skins from India are despatched from Madras, and most of the remainder from Bombay, though from 2 to 4 per cent. of the total find an outlet through Sind. The skins for the Madras trade are drawn from Mysore as well as from the Presidency. The port of Madras has a practical monopoly of the trade. The tanned skins, like the raw, are available all the year round. For export they are pressed, wrapped in gunnies, and roped, each bale weighing about 600 lb. net. They are described according to the locality from which they come, *e.g.* Trichies, Coimbatores, Dindiguls, Coasts; also, in some cases, according to the quality, as Prime City and Medium City.

The distribution overseas of the total exports of tanned goat-skins from India, both before and during the war, as given in the Indian trade returns, is shown in the following table (the italicised figures are percentages):

Exports of Tanned Goat-skins from India: Distribution

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	61,741	74,126	61,288	70,773	83,861
,, value	£871,905	1,073,767	882,265	986,999	1,697,796
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
To United Kingdom	56,644 *91·7*	66,446 *89·6*	53,404 *87·1*	44,849 *63·4*	53,027 *63·2*
,, United States	2,641 *4·3*	5,846 *7·9*	6,913 *11·3*	25,682 *36·3*	30,073 *35·9*
,, Germany	2,369 *3·8*	1,663 *2·2*	670 *1·1*	—	—
,, Other countries	87 *0·2*	171 *0·3*	301 *0·5*	242 *0·3*	757 *0·9*

Before the war the tanned goat-skins exported from India, like the tanned hides, were consigned chiefly to the United Kingdom. Indeed the trade was almost entirely in the hands of United Kingdom buyers. They were taking nine-tenths of the total; and the United States and Germany were the only other countries taking more than trifling quantities. On the outbreak of war the exports to Germany ceased; at first there was little development in the direct trade with the United States, and in 1914–15 the United Kingdom still took 87 per cent. of the total; but both in 1915–16 and in 1916–17 the exports of tanned goat-skins from India to the United Kingdom declined to 63 per cent. of the total, while those to the United States increased to 36 per cent. The loss to the industry, as distinct from the trade, of the United Kingdom, was not so great as might appear from these figures. On the contrary, the industrial supply of Indian tanned goat-skins in the United Kingdom during the war, up to and including 1916, would seem to have been larger than before the war. The United Kingdom statistics do not show what proportion of the imports of tanned goat-skins from India alone are re-exported, but it may be inferred from the returns of the United Kingdom trade in tanned goat-skins from all overseas sources that ordinarily by far the greater part of the Indian skins imported are sent out of the country again. The following table gives the returns for the five years period beginning 1913—the first year for which such returns were published (the italicised figures are percentages of the total imports):

United Kingdom Trade in Rough Tanned Goat-skins

Imports from	1913. *Cwts.*	1914. *Cwts.*	1915. *Cwts.*	1916. *Cwts.*	1917. *Cwts.*
British India . .	62,935	60,302	56,501	78,781	
	81	*82*	*84*	*93*	
British West Africa	12,588	9,959	8,715	5,726	
Other countries .	1,764	2,887	1,998	251	
Total Imports .	77,287	73,148	67,214	84,758	36,588
Re-exports . .	65,342	57,544	39,434	70,344	27,015
	85	*79*	*59*	*83*	*74*
Net Imports .	11,945	15,604	27,780	14,414	9,573

Contrary to what has been noticed in connection with the trade in raw goat-skins, the exports of tanned goat-skins from India to the United Kingdom, as given in the Indian returns (see p. 230), are in much closer agreement with the gross than with the net imports of tanned goat-skins into the United Kingdom from India, as given in the United Kingdom returns. According to the latter returns, over 80 per cent. of the total imports of such skins before the war came from India, and the proportion increased to 93 per cent. in 1916. Of these total imports, however, three-fourths or more were re-exported in each of the last five years except 1915, when the proportion fell to three-fifths. The quantity retained in the year before the war was 11,945 cwts., and this was exceeded in each of the next three years; but in 1917, when the total imports were over 50 per cent. below the average for the previous four years, the quantity retained fell to 9,573 cwts. The largest share of the re-exports in 1913 went to Germany (42 per cent.), but the United States (33 per cent.) was not far behind, and during the war most of the re-exports have gone to the latter country (80 per cent. in 1915; 81 per cent. in 1916). The chief uses to which these Indian tanned goat-skins are put are bookbinding and the manufacture of fancy leather articles.

Sheep-skins

Like other tropical breeds, the sheep of Peninsular India are not generally distinguished for either their mutton or their wool. The fleece is often coloured (red or brown or grey) and the wool tends to be short and coarse. The ewe rarely produces more than one lamb at a birth, but may bear young twice a year. Here and there attempts have been made to improve the breed, and the results obtained by crossing Deccani ewes with Dumba rams—the fat-tailed sheep of Afghanistan—are described as very satisfactory, the half-breeds yielding good mutton and long fine wool, like that of the pure Dumba. In some of the cooler parts of India farther north, where the wool-producing qualities of the sheep reach a higher general level, good results have been obtained by the introduction of merinos from Australia, and the half and three-quarter bred rams are in great demand in the Punjab and the United Provinces. So far, however, grading-up experiments have been on a comparatively small scale, and of a tentative character; the great mass of the flocks are still untouched. Apart from breed-improvement measures, it is claimed that much good would result from the more general adoption of the practice of dipping. Some years ago (*Agric. Journ. India*, 1912, **7**, 55), Major F. S. H. Baldrey, Superintendent of the Civil Veterinary Department in the Central Provinces, estimated that the average weight of the wool clip would be increased from 3 lb. to 4 lb. per sheep, and the value from 6*d.* to 7*d.* per lb. if the animals were not tormented by skin parasites. Even as things are, the annual exports of raw wool from India before the war amounted to about 50,000,000 lb., with an export value of about £1,750,000 sterling.

Raw Sheep-skins.—The measures advocated for improving the quality of the sheep as meat and wool producers are usually put forward without regard to the value of the skins. The skins are a by-product, with which, as in the case of other hides and skins, only Mohammedans and low-caste Hindus will have anything to do. Moreover, sheep-skins are a much smaller factor than goat-skins in the foreign trade of India. This is especially true of the raw sheep-skins, which occupy quite a minor place in the Indian trade in hides and skins. The exports of raw sheep-skins during the last five years for which returns are available are shown in the following table, together with the average weight of the skins and their average export value per lb. in each year:

Exports of Raw Sheep-skins from India

Year.	Quantity.		Value.	Average weight.	Average value per lb.
	Number.	Weight. *Cwts.*	£	*lb.*	*d.*
1912–13 .	2,297,499	31,668	155,285	1·5	10·5
1913–14 .	2,373,122	33,067	173,999	1·6	11·3
1914–15 .	1,956,986	26,295	132,355	1·5	10·8
1915–16 .	2,245,075	32,517	154,438	1·6	10·2
1916–17 .	2,918,458	45,134	323,968	1·7	15·4

On average, raw sheep-skins are a good deal lighter than goat-skins, but before the war they were worth (export value) from 1*d.* to 1½*d.* per lb. more. Alike in number, total weight, and total value, the exports of raw sheep-skins were increasing before the war. The increase was checked when war broke out, and in 1914–15 the trade declined considerably; but it largely recovered in the following year, while in 1916–17 the returns were far greater than in 1913–14. In percentages of the exports in 1913–14, the exports in the three following years were: in 1914–15, weight 80, value 76; in 1915–16, weight 98, value 89; in 1916–17, weight 136, value 186. The figures for 1916–17 were not reached in the following year. The available Indian trade returns for 1917–18, under the head of Raw Skins, give particulars only of the goat-skins exported; but the exports of "Other Raw Skins" (which in previous years consisted almost entirely of sheep-skins) amounted to 36,994 cwts. valued at £249,997.

The chief outlet for raw sheep-skins from India is Karachi. In 1912–13, 79 per cent. of the exports of this description were despatched through the ports of Sind, and in 1913–14 the proportion rose to 90 per cent. The rest were divided almost entirely between Bengal and Bombay ports. After the outbreak of war, the share of the trade enjoyed by Sind ports declined, but in 1916–17 nearly 75 per cent. of the exports of raw sheep-skins were still despatched from Sind, while 20 per cent. were despatched from Bombay ports and 5 per cent. from Bengal.

The destinations of the exports, according to the Indian trade returns, were as follows (percentages in italics):

Distribution of Raw Sheep-skins exported from India

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity *cwts.*	31,668	33,067	26,295	32,517	45,134
,, value . .	£155,285	173,999	132,355	154,438	323,968
To British Countries:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom.	1,081 *3·4*	1,599 *4·8*	326 *1·2*	340 *1·0*	60 *0·1*
Others . .	46	340	143	614	622
Total . .	1,127 *3·6*	1,939 *5·9*	469 *1·8*	954 *2·9*	682 *1·5*
To Allied Countries:					
United States .	28,986 *91·5*	28,818 *87·2*	24,682 *93·9*	31,404 *96·6*	43,704 *96·8*
Others . .	357	220	156	159	748
Total . .	29,343 *92·7*	29,038 *87·8*	24,838 *94·5*	31,563 *97·1*	44,452 *98·5*
To Enemy Countries [1]	740 *2·3*	1,799 *5·4*	898 *3·4*	—	—
To Neutral Countries [2]	458 *1·4*	291 *0·9*	90 *0·3*	—	—

[1] *Almost exclusively Germany.* [2] *Almost exclusively Holland.*

The controlling factor in this trade has been the United States; before the war about nine-tenths of the exports of raw sheep-skins from India were consigned there. The exports to the United Kingdom are normally small in themselves and small in comparison with the imports of such skins into the United Kingdom from other sources. In the Indian trade returns no distinction is made between the different classes of raw sheep-skins which are exported; but the *Annual Statement of the Trade of the United Kingdom* gives separate returns for woolled skins—that is, skins from which the wool has not been removed—and pickled skins. As the former are reckoned by weight and the latter by number, direct comparison of quantities is impossible; but the value of the United Kingdom imports of woolled skins is normally about three times that of the pickled skins. Between one-third and one-half of the woolled skins are re-exported normally, and a much larger proportion of the pickled skins. The following table gives the figures for five years:

United Kingdom Trade in Raw Sheep-skins (Foreign and Colonial Merchandise)

A.—Woolled

Imports from	1912. lb.	1913. lb.	1914. lb.	1915. lb.	1916. lb.
British India .	171,201	641,649	364,479	608,092	1,156,550
Other countries [1]	77,840,000	81,620,595	71,017,464	86,810,405	51,216,225
Total Imports	78,011,201	82,262,244	71,381,943	87,418,497	52,372,775
Re-exports .	36,680,432	34,990,043	23,834,070	26,747,186	15,378,041
Net Imports .	41,330,769	47,272,201	47,547,873	60,671,311	36,994,734

B.—Pickled

Imports from	1912. Number.	1913. Number.	1914. Number.	1915. Number.	1916. Number.
British India .	34,275	65,088	80,598	96,006	70,150
Other countries [2]	8,350,561	7,468,710	6,344,310	8,834,097	4,785,923
Total Imports	8,384,836	7,533,798	6,424,908	8,930,103	4,856,073
Re-exports .	6,122,934	6,716,190	5,814,179	7,774,649	5,009,263
Net Imports .	2,261,902	817,608	610,729	1,155,454	*

* Excess of re-exports over imports, 153,190 skins.

[1] *Chiefly Australia and South Africa, with New Zealand third, but a long way behind.*

[2] *Chiefly New Zealand (normally three-fourths of the total).*

Though India plays so small a part in these returns, they are not without instruction in the present study of the Indian trade in hides and skins. They show clearly that under pre-war conditions there was no great industrial demand in the United Kingdom for pickled sheep-skins, and that though considerable quantities of woolled sheep-skins were absorbed, the demand was more than met from other countries than India, chiefly British. In the re-export trade from the United Kingdom, the best customer for the woolled skins before the war was France (between 40 and 50 per cent.), followed by the United States (between 25 and 35 per cent.). Of the pickled skins re-exported, over 85 per cent. went to the United States.

Tanned Sheep-skins.—As previously indicated, one distinguishing characteristic of the Indian trade in sheep-skins, as compared with the trade in hides and goat-skins, is that the exports of tanned sheep-skins exceed the exports of raw sheep-skins in both quantity and value. The number, weight, and value of the tanned sheep-skins exported, with the average weight per skin and the average price per lb., are given in the following table for the last six years:

Exports of Tanned Sheep-skins from India

Year.	Quantity.		Value.	Average weight.	Average value per lb.
	Number.	Weight.			
		Cwts.	£	lb.	d.
1912–13	9,701,682	60,355	776,893	0·70	27·6
1913–14	8,119,205	49,652	639,000	0·68	27·6
1914–15	7,512,804	45,978	588,965	0·69	27·4
1915–16	8,219,040	49,345	658,478	0·67	28·6
1916–17	11,172,365	66,254	1,400,686	0·66	45·3
1917–18	—	15,895	458,630	—	61·8

In 1912–13 the tanned sheep-skins exported were between four and five times as numerous as the raw skins, nearly twice as weighty, and five times as valuable. In 1913–14, the tanned skins were about 50 per cent. greater than the raw skins by weight. These comparisons relate to totals. The average weight of the tanned skins is less than half that of the raw skins, while the average price per lb. (export value) is normally between two and three times that of the raw skins. As in the case of goat-skins, the values of the raw and tanned sheep-skins are much more nearly equal *per skin*. Indeed, tanning adds very little to the value of the sheep-skins normally. Thus in 1913–14, while the average value of the raw sheep-skins exported was 17·6*d.* per skin, that of the tanned sheep-skins was only 18·9*d.* per skin. Neither in 1914–15 nor in 1915–16 did the total exports of tanned sheep-skins show any very striking variation from the total in the latest pre-war year, 1913–14; but in 1916–17 the exports were greater in weight than they had been for some years before the war, and with a big increase in prices the total value exceeded £1,400,000. The sudden drop in 1917–18 is explained by the Government restrictions on the tanning and export of skins. In percentages of the exports in 1913–14 the exports in the four following years were: in 1914–15, weight 93, value 92; in 1915–16, weight 99, value 103; in 1916–17, weight 133, value 219; in 1917–18, weight 32, value 72.

Usually between 80 and 90 per cent. of the exports of tanned sheep-skins are despatched from the Madras Presidency (78 per cent. in 1916–17), and most of the remainder from Bombay. The Madras *Handbook of Commercial Information*, commenting on the provincial trade in sheep-skins, says that the raw skins are available all the year round, and the supply would be large if the demand existed; but as a rule it is found to pay better to tan the skins. Tanned sheep-skins are important chiefly in the Ceded Districts, Mysore and Coimbatore. Of the provincial exports, 94 per cent. are despatched from the port of Madras, and 6 per cent. from Tuticorin. They are packed in pressed bales of from 500 lb. to 600 lb. net, wrapped in gunnies and roped.

The destinations of the total exports from India, as given in the Indian trade returns, are shown in the following table (percentages in italics):

Distribution of the Exports of Tanned Sheep-skins from India

	1912–13.	1913–14.	1914–15.	1915–16.	1916–17.
Total quantity . *cwts.*	60,355	49,652	45,978	49,345	66,254
,, value . .	£776,893	639,000	588,965	658,478	1,400,686
To British Countries:	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
United Kingdom .	34,944 *57·9*	29,202 *58·8*	29,180 *63·5*	31,553 *63·9*	41,623 *62·8*
Straits Settlements	2,469	1,718	1,766	1,771	1,738
Other countries .	312	511	256	387	119
Total . . .	37,725 *62·5*	31,431 *63·3*	31,202 *67·9*	33,711 *68·3*	43,608 *65·8*
To Allied Countries:					
United States .	13,382 *22·2*	10,365 *20·9*	6,209 *13·5*	9,770 *19·8*	16,066 *24·2*
Japan	9,129 *15·1*	7,459 *15·0*	8,424 *18·3*	5,803 *11·8*	6,428 *9·7*
Other countries .	79	280	91	41	152
Total . . .	22,590 *37·4*	18,104 *36·5*	14,724 *32·0*	15,614 *31·6*	22,646 *34·2*
To Enemy Countries	11	117	48	—	—
To Neutral Countries	29	—	4	20	—

Practically all the tanned sheep-skins exported from India were despatched, even before the war, either to other British countries or to countries now among the Allies. The proportion consigned to the United Kingdom was not so large as in the case of tanned kips, tanned buffalo-hides, and tanned goat-skins; none the less it amounted to three-fifths of the total. The remainder went chiefly to the United States and Japan. Up to and including 1916–17, the distribution underwent little change during the war.

Undressed (rough tanned) sheep-skins figured in the United Kingdom trade returns as a separate entry for the first time in 1913. In that year India contributed 44 per cent. of the total imports of such skins into the United Kingdom; but 56 per cent. of the total were re-exported. During the war a much larger proportion of the imports has been retained. The following are the figures for 1913 and subsequent years :

United Kingdom Trade in Rough Tanned Sheep-skins (Foreign and Colonial Merchandise)

Imports from	1913. Cwts.	1914. Cwts.	1915. Cwts.	1916. Cwts.	1917. Cwts.
British India . .	39,253	28,764	32,946	45,186	—
Other countries . .	49,393	45,888	57,370	26,978	—
Total Imports .	88,646	74,652	90,316	72,164	47,945
Re-exports . .	49,938	29,087	9,994	35,501	14,158
Net Imports . .	38,708	45,565	80,322	36,663	33,787

Of the re-exports in 1913, Germany took 18,669 cwts. (37 per cent.), Austria-Hungary 9,569 cwts. (19 per cent.), and the United States 14,138 cwts. (28 per cent.); together these three countries took 84 per cent. of the total, and the remainder went almost entirely to the Netherlands and other foreign countries. During the war the re-exports have gone almost entirely to the United States.

East India tanned sheep-skins are suitable not only for the manufacture of fancy articles but for roller leather, which is used largely in cotton-spinning machinery for covering small rollers over which the cotton-thread is drawn. They are also suitable for currying purposes, for light-boot upper-work.

NOTES

Map and Diagrams of the Chief Metal Resources of the Empire.—This publication, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, is now issued. The chief British countries of occurrence and production of the principal minerals are shown on the map. The diagrams give the outputs of these countries for 1915 in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium and mercury.

The map and diagrams are mounted on linen and folded. The publication is obtainable from the Imperial Institute, price 5*s.* 6*d.* (post free).

The Imperial Institute and the Mineral Resources of the Empire.—The following leading article appeared in the *Madras Weekly Mail* for April 26, 1918:

"The BULLETIN OF THE IMPERIAL INSTITUTE for the quarter July—September 1917, received by the last mail, contains a special article on the constitution and work of the Institute with reference to the mineral resources of the Empire.

"A brief account is given in the article of the constitution of the Institute and the various legislative measures which have been passed to put its control and management on a basis which will secure its functions being properly carried out. The latest of these was a couple of years ago, and our readers may remember the temporary excitement caused in India by the announcement that its management would in future be vested in the Secretary of State for the Colonies. The perturbation did not last long, however, for the reassuring news was received that the governing body would contain representatives of the Government at Home as well as the Dominions, India and the Colonies. We know now that any idea that was entertained that this transfer of management would entail greater interest being displayed in the resources of the Dominions and Colonies at the expense of India was quite erroneous.

"The publications of the Institute and the periodical bulletins of progress prove that India receives just as much attention as any other part of the Empire. Scarcely a bulletin reaches us in which we are not able to find some record of investigations carried out, enquiries made, advice given regarding the value and commercial possibilities of one or other of India's industries and products, especially those recently discovered or previously overlooked, in which further development may give desirable results. For instance it does not require a very extensive knowledge of Indian commerce, industries and products to realise the potential value of the country as a source of mineral wealth, especially of those rarer minerals the chief value of which lies in their adaptation to the improvement of existing industries. When we consider the size of the Empire, it is not surprising that most of these minerals are found in one part of it or another. What has always been surprising, however, is the way in which this knowledge has been foolishly, almost contemptuously, ignored, and the development of these resources and the profit to be derived from them has been allowed to fall into the hands of a people who have been for many years our keenest and most unscrupulous commercial rivals and are now our declared relentless enemies. The pitiful thing about the whole business is the way in which this criminal neglect has allowed Germany from the very beginning to have the upper hand in the matter of munitions and offensive material in this most devastating war. British neglect has caused us to lumber along in the rear, endeavouring to make up leeway.

"It is a painful subject and has frequently and regretfully been dealt with in the past, and there is little to be gained now by further lamentation. The fact, however, is evident in this article in the BULLETIN under review. We have had proof of it in India in connection with the Burma wolfram industry and that of monazite in Travancore, and similar instances abound in other parts of the Dominions, particularly Australia. The mention of wolfram reminds us that almost all the ores required for the manufacture of "high speed" steels, which are of such outstanding importance in modern engineering, are more or less monopolies of the British Empire, yet Great Britain has been supinely content to get her supplies of alloys of titanium, tantalum, tungsten, molybdenum, etc., from Germany, France and the United States. It passes comprehension now, but the fact remains. Take, next, the case of monazite. Until a few years ago the sole source of thorium, the most valuable constituent of this mineral, was Brazil, but it was controlled by a German syndicate. Now the most important source of supply is the Travancore deposits, and we know the efforts that were made to secure German control of these. Since then more or less important discoveries of monazite, thanks mainly to the efforts of the Institute, have been made in Ceylon, the Malay Peninsula, Nyasaland, Northern Nigeria and elsewhere. The beach deposits of monazite sand in Ceylon will form a very useful addition to existing sources of supply. It may here be mentioned that in the new mineral thorianite, recently discovered in Ceylon, we have one of the ores richest in its content of thorium, the principal and most essential ingredient in the manufacture of gas mantles, etc.

"Returning for a moment to the manganese group of ores, we know that India and other parts of the Empire are particularly rich in the supply of manganese, yet the special manganese used for the manufacture of dry electrical batteries was the monopoly of Germany. Since the outbreak of the war there has been much groping after the specification of the ore used for this purpose, a trade secret which Germany refused to part with. Another mineral which in pre-war days was procured solely from Germany is diatomite, which is largely used as a filtering medium. The sources of supply here too were entirely British, and include the United Kingdom, East Africa, Canada and Australia. The best came from the last-mentioned place. A grade of diatomite ore useful for the making of dynamite has also been discovered in Canada and Australia. The bauxite deposits of the Central Provinces in India also promise a brighter future for the British production of aluminium."

South African Beans and Peas.—In an article entitled "The Peas and Beans of Commerce" which appeared in a recent issue of this BULLETIN (1917, **15**, 503) some account is given of the principal sources whence the United Kingdom derives its supplies of beans and peas intended for human consumption and also for feeding animals. Since that article was published the Imperial Institute has received from the London Corn Trade Association a collection of samples representing the peas and beans which are now being imported into the United Kingdom in considerable quantities from South Africa.

The following is a list of the various kinds of beans represented :

Butter Beans.—Long, oval, or kidney-shaped, 1 in. long by ½ in. broad, glossy ivory-white.

Large White Haricots.—Long, narrow, oval, ¾ in. long by ¼ in. broad, ivory-white.

Small White Haricots.—Similar to the preceding, but smaller.

Rose Cocos.—Oval or kidney-shaped, ½ to ¾ in. long by ¼ to ½ in. broad, buff ground-colour streaked and mottled with rose, hilum (eye) white outlined with brown.

Painted Ladies.—Plump, oval, about ½ in. long by ⅜ in. broad, distinctly marked, one half ivory-white, the other pinkish-buff speckled with rose.

Yellow Sugar Beans.—Plump, oval, about ½ in. long by ⅜ in. broad, pale buff yellow with a dark stain round the hilum.

Brown Sugar Beans.—Similar to the preceding, of a light coffee-brown colour with a deeper tint round the hilum.

Brown Beans.—Similar to the preceding but slightly longer and of a deeper tint of brown.

Kidney Beans.—Kidney-shaped, ¾ in. long by ¼ in. broad, greyish buff with a deeper tint round the hilum.

Small Salmon Beans.—Flat, oval or kidney-shaped, from ¼ to ½ in. long by about ¼ in. broad, light buff suffused with pink.

Canadian Wonder.—Long, kidney-shaped, ¾ in. long by ¼ in. broad, of a uniform dark purple.

French Beans.—Long, narrow, about $\frac{1}{2}$ in. long by $\frac{1}{4}$ in. broad, deep purple speckled with buff.

Red Beans.—Flat, kidney-shaped, $\frac{3}{4}$ in. long by $\frac{3}{8}$ in. broad, purplish-rose ground spotted and streaked with dark purple.

Mont d'Or.—Plump, oval, $\frac{1}{2}$ in. long by $\frac{3}{8}$ in. broad, ivory white with irregular black blotches round the hilum.

All these beans are varieties of *Phaseolus vulgaris*, or true haricots, and most of them are well-known market kinds. In addition to the haricots was a sample labelled "Jugo beans," which consisted of the seeds of *Voandzeia subterranea*, the Bambarra ground nut (see this BULLETIN, 1912, **10**, 235).

Three samples of peas (*Pisum sativum*) were also received, comprising white peas, green peas, and a mixed sample of white and green kinds.

At the present time there is a large market in the United Kingdom for pulses of the kinds represented by these samples, provided they are of good and uniform quality. There is, however, no market for mixed beans for human consumption, and considerable expense and loss of time are involved in sorting and grading mixed samples for sale in this country. Complaints have been made by importers that several shipments of mixed beans have recently been received from South Africa. Samples of two such shipments have been forwarded to the Imperial Institute and have been found to consist of a mixture of white and coloured beans of *Phaseolus vulgaris* in about equal proportions. The white beans contained a considerable percentage of shrivelled and discoloured beans, but the coloured kinds with which they were mixed were of good quality.

The need for sorting and grading these mixed beans in South Africa before they are shipped is clearly illustrated by these two samples, both of which contain a large proportion of low-grade beans which are not worth freight charges and should be eliminated from consignments. White beans intended for human consumption should be of plump appearance and of good colour and should be graded according to size, each grade consisting of beans of an even size. Coloured beans should be separated from white beans and sorted according to variety, each variety being marketed under its distinctive name. The different varieties of beans should be grown separately and kept separate for shipment. Once they are mixed, sorting and grading is best accomplished by hand-picking.

A set of standard samples of beans prepared by the

London Corn Trade Association has been sent to South Africa, and it is important that future consignments should conform to these samples, each quality being shipped under its own distinctive mark. At present shippers frequently forward various qualities under one mark, a practice which entails careful sorting and sampling on arrival here with consequent delay and expense.

Fiji Bay Oil.—In this BULLETIN (1916, **14,** 295) reference was made to the bay oil industry of the West Indies, and it was pointed out that the industry might well be extended if oil of a reliable and uniform quality could be produced in regular quantities.

It has been pointed out in the *Kew Bulletin* (1918, No. 4, p. 158) that the production of such oil has been rendered difficult by the fact that the leaves of the true bay tree (*Pimenta acris,* Kostel.) are frequently mixed with those of two other forms which are so similar in appearance as to be practically indistinguishable. These two forms are known as " Bois d'Inde Citronelle " (*Pimenta acris* var. *citrifolia*) and " Bois d'Inde Anise " which does not seem to have been distinguished botanically. The oil obtained from the leaves of " Bois d'Inde Citronelle " has a lemon-like odour owing to the presence of citral, and that of the " Bois d'Inde Anise " is equally undesirable, and reduces the value of any bay oil in which it may be present. It is suggested that in bringing the bay tree under cultivation, care should be taken to ensure that the plants are selected from a pure stock of the true *Pimenta acris,* Kostel.

In connection with this question, it may be mentioned that in 1909 a sample of bay oil was received at the Imperial Institute from Fiji which differed considerably from ordinary commercial bay oil and could not be sold as such in the European market. The oil was pale brown and had the characteristic odour of bay oil with, in addition, a distinct anise-like odour. On examination, it furnished the following constants: specific gravity at 15° C., 0·961; optical rotation in 100 mm. tube at 20° C., − 1° 58′. The oil was soluble in its own volume or more of 90 per cent. alcohol and contained only 23 per cent. of phenols instead of the 60 per cent. found in good bay oil and was unusually rich in methyl ethers.

In view of the note in the *Kew Bulletin* referred to above, it now seems probable that the Fiji sample consisted of oil derived from the leaves of the form of *Pimenta acris* known as " Bois d'Inde Anise."

Empire-grown Sugar.—The *Journal of the Royal Society* *of Arts* (1918, **66**, 473) contains a paper by Mr. George Martineau, C.B., entitled "Sugar from Several Points of View," which gives a short historical review of the sugar industry. In connection with the rise of the beet-sugar industry, it is pointed out that Germany supplied the necessary stimulus to the cultivation, by levying a duty, not on the sugar produced, but on the roots. The farmer was thus encouraged to produce the richest possible roots, and the manufacturer to extract the maximum quantity of sugar. This policy resulted in the amount of sugar in the roots being increased from 6 per cent. at the beginning to an average of 17·63 per cent. for the whole of Germany in 1908. Reference is made to the invention of the diffusion process of extraction which was another result of the stimulus, the invention of the multiple evaporator, and the development of the double carbonatation process. In consequence of these great advances in the beet-sugar industry, rapid improvements were made in connection with the production of cane-sugar. The multiple evaporator was adopted and many other improvements were introduced into the mills, thus effecting great reduction in the cost of production. These facts are regarded by the author as proving "that nascent industries can be encouraged, research stimulated, and efficiency created, by a rational, well-regulated, but moderate stimulus."

With regard to the cane-sugar industry, it is recalled that the United States of America give preferential treatment in their own markets to sugar produced in their own territories, and also give a slight preference to Cuba. The effect of this preference enabled the Cuba sugar industry to recover from the effects of the Spanish-American war, and to increase its production until in 1903 it again reached the level of the output in 1894 and 1895, viz. about 1,000,000 tons per annum. In 1913, Cuba produced 2,500,000 tons, and last year no less than 3,000,000 tons. The effect of preferential treatment in the home market has also caused enormous increases in sugar production in Louisiana, Hawaii, Porto Rico, and the Philippine Islands, with the result that the United States, with the help of Cuba, now produces enough sugar for the whole of its own consumption. The author considers "that preferential treatment in home markets is the best and perhaps the only way to give real confidence to capital; and that with that confidence, coupled, of course, with favourable natural conditions, British industries will flourish and may even become capable of furnishing the whole consumption of the Empire."

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Foodstuffs and Fodders

Dried Yeast.—Experiments have been carried out at the Manor Farm, Garforth, on the digestibility of dried yeast when fed to sheep, and the results are recorded in a paper by Charles Crowther and Herbert E. Woodman in the *Journ. Agric. Sci.* (1917, **8,** 448). It was found during the course of the trial that the dried yeast being used contained only 32·5 per cent. of proteins, whereas the dried yeast on the market contains, on the average, about 45 per cent. It is considered, however, that in spite of this the results may be regarded as of general applicability. The average percentage digestion coefficients obtained from the experiments were as follows: total dry matter, 87·5; organic matter, 90·3; ash (sand-free), 63·4; crude protein, 88·1; true protein, 87·9; nitrogen-free extract, 94·5. The digestibility of the ether extract (oil) and crude fibre of the yeast could not be determined owing to the small proportions of these ingredients present. The results indicate that dried yeast compares favourably with the most highly digestible foods used in farm practice.

Palm-kernel and other Feeding Cakes.—From time to time statements have been made to the effect that palm kernel, coconut and ground-nut cakes deteriorate on keeping and soon become rancid. In order to test the validity of this contention, an investigation of the comparative keeping properties of these and other oil-cakes has been made by William Godden, of the Department of Agriculture, Leeds University, and the results have been published in the *Journ. Agric. Sci.* (1917, **8,** 419). Samples of palm-kernel, coconut, ground-nut, linseed, undecorticated cotton-seed, "soycot" and soya cakes were kept (1) in a cake store under ordinary farm conditions; and (2) in the laboratory in a moist state at 37° C., which conditions were regarded as those most likely to promote decomposition. The results showed that in keeping properties palm-kernel cake compares favourably with most of the oil-cakes commonly used on the farm. The only change which occurs during storage under ordinary farm conditions is an increase in the percentage of free fatty acids of the oil, and this change was found to be common to all the oil-cakes examined. In the laboratory experiments, only four of the cakes, viz. cotton-seed, ground nut, "soycot" and soya cakes, showed any marked development of moulds. It was found that the growth of moulds is always accompanied by loss of organic matter, this loss being divided between the oil and the soluble carbohydrates of the cake. No mould appeared on cakes from which the oil had been previously extracted. The conclusion is drawn that oil-cakes must be kept in dry storage in order to prevent the formation of moulds and the consequent loss of organic matter; if kept under very damp conditions a serious reduction in the oil-content may take place.

In view of the scantiness of information on the digestibility of palm-kernel cake and meal, feeding experiments with sheep have been carried out at the Manor Farm, Garforth, by Charles Crowther and Herbert E. Woodman, of the Institute for Research in Animal Nutrition of Leeds University, and an account of the investigation has been published in the *Journ. Agric. Sci.* (1917, **8,** 429). In order to obtain a direct comparison of the palm-kernel products with some feeding-stuff of similar composition and widely used in farm practice, the digestibility of a sample of undecorticated cotton-seed cake made from Egyptian cotton seed was included. The average digestion coefficients of the two cakes and the meal were found to be as follows:

	Undecorticated Cotton-seed Cake.	Palm-kernel Cake.	Extracted Palm-kernel Meal.
	Per cent.	*Per cent.*	*Per cent.*
Organic matter	58·0	70·8	76·7
Crude protein	67·4	75·4	79·2
" " (corrected for "metabolic protein" in fæces)	74·7	88·5	90·0
Ether extract (oil)	(100 ?)	98·2	96·3
Nitrogen-free extract	62·0	78·6	86·0
Crude fibre	34·6	20·6	44·8

It is evident from these figures that the cotton-seed cake compares very unfavourably with the palm-kernel cake and meal. By applying these coefficients to the composition of each feeding-stuff as determined by analysis, the following percentages of digestible ingredients were obtained:

		Undecorticated Cotton-seed Cake.	Palm-kernel Cake.	Extracted Palm-kernel Meal.
Organic matter . .	*per cent.*	48·2	60·0	64·9
Crude protein . .	,,	16·6	15·4	16·9
Ether extract (oil) .	,,	4·5 (est.)	8·8	2·0
Nitrogen-free extract .	,,	20·7	35·1	40·7
Crude fibre . .	,,	7·9	2·8	7·3
Food units	.	81·4	98·4	95·2
Starch equivalent (Kellner) .	.	46·2	73·6	68·7

The "food units" in this table are calculated by the conventional expression and are designed to furnish a measure of the relative money values of the feeding-stuffs, whilst the starch equivalents give a measure of their feeding value when added to a maintenance ration. These data indicate that, for the samples of feeding-stuffs used in the experiments, the palm-kernel cake was a little superior to the meal both in money value and in feeding value, whilst its superiority over the cotton-seed cake was roughly 20 per cent. in money value and 60 per cent. in feeding value.

Sugar.—An interesting account of scientific progress in sugar cultivation and manufacture in Java during the last three years has been contributed by H. C. Prinsen Geerligs, Ph.D., to the *International Sugar Journal* (1918, **20,** 60). The crops of 1914 and 1915 were very unsatisfactory owing to protracted drought in the vegetative periods, and the poor results obtained were attributed by some to lack of efforts to control diseases and insect pests and to the degeneration of the sugar-cane. The increased prevalence of diseases and pests was, however, really due to the unfavourable weather conditions, and it is evident that no great deterioration of the cane had taken place as although the cane was not replaced by any other variety the crops of 1916 and 1917 showed a decided improvement. In the latter year, although the area planted (about 394,350 acres) was little greater than that of 1916 (371,954 acres), the estimated production of cane was 1,800,000 tons or 10,167 lb. per acre, as compared with 1,299,272 tons or 7,786 lb. per acre in 1915. The better results of 1916 and 1917 were, however, not entirely due to the better weather, but also to the greater care bestowed on the planting material, the planters having to a large extent returned to the old method of planting nursery fields for tops in favourably situated localities.

Endeavours are being made to raise new varieties of cane, and the Experiment Station is now growing seedling canes on Mendelian principles and carefully recording the progress of the experiments, so that if a really superior cane is produced and should subsequently lose its qualities, it may be possible to reproduce it by following out the plan by which it was originally obtained.

Owing to the difficulty of obtaining sulphate of ammonia which was formerly the most generally used manure in Java, the planters are now employing Chili nitrate and organic manures, such as castor cake, ground-nut cake, and bat's dung, and these have been found to give good results.

The Java sugar industry is having to contend with serious difficulties in connection with transport, and one million tons of the 1916–17 crop are still awaiting shipment. The problems involved in the storage of such large quantities of sugar have been energetically studied, and it is anticipated that every precaution will be taken to maintain the quality of the sugar until transport facilities become normal again.

Wheat.—A special Committee has been appointed by the Advisory Council of Science and Industry, Commonwealth of Australia, to investigate the damage caused by grain weevils and other pests to wheat in store. This Committee has issued a progress report on the subject of grain weevils which has been published in *Bulletin* No. 5 of the Advisory Council, entitled "Problems of Wheat-Storage." This Bulletin also contains a report of a Committee which was appointed to investigate the effect of quick-lime on wheat.

In the latter report, an account is given of a series of experiments which have been carried out with the object of investigating the following proposals made by Mr. A. O. Barrett for the purification of wheat by treatment with lime. The wheat after being screened to free it from foreign matter is mixed with 1 per cent. of its weight of hot, freshly burned quick-lime and transferred to a suitably situated large basin silo, built of brick or cement work, with a hopper-bottomed asphalt flooring. The wheat should be stored in this silo until required for use. It would then be freed from lime by passing it through suction and sifting machinery. The wheat to be treated in this way is such as has been attacked by weevils or mice, or damaged by damp, etc.

The experiments have led to the following conclusions. When wheat is treated in the manner described, the bacteria on the outer layers of the grains are considerably reduced in number, and the surface is slightly corroded and cleansed from organic nitrogenous compounds. When wetted, the treated wheat turns distinctly yellow although all the free lime has apparently been removed by screening. With f.a.q. wheat, the effect is to facilitate the process of tempering and to improve the quality of the bread baked from the flour. In testing the effect of the lime treatment on weevils it was not practicable to arrange for the addition of hot lime on a small scale, but it was found that treatment with cold lime does not immediately kill the fully grown insects, nor does it prevent the eggs from hatching. Damaged wheat is not rendered wholesome if the grains are rotted throughout, but further deterioration is checked. In the case of mousey-tainted wheat, the taint is removed, and the grain, if not otherwise deteriorated, can be used for bread-making. It has been found that the degree of contamination or deterioration of wheat is indicated by the ammonium content of the extract obtained by soaking the wheat in water; the damaged samples used in the experiments were found to yield from eight to twelve times as much ammonia as the clean wheats. The Committee recommend that the method of treating wheat with lime and storing it in large basin silos should be given a trial.

Limes.—Considerable progress is being made in the cultivation of limes in Grenada (*Rep. Agric. Dept., Grenada*, 1916–17). The total area devoted to limes is 1,124 acres, of which 533 acres are situated in Grenada and 591 acres in Carriacou. In 1916, the exports of lime products amounted to 150,525 gallons of raw juice and 7,500 gallons of concentrated juice. The crops of the years 1914–1916, expressed in terms of barrels of fruit, were as follows: 1914, 2,684; 1915, 8,396; 1916, 27,265. The Department of Agriculture have continued to encourage the industry by the propagation and distribution of plants and by educational methods, and further extension of the industry is anticipated.

Oils and Oil Seeds

Aleurites Species.—Wood oil (tung oil) obtained from seed grown in the United States of America has been examined and found to be equal in quality to the best imported Chinese wood oil (*Oil and Colour Trades Journ.*, 1918, Jan. 12, p. 123). In the case of two samples of seed grown in California, however, the oil was of abnormal character, which is thought to be due to the climatic conditions under which the plants were grown.

Castor Seed.—Owing to the use of castor oil as a lubricant for aeroplane engines, an enormous demand has arisen for castor seed, and efforts are being made in many countries to increase the cultivation of this crop. As the castor plant thrives in Algeria, an extension of cultivation is recommended and a general description of the method of cultivation is given in a recent number of the *Bulletin du Gouvernement général d'Algérie* (1917, **23**, 186).

The castor plant flourishes as a weed in the São Paulo district of Brazil and small quantities of oil have been produced in the local mills (*U.S. Commerce Repts.*, 1917, No. 273, p. 711). American buyers are importing seed from São Paulo and the newly established oil mill (see p. 252) is endeavouring to obtain machinery from the United States for crushing castor seed.

In Trinidad the extension of cultivation is also recommended and an American firm is stated to have placed orders for 500 tons of seed (*Trinidad Guardian*, Nov. 9 and 10, 1917).

Coconuts.—Much of the copra produced in the Philippine Islands is of poor quality owing to imperfect methods of drying. Brill, Parker and Yates have investigated the various factors causing inferiority of copra and have suggested methods for improving the quality (*Phil. Journ. Sci.*, Section A, 1917, **12**, 55). Unless dried so as to contain not more than 6 per cent. of moisture, the copra is attacked by various micro-organisms which cause loss of oil and heating of the copra in store or during shipment. Philippine copra is dried either in the sun or by means of a "tapahan" or crude native kiln; mechanical driers would probably solve the difficulty of drying copra, but their cost and the expense of working are generally too great to allow of their adoption; the authors consider that a small cheap mechanical drier capable of drying copra rapidly and cheaply would find a ready market in the Philippines. The Bureau of Science has devised a method of treating copra with sulphur dioxide gas before drying, whereby the copra produced by subsequent drying without artificial heat is white and free from mould, and is said to yield oil of excellent quality.

In the same journal (p. 87) Parker and Brill describe the Filipino method of preparing coconut oil; this consists in grating the fresh meat, which is then steamed and packed in rattan bags, the oil being expressed by means of a wooden screw press; the emulsion of oil, water and cellular tissue is separated by heating. The oil obtained by the first pressing of the fresh meat amounts to about one-third of the total oil, and is used as edible oil.

Further quantities of oil are then obtained from the meat by allowing it to ferment and again pressing it; this oil is of poor quality, and is used for soap making. The authors have attempted to devise improved methods of oil preparation, and state that oil of good quality can be obtained by grinding the fresh meat, followed by drying the ground-up meat at 70–85° C. on trays, and by expression of the oil. No details of the small experimental drying machine used are given, but it is stated that the amount of moisture in the ground-up meat was reduced to 10 per cent. in an hour, and on pressing once 80 per cent. of the total oil was obtained. Although the method appears not to be suitable for native use on a small scale, it possesses the advantages of avoiding handling of the material, producing good oil and a clean residual cake suitable for use as human food, and the authors consider there should be an opening for a plant to produce edible oil and press cake for human food.

The most destructive insect enemy of the coconut palm in Panama is the larva of *Brassolis isthmia* (*Rev. Applied Entomology*, 1918, **6**, Ser. A, p. 19). Spraying is unsatisfactory as a remedial measure, the only sure method being to collect the nests of larvæ before the latter are fully grown, and destroy them by crushing, burning or dipping in some strong insecticide; this method is troublesome as it necessitates the use of long ladders. Banding the trunks of the trees with tar will prevent young larvæ from reaching the leaves. The pest is destroyed by birds, toads, lizards and ants, and parasitic insects destroy many pupæ after the larvæ have caused damage, while a parasitic fungus also attacks mature larvæ and pupæ.

Cotton Seed.—A good deal of cotton is grown in the São Paulo district of Brazil, but the seed is often damaged by being allowed to lie in heaps unprotected from the weather; farmers are now beginning to realise the value of the seed and an improvement in handling is expected in the immediate future (*U.S. Commerce Repts.*, 1917, No. 273, p. 710). A mill for the manufacture of cotton-seed oil has obtained machinery from the United States and commenced operations; oil said to be equal in quality to the best oil made in the United States is being produced and large shipments have been made to the Argentine. Obstacles to the rapid development of the industry have been the difficulties of collection of seed, and of obtaining materials for making containers for the oil.

Ground Nuts.—Ground nuts grow well in the São Paulo district of Brazil, and it is expected that large quantities of seed sufficient to supply the recently established oil-mill for six months will be available (*U.S. Commerce Repts.*, 1917, No. 273, p. 710.)

Linseed.—Considerable quantities of flax are grown in the São Paulo District, and preparations are being made to crush the seed for oil (*loc. cit.*).

Para Rubber Seed.—A paper on the oil content, keeping qualities and commercial possibilities of Para rubber seed is contributed by Spring and Day to the *Agric. Bull., Federated Malay States* (1918, **6**, 231). It has been estimated that from 306 to 330 lb. of seed per acre can be obtained annually from rubber estates. The cost of collection still seems to be somewhat uncertain, but six tons of seed were collected on a Selangor estate on behalf of the Agricultural Department at a cost of £11 13*s.* 4*d.* It is recommended that seed should be collected during the fruiting season once in every two or three weeks, as it does not suffer from lying on the ground for short periods. It is estimated that 427,000 seeds are required to produce one ton of kernels. A series of experiments on the keeping qualities of the seed was carried out; seeds and kernels were stored in sacks and in closed boxes for varying periods of time, after which the seeds were examined and the amounts of moisture, oil and free acid in the oil were determined. The results show that air-dried seed or kernels may be stored in sacks for periods up to six months without appreciable deterioration; storage in boxes is less suitable as the contents were found in many cases to be attacked by mould. These results are in accordance with the earlier results of examination at the Imperial Institute of a consignment of air-dried kernels from Ceylon which were found to be in satisfactory condition on reaching London. With regard to the possible utilisation of the seed and oil the authors quote in full most of the information already published in this Bulletin (1913, **11**, 551).

Experiments on the expression of Para rubber seed oil are being made on a fair scale in the Federated Malay States and a consignment of 30 tons of seed was sent recently to a firm at Hull. The oil produced sold at £50 per ton when linseed oil was worth £60 per ton, while the residual meal sold at £8 per ton. There can be no doubt therefore that air-dried kernels in good condition, or Para rubber seed oil and meal of good quality would be readily saleable. It only remains to be seen whether owners of rubber estates can organise the collection of seed so as to place it on the market in sufficiently large and regular supplies to induce oil manufacturers to work this material.

Miscellaneous.—Considerable quantities of tomato seed and skins are obtained as waste products of the canning industry, and the disposal of the waste seed mixed with skin is a matter of some importance as the residue soon becomes offensive. In Italy the seeds have been utilised as a source of oil for some time past, and Rabak discusses the question and describes the processes employed in *Bulletin* 632, 1917, *U.S. Dept. Agric.* The method of recovering the seed consists in drying the residue and separating the seed and skin in sifting and fanning machines. The seed, which contains about 22 per cent. of oil, can then be treated for the recovery of oil by the usual methods of expression and extraction. The oil is liquid and when purified is of pale yellow colour and possesses a bland nut-like taste and smell. In Italy feeding experiments with the residual cake or meal have given satisfactory results; and several grades of cake or meal made in Milan from the seed residue mixed with skins are sold at prices ranging from about £6 to £6 10*s*. per ton In the United States it is estimated that about 3,390 tons of waste seed and skins are at present produced annually, equivalent to about 343 tons of oil, 1,200 tons of seed meal and 1,800 tons of skins; and as the quantity of waste material is likely to increase in the future, a co-operative system of collection and utilisation seems advisable.

The seeds of *Echinocystis oregana*, a plant widely distributed on the Pacific Coast of North America and commonly known as "wild cucumber," contain 30–35 per cent. of oil similar in character to cotton-seed oil (*Journ. Indust. Eng. Chem.*, 1918, **10,** 126).

Owing to the shortage of oils in Germany, attention has been turned to a number of seeds which can be obtained from indigenous plants or which can be easily grown there (*Int. Rev. Sci. and Practice of Agric.*, 1917, **8,** 1128). Colza (rape) was being cultivated, and of the 642,486 acres of copse available for this crop 86,488 acres were to be used in 1917. The cultivation of sunflowers was still in an experimental stage at the end of 1916. Poppies can only be grown in good well-sheltered soil. The collection of beech nuts has been undertaken, and an estimated yield of about 490,000 tons of nuts yielding 2,200,000 gallons of oil at a cost of 3 marks (3*s*. at par) per gallon was expected. There are few walnuts or hazel nuts available in Germany; horse-chestnuts only yielded about 5 per cent. of oil, the utilisation of which is still being studied; lime seed yielded only about 2·5 per cent. of oil on expression. Spruce seed yields 25 per cent. of oil, but only about 393 tons were available. It appears that beech-nuts are to be used for the production of oil and cake for human consumption, while horse-chestnuts and acorns are to be reserved for cattle food, their use being regulated by Federal order and their sale controlled by the Sales Union of German farmers at 190 marks and 150 marks per metric ton (dried) respectively.

Rubber

Castilloa.—The special Rubber Committee of The Trinidad and Tobago Department of Agriculture have arrived at the conclusion that the planting of *Castilloa* as a pure crop is unprofitable, and that further planting even as a shade for cocoa is inadvisable except on estates where *Castilloa* has already given good results with cocoa (*Bulletin Dept. Agric., Trinidad,* 1917, **16,** 95). Where *Castilloa* is growing well it will, however, pay to tap it, the most profitable method being to make oblique upward cuts with a cutlass one foot apart on one side of the tree; tapping should be done two or three times a year in dry weather, the rubber being collected in the form of "scrap-ball."

Hevea.—The Report of the proceedings of the First Agricultural Conference, Malaya, held at Kuala Lumpur in April 1917, contains a number of papers dealing with the cultivation, tapping, preparation and pests of Hevea rubber.

The report of the Special Rubber Committee of the Trinidad and Tobago Department of Agriculture, referred to above, also deals with Hevea rubber. On certain plantations the results with Hevea have been equal to those obtained on average estates in the East, and the industry is regarded as worth encouragement in suitable districts. Although rubber is unlikely to become as important a crop as cocoa, sugar or coconuts, it should become one of the most important secondary industries. Trees should be planted not closer than 20 × 20 ft. and thinned out later. Coffee, especially *Coffea robusta,* is considered to be the most suitable intercrop, and cover crops, especially on hilly lands, are desirable to prevent "wash." Experiments have indicated that a tapping interval of four days is most profitable under local conditions, but experiments at lesser intervals are being made. The formation of a local Rubber Planters' Association is recommended, as well as the appointment of a rubber expert with experience in Eastern rubber plantations.

A résumé of the recent work on rubber of the Malay Department of Agriculture is given by Eaton (*Agric. Bulletin F.M.S.*, 1917, **6**, 147). The author considers that the best method of preparing quick-curing "slab" rubber will probably consist in cutting up the matured coagulum into worms, followed by drying in a vacuum or in hot air and pressing into block. In this way the expense of shipping wet slab containing 15–20 per cent. of moisture and therefore requiring washing after export to the rubber mills will be avoided. It has been found that the chromogenic organisms which produce "spots" on rubber retard the rate of cure of quick-curing rubbers produced from matured slab when the rubber is packed loose in a moist condition; if, however, such wet rubber is pressed into a compact block no formation of pigment takes place, whence therefore it appears that the chromogenic organisms attack the substances causing acceleration in rate of cure.

Manihot.—The cultivation of Manihot trees in German East Africa is dealt with in an article by Christy in the *Journ. African Society* (1918, **66**, 113). He considers that the industry is likely to prove of value, but it should perhaps be pointed out that this view is not universal (cf. this Bulletin, 1914, **12**, 486). Manihot trees have been planted in large numbers in the bush along the railroad from Dar-es-Salaam to Ujiji; the trees are planted 8 ft. apart in rows 10 ft. apart (at the rate of 550 trees per acre). Little previous clearing of bush has been made as the trees soon form a canopy, preventing further growth of grass or bush, and practically nothing is spent on upkeep. Where Manihot has failed to thrive Sisal hemp has been planted. Tapping is cheap and simple, and transport of goods and rubber is easily effected by motor-car along roads between the blocks of rubber trees. Although Manihot trees are inferior to Hevea as a source of rubber, and do not yield an increased return as the tree grows older, Manihot can be tapped when about two years old, so that the older trees which become unproductive owing to thickening of bark after five or six years of tapping can be cut out and rapidly replaced. The author considers that under normal conditions the exports of Ceara rubber from German East Africa would have been large and steady.

Balata

An account of the balata industry of Venezuela is given in *U.S. Commerce Reports*, 1917, No. 272, p. 698. The collection of balata commenced near Maturin, but in 1894 the trees in this district had already been exterminated. Exploitation was then carried on near San Felix in the State of Bolivar, and extended eastwards to the British Guiana boundary and southward along the Orinoco and its tributaries. It is estimated that 10,000 collectors have destroyed 36,000,000 trees in the last ten years. Although tapping is enforced in British and Dutch Guiana, and felling of trees is forbidden, regulations to prevent destruction of trees have been opposed in Venezuela. The trees are unproductive during the first ten years of their growth, and only become fully developed in thirty years; natural regeneration is slow owing to the fruits being eaten by wild animals. The collection of balata takes place from May till August, though the trees can be worked at all times during years of continuous rain except when they are flowering, at which period the sap is too weak to render collection remunerative. The average yield of latex per tree is at present 3 gallons, equivalent to 18 lb. of balata, but by proper tapping each tree should produce $2 worth of balata per year for thirty or more years. The exports of balata amounted to 2,219, 894 and 1,096 metric tons in 1913, 1914 and 1915 respectively, while 287 metric tons were exported in the first six months of 1916. Before the war Germany was the principal buyer, followed by France, the United States and the United Kingdom in the order named; in 1916 the United Kingdom and the United States appear to have been the only buyers.

Fibres

Sisal Hemp.—It is stated in the *Rep. Dept. Agric., Antigua*, 1916–17, that a definite start has been made in the island of Antigua in the cultivation of Sisal hemp on a commercial scale. About 8,000 plants have already been set out, arrangements are being made to import large numbers of plants from Anguilla, and it is anticipated that extensive areas will be devoted to the crop. When the plants are sufficiently mature, modern machinery will be imported for extracting the fibre.

Paper-making Materials.—The *Indian Forester* (1917, **43**, 479) contains an article by R. S. Hole, I.F.S., Forest Botanist, on the best method of working "ulla" grass-lands. In 1910, samples of "ulla" grass (*Anthistiria gigantea*, Cav., sub. sp. *arundinacea*, Hack.) were examined by Raitt, and as an outcome of his report on the value of the material for paper-making it was proposed to establish a paper-pulp factory in the Pilibhit Division of the United Provinces. It therefore became necessary to determine the best method of harvesting the grass in order to obtain a sustained maximum yield per unit area, especially of the flowering culms, which form the most valuable part of the crop in respect of the quantity and quality of pulp produced. At the time of cutting the crop it is usually found that the majority of the culms which would become flowering culms in the succeeding year are present as leafy shoots. If these shoots are cut when the flowering culms are harvested the yield of grass in the next year will be diminished. It is therefore of importance that only the flowering and dead culms should be cut, the leafy culms being spared. It is also pointed out that, according to Raitt, the inclusion of immature leaf in the crop is objectionable from the standpoint of the paper-maker as it causes agglutination and also interferes with the bleaching. Another point which has to be considered in connection with the harvesting of ulla grass is the fact that the dry grass-lands of Pilibhit are very liable to damage by fire. A late fire in April or May is very destructive and burns all the shoots to the ground. Assuming that the fire is unpreventable, the damage could be reduced by burning purposely immediately after cutting. This procedure, however, if continued from year to year would probably cause a diminution in the yield by reducing the quantity of organic matter and moisture in the soil. The effect of fire is also to facilitate the access to the grass-lands of deer and other animals which eat the young shoots and thus increase the damage.

In view of the above facts, experiments have been carried out to determine the comparative merits of the following methods of treating the Pilibhit grass-lands: (1) cutting all shoots, flowering and leafy, and burning the area as soon as possible after cutting; (2) cutting all shoots, flowering and leafy, and then protecting the area from fire; (3) cutting only the flowering and dead shoots and burning as soon as possible after cutting; and (4) cutting only the flowering and dead shoots and then protecting the area from fire. The results obtained are so strongly in favour of treatment (4) that there seems no reason to doubt that this is the best treatment to adopt. It is also suggested that efforts should be made to increase the yield of the grass by improving the fire-protection arrangements and by increasing the proportion of ulla in the crop by artificial propagation. The experiments are being continued and further trials are being made to ascertain the effect of (1) alternate burning and protection, and (2) alternate complete and partial cutting.

Cotton

Union of South Africa.—Reference was made in this Bulletin (1917, **15**, 453) to the progress which is being made in cotton growing in South Africa. It has now been stated in the *South African Journal of Industries* (1917, **1**, 175) that the area estimated to be devoted to cotton in the Union during the present season is from 7,000 to 10,000 acres. A number of farmers are planting cotton in Zululand, over 2,000 acres having been sown in one district.

Further information on the subject is given in the *South African Journal of Industries* (1917, **1**, 290, 492, 562). Cotton is being produced on a commercial scale in the Rustenburg and Waterberg Districts of the Transvaal. The cultivation has been carried on for several years in the Zoutpansberg and Pietersburg Districts, but has failed to make proper progress owing chiefly to lack of organisation in ginning and marketing the crop. Cotton has been found to thrive in parts of the Lydenburg, Middelburg and Barberton Districts, but the crop has not proved remunerative in these areas on account of the absence of ginning facilities. In the Lydenburg District, however, a ginnery has now been erected and cotton is being grown on a commercial scale. Swaziland is well adapted for cotton growing, but the industry has been hindered by the lack of transport and ginning facilities. Small areas have been planted in parts of Zululand and Natal during the last few years and have given successful results. In the Transkei and Pondoland, cotton can be grown with success, and, under existing conditions, would doubtless be produced chiefly as a native crop. Five bales of cotton from Pondoland were shipped to Liverpool last March and three of these were sold at 16*d.* per lb. The crop was grown on the banks of the Umzimvubu River, in both light and black soils, the latter yielding the better results. It is not considered likely that cotton growing will be taken up extensively in this district at present, as it is said to yield smaller profits than maize, and the labour supply presents some difficulty.

India.—In the *Rep. Dept. Agric., Punjab,* 1916–17, attention is drawn to the great developments which have taken place in connection with the cultivation of the American cotton, known as 4F. The area devoted to this variety has increased from 7,700 acres in 1915 to 50,000 acres in 1916, and 215,000 acres in 1917. On by far the greater part of this area (about 90 per cent.) the cotton is grown as a pure crop, but on the remainder the 4F is more or less mixed with native cotton. Efforts are made to keep the cotton pure, but the demand for seed is so great that the Zamindars insist on growing even mixed seed if they cannot obtain supplies of the pure variety. As the 4F cotton commands a premium of about 4 Rs. per maund above the price of the native cotton, it was estimated that the extra profit obtained by the growers of the 4F variety during the winter of 1917 would amount to over £300,000. The American cotton has to be sown early on good land, and the peasant prefers native cotton for his own domestic use. It is therefore considered unlikely that the 4F variety will ever completely displace the native cotton.

An interesting account of the efforts made to improve the cotton-growing industry of Madras is given in the *Rep. Dept. Agric. Madras,* 1916–17. In the "Northerns" and "Westerns" area, 934 acres were sown in 1915 in the Bellary district and 980 acres in the Kurnool district with the selected strains known as Sircar Nos. 1 and 2. The crop was grown under seed-farm conditions and the yield was only about 40 lb. per acre as compared with 50 lb. given by the local cotton. It is therefore evident that more attention must be directed to the yield of lint per acre in making selections for these tracts. Hitherto the strains have been selected mainly for good staple, colour and strength, but to the ryot the yield is the most important consideration as the difference in price between long- and short-stapled cotton is not sufficient to compensate for the poorer yield of the former. In Kurnool, an experiment was made to ascertain whether it would be profitable for a ryot to clean his seed-cotton before selling it, but as a result a considerable loss was sustained as the buying firms refuse to pay any higher price for the clean cotton. It is therefore concluded that the usual practice of selling the good and bad cotton together just as it comes from the field is obviously the best plan in the circumstances.

In the "Tinnevellies" tract, 552 acres were cultivated as seed-farms in 1915 with the varieties known as Company No. 2 and Company No. 3. The average yield of lint per acre was 96 lb. for Company No. 2 and 139 lb. for Company No. 3 for the first picking in each case. A second picking is not taken on these seed-farms, as the seed thus obtained is not of such good quality. The average yield of unselected Tinnevelly cotton is about 90 lb. per acre, including both pickings. The selected strains thus combine both good yield per acre and good staple. Efforts to restrict the cultivation of the inferior "pulichai" cotton were made by (1) a combination of the buying firms refusing to purchase it, and (2) a distribution of seed of the Company No. 3 variety which gives the grower a better return per acre than "pulichai." As a result, "pulichai" has been largely rooted out, but it still exists as an impurity in the general crop over a wide area. It is considered that it will take years to eliminate it completely, not because it will be grown deliberately, but because many ryots are careless about their seed.

Uganda.—An account of the progress of the cotton industry of Uganda is given in the *Ann. Rep. Dept. Agric., Uganda Protectorate*, 1916–17. It is estimated that 129,833 acres were planted, the whole of the seed sown being of the "Sunflower" variety, and derived from selections made at the Government Plantation at Kadunguru. Owing to the prevalence of wet and cold weather, the yield per acre was the lowest on record, and the crop contained a good deal of stained and immature fibre. Where the crop was successful, however, the cotton showed a distinct improvement, being more regular in staple, stronger, and having a better twist than that of previous years. The crop met with a good demand and realised high prices, especially in the Buganda Province. The exports amounted to 77,691 cwts. of ginned and 32 cwts. of unginned cotton as compared with 91,231 cwts. and 8,110 cwts. respectively in the preceding year. The value of the crop was greater, however, being £348,914 as against £245,426 in the previous year. The cotton was of a high grade and, when marketed in good, clean condition, generally realised 4*d.* or 5*d.* per lb. in advance of the price of "middling" American. The amount of cotton seed exported was 5,460 tons as compared with 5,225 tons in 1915–16. New ginneries have been erected at Kalaki in Lango and Kidongole in Teso, and others are being constructed in various parts of the country. Practically the whole of the cotton is now ginned and baled in the Protectorate.

West Indies.—In a report on the cotton industry of St. Vincent (*Rep. Agric. Dept., St. Vincent*, 1916–17), it is stated that the area devoted to Sea Island cotton in that year was only 2,401 acres, which is the smallest acreage planted since 1906–7. Unfavourable weather was again experienced with abnormally heavy rains in October and November, and the total estimated yield of cotton was only 160,168 lb. or about 66 lb. per acre. Many of the bolls were affected with disease, especially with internal boll-rot following attacks of the cotton stainer. Energetic measures were taken to control the cotton stainer (compare this BULLETIN, 1918, **16**, 115). Although cotton cultivation has experienced several unfavourable seasons in succession, many planters are resolved to give the industry a further trial in the hope that their efforts may be rewarded by a good season and high prices for the crop. The area cultivated with "Marie Galante" cotton in the Southern Grenadines was 1,050 acres and the yield amounted to 45,852 lb. Sea Island cotton is grown in these islands as well as "Marie Galante" and the acreage devoted to the former is steadily increasing, the Sea Island seed for planting being obtained from St. Vincent. Manurial experiments which have been carried on in St. Vincent at the Government Experiment Station for five years have given the following results. The percentage of flowers which produced ripe bolls was not affected by differences in manurial treatment. All the manured plots showed a larger yield than the unmanured. The most necessary manure for cotton in St. Vincent is potash, the application of which produced a yield of 76 per cent. more than that given by the unmanured plots. An application of phosphate and potash was found to be less beneficial than potash alone. Artificial manures and cotton-seed meal in combination gave better results than either alone. An application of cotton-seed meal at the rate of 600 lb. per acre was apparently insufficient to meet the full requirements of the plants when grown on the same soil for a number of years. These results emphasise the necessity of manuring heavily and adopting a rational system of rotations.

According to the *Rep. Agric. Dept., Montserrat*, 1916–17, the area planted with cotton in that island in 1916–17 was 1,997 acres and the yield amounted to 313,322 lb., or an average of 156 lb. per acre. The season was favourable on the whole and comparatively little damage was caused by the cotton worm. Cotton stainers were not abundant until towards the end of the year, the suppression being effected by collecting the insects by hand when they first made their appearance. The amount of stained cotton in the crop amounted to 7·7 per cent. of the whole. The work carried out at the Experiment Station is leading to the production of a high-grade cotton which realises good prices and to the provision of a reliable supply of seed of good quality. The cotton produced in Montserrat during the last two seasons has shown a distinct improvement in quality, and this is largely due to the continued selection and extended cultivation of the type known as Heaton No. 9.

It is stated in the *Rep. Agric. Dept., Antigua*, 1916–17, that the area planted with cotton in Antigua in that year was only 280 acres, which is the smallest for 14 years and about 160 acres less than in 1915–16. The decrease was largely due to the high prices obtainable for sugar, which induced some planters who had previously grown cotton to grow sugar-cane instead. A large proportion of the area was cultivated by peasants and the yield was estimated at about 100 lb. per acre. About 100 acres were also planted in Barbuda. The hybrid cotton, Sea Island × St. Eustatius, which was produced some years ago by the Agricultural Department of Antigua, gave a yield of 245 lb. per acre ; this cotton varies in length from about 1·6 in. to 1·85 in., with an average of 1·73 in.

United States.—Strenuous efforts are being made in the United States to guard against invasion of the pink boll-worm. An interesting example of the stringent measures adopted is given in the *Service and Regulatory Announcements* (Fed. Hort. Bd., 43), *U.S. Dept. Agric.* A single specimen of the pink boll-worm was reported in a field at Hearne, Texas, adjacent to one of certain mills which had received cotton seed from Mexico. Twenty-five entomologists from the Federal Horticultural Board, the Bureau of Entomology and the inspection and entomological departments of the State of Texas assembled at Hearne and undertook a plant-to-plant examination of every field in the neighbourhood of the mills. Over 400 labourers were employed to destroy all the cotton fields in the vicinity of Hearne within possible range of infestation. The cotton plants were uprooted and burned and the bare land was burned over with a burner such as is used for softening asphalt in repairing pavements. The cotton grown in the neighbourhood of the mills concerned was kept under constant observation and none of the locally grown seed will be allowed to be used for planting. The lint produced from the crop in question will all be exported overseas and the seed promptly ground up at the mills. Special legislation is being enacted to control the growth and movement of cotton on the Mexican border and at any other point in Texas which may become invaded by the pink boll-worm.

Further references to the pink boll-worm and the efforts made to prevent its spread are made in the *Service* *and Regulatory Announcements* (Fed. Hort. Bd., 48, 49 and 50), *U.S. Dept. Agric.*, of January, February and March, 1918. Within certain areas, including the Hearne district, and the counties of Chambers, Jefferson and Galveston (except the island of Galveston), and portions of Brazoria, Fort Bend, Harris, Liberty and Hardin counties, cotton growing is designated a public menace and is prohibited for a term of three years or so long as such conditions of menace to the cotton industry shall be deemed to exist. It is considered that there is a reasonable chance of exterminating the insect in Texas if the State authorities and all the planters loyally co-operate. A border cotton-free zone has been established to include the counties of Kinney, Maverick, and Valverde owing to the infestation of cotton lands in Mexico within twenty-five miles of the Texas-Mexico border. The State extension service of Texas is co-operating with the Federal authorities in educational work with respect to the planting of other crops as substitutes for cotton, such as ground nuts, soy beans and sugar-cane.

An account is also given of the damage caused in Brazil by the pink boll-worm. It is stated that the loss on last year's cotton crop in that country amounted to $27,500,000 (about £5,730,000). In the State of Piauhy, the pest caused the loss of one-third of the 1917 crop, whilst in the State of Ceara the crop was reduced to one-third of that of 1916.

NOTICES OF RECENT LITERATURE

La Tunisie. By J.-L. de Lanessan, Ancien Ministre de la Marine, Ancien Gouverneur général de l'Indo-Chine. Second edition. Pp. vi + 308, Demy 8vo. (Paris: Librairie Félix Alcan, 1917.) Price 5*fr.* 50; post free, United Kingdom and abroad 4*s.* 10*d.*

Though described on the title-page simply as a second edition, revised and brought up to date, the present issue of M. de Lanessan's *La Tunisie* is practically a new work. The first edition was published in 1887, only half a dozen years after the French established their protectorate over Tunis. A few passages in the original volume, relating to such matters as the native methods of agriculture, are true of present-day conditions; but even in such cases it has been necessary to introduce supplementary matter, while as regards the great bulk of the book—which is almost exclusively concerned with the economic development of the country—the changes of the past thirty years have brought about so complete a transformation that it has been a question not of revising but of rewriting the various chapters.

The mining industry, for example, is largely the creation of the period following the French occupation. The output of the mines during that period, up to and including the year 1915, was over £21,000,000, of which phosphates provided two-thirds, while ores of zinc, lead, and iron made up the remainder. The exports of phosphates, which began in 1899 with 70,000 tons, grew continuously and rapidly till in 1913 they totalled 2,000,000 tons; then came the war, and in 1915 they were down to little more than a million tons. Zinc ores, of which nearly 2,300 tons were exported in 1892, reached their maximum export of 37,000 tons in 1912; but for several years previously the returns had fluctuated and shown few signs of growth; in 1915 the exports dropped to 4,500 tons. Lead ores were first exported in 1898 (2,000 tons), and the exports continued to grow till 1913, when they amounted to 58,500 tons; in 1915 they fell to 21,000 tons. A later development than any yet mentioned has been the trade in iron ores. The exploitation of these goes back only to 1908, but in the six years before the war the exports of iron ores increased from 96,000 tons to 585,000 tons; in 1915 they stood at 292,500 tons.

In most other branches of economic activity similar progress could be shown prior to the war. M. de Lanessan's statistics are not always so up to date as in the case of those quoted above; usually he is content with figures for 1912 or earlier. But he gives a fair idea of the development of Tunis under French protection, beginning with a chapter on the soil, climate, and population, and then dealing in turn with mines, forests, native and European agricultural and manufacturing enterprise, the mining and fishing industries (a rather curious arrangement in view of the earlier chapter on mines), trade, communications, and administration. A folding map, printed in colours, is a useful adjunct, and shows that the areas classed as forest lands comprise only one considerable expanse of true forest country, in the extreme north-west.

RUBBER: ITS PRODUCTION, CHEMISTRY AND SYNTHESIS IN THE LIGHT OF RECENT RESEARCH. By A. Dubosc and Dr. A. Luttringer. English edition by Edward W. Lewis, A.C.G.I., F.C.S. Pp. xi + 384, Demy 8vo. (London: Charles Griffin & Co., Ltd., 1918.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 25*s.* 8*d.*

The French edition of this book was published in 1913; in view of the fact that practically no references to literature since 1913 have been added by the translator, it is obvious that the phrase "in the light of recent research" does not hold good as regards the English edition. Considerable advances in our knowledge of rubber have been made since 1913, and a new and comprehensive book on the subject might have been more useful than a translation of a work which, however useful when first issued, is now nearly five years old. In justice to the translator it should be mentioned that he explains in the preface that the publication of the English edition has been delayed owing to the war.

The book is divided into three sections. The first deals with the rubber industry, rubber-producing plants, resinous rubbers, reclaimed rubber and the cost of production of rubber.

In Section II the laticiferous system of rubber plants, the physical and chemical properties of latex and of coagulated rubber, coagulation and the chemical constitution of rubber are considered.

Section III deals with the synthesis of caoutchouc, including methods of producing isoprene and its homologues and the preparation of synthetic rubber.

In the preface the translator states that he has corrected the many textual errors of the original, but they are still rather numerous: for instance, on one page (23) "Mandar" for "Mudar" or "Madar," *Callotropis* for *Calotropis*, *Mardsnenia Verrucosa* for *Marsdenia verrucosa*, *Adamsonia* for *Adansonia*, follow one another within a dozen lines. On p. 273, in the description of a process for the preparation of isoprene from amylenedibromide, 200 parts of the latter are stated to have yielded 36 to 40 parts of isoprene and that "the yield was thus about 60 per cent," apparently a misprint for 20 per cent.

The book contains much useful information not readily available elsewhere.

Cellulose: an Outline of the Chemistry of the Structural Elements of Plants with Reference to their Natural History and Industrial Uses. By Cross and Bevan (C. F. Cross, E. J. Bevan and C. Beadle). New Impression with a Supplement. Pp. xx + 348, Crown 8vo. (London: Longmans, Green & Co., 1918.) Price 14*s*. net; post free, United Kingdom 14*s*. 6*d*., abroad 14*s*. 9*d*.

Owing to difficulties occasioned by the present international complications, the authors of this well-known work have been unable to complete the records necessary to justify the publication of a No. 4 of their "Cellulose

Researches." They have, therefore, taken the opportunity afforded by the issue of this new impression of adding a series of notes on recent investigations as a supplementary chapter. These notes include references to pure and normal cellulose, ester anhydrides of cellulose, the decomposition of cellulose by ozone and by heat, certain physical properties of cellulose, the chemistry of the lignocelluloses, and recent technical progress, particularly in connection with viscose products.

The Chemistry of Farm Practice. By T. E. Keith. Pp. xii + 253, Crown 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1917.) Price 6*s.* net; post free, United Kingdom and abroad, 6*s.* 6*d.*

The author of this book, which is included in "The Wiley Technical Series for Vocational and Industrial Schools," is chemist to the South Carolina Experiment Station, and Professor of Soils in the Clemson Agricultural College, S.C. He states that the purpose of the book "is to furnish the knowledge of the fundamentals of chemistry required for intelligent agriculture and to apply this knowledge to the art of agriculture and to the problems of the agriculturist." The first fifty pages or so deal concisely with the elements of chemistry, and the remainder of the book is concerned with the study of soils and manures, feeding stuffs, milk, insecticides and fungicides, paints, fuels and cement. It will be seen that the book has a wider scope than most elementary treatises on this subject, and it should prove of value as an adjunct to an elementary course in this important branch of agriculture.

Mineral Enterprise in China. By W. F. Collins, A.R.S.M., M.Inst.M.M. Pp. xi + 308, Demy 8vo. (London: William Heinemann, 1918.) Price 21*s.* net; post free, United Kingdom and abroad 21*s.* 6*d.*

The author, who was lately Vice-Chairman of the Peking British Chamber of Commerce, disarms criticism by describing his treatise as merely an attempt to outline the existing state of mineral development in China, and to provide answers to the questions: Why is the Chinese mineral industry so far behind that of other countries? Do important mineral deposits exist in the country? Are they likely to be as rich as in other corresponding areas of the earth's surface, or have they been exhausted? What are the factors retarding development of the industry? Can these factors be removed?

The first of these questions is concisely answered by the author in his preface, the history of mineral enterprise in China up to modern times being summarised as the story of the growth of what was considered a canker and of its repression; while its latter history is the tale of securing enough freedom from taxation and official interference for a few favoured enterprises to exist. Since the Revolution in 1912, much of the Chinese prejudice against machinery and foreign mining methods has given place to a real desire for their introduction; but, although the necessity for economic development on foreign lines is seen, Chinese nationalism still objects to the utilisation of the foreigner in furthering it.

Existing methods of administration need improvement, mainly by way of relaxation of official restraint on the industry. Taxation of mineral products is heavy, the taxes are collected in a harassing manner, and little progress in mining under either native or foreign auspices can be hoped for, otherwise than under exemptions, until a considerable part of this pressure is relieved.

Chinese mineral resources are undoubtedly of great value, but the author thinks it unlikely that they are of greater importance than those of other corresponding areas of the earth's surface, while they may be considerably less important. However valuable they may be, he is satisfied that no foreign capitalist will lend large sums of money to China on so uncertain a security as a wasting asset to be worked under government control, even if the Chinese Government were willing to assume the responsibility of guaranteeing repayment and interest. He suggests that, if China does not turn to foreigners and foreign capital for the development under her own control of her mineral industry, she will find her minerals developed by foreigners without her control, as is already taking place in Mongolia and Korea, and is likely to take place in Manchuria and in Shantung.

In China, outcrops have for the most part been worked out, and special encouragement must therefore be given to the prospector, who, as in the case of the Standard Oil Company, may spend large sums of money without result, and should be given the possibility of securing large profits as an inducement to take corresponding risks. With a view to encouraging the exploration of partially exhausted deposits, it would appear necessary to consider, in the case of metal mining, the advisability of granting prospecting concessions, similar to those which have proved eminently successful in Korea, over areas considerably larger than those contemplated in the existing mining regulations.

The Chinese objection that it is impossible to obtain foreign capital, and to employ foreign engineers, without extending foreign influence in the country, appears to the author as fundamentally unsound. The State railways in North China are a standing illustration that the contention is false in the political sense. This system was built in large part by foreign capital; it was constructed under the supervision of foreign engineers; the greater part is now operated by them under Chinese management, and there is no suspicion of foreign political influence, the system working admirably, being well adapted to the circumstances of the country. Similarly in Korea, the working of mines with foreign capital and under foreign control has resulted in nothing but good. Another case in point is that of the P'ing Hsiang coal mine, which, though opened up and worked under foreign supervision, has resulted in no increase of foreign political privileges, or danger of territorial loss.

Five maps are bound up in the book, these showing railways and projected railways (in colour), also the localities of the chief mining centres; and there are two small sketch-maps in the text.

The book does not concern itself with statistics of mineral production in China, the author referring the reader elsewhere for such information. Trustworthy figures showing the output of minerals and metals in Hunan and other provinces since the beginning of the present century might advantageously appear in a new edition, and there are other obvious directions in which the work might be usefully expanded without increase of price, notably in giving an adequate account of the mineral resources of the country.

A TEXT-BOOK OF MINING GEOLOGY. By James Park. Fourth edition. Pp. xii + 342, Crown 8vo. (London: Charles Griffin & Co., Ltd., 1918.) Price 9*s.* net; post free, United Kingdom and abroad 9*s.* 6*d.*

This is a fourth edition, revised and enlarged, of a well-known text-book dealing with various aspects of mining geology, and is intended for the use of mining students and miners. The subjects treated include the nature and origin of mineral deposits, mine sampling and ore valuation, and the examination and valuation of mines. The new matter that has been added relates chiefly to the mode of occurrence, genesis, and persistence of ore deposits in depth.

The chapter dealing with "Ores and minerals considered economically" treats of the mineral industry as it was in pre-war days, and gives no indication of the changes brought about by the war, which have been very remarkable in some cases; but, as mentioned in the preface, the statistics available for the war period are incomplete.

There have been, however, many recent changes in the mineral industry which deserve notice in a chapter of this description. Even as a pre-war statement up to 1914 the account is not up to date; but Professor Park will doubtless revise this chapter for the next edition, and add still further to the usefulness of his text-book.

Prospecting for Minerals: A Practical Handbook. By S. Herbert Cox. Seventh edition. Pp. xi + 260, Crown 8vo. (London: Charles Griffin & Co., Ltd., 1918.) Price 5*s.* net; post free, United Kingdom and abroad 5*s.* 6*d.*

A useful book that has reached a seventh edition should be fairly free from errors, and should be in a position to claim that it is a safe guide to the subject with which it deals. The preface to this seventh edition of "Prospecting for Minerals" states that the demand for this edition "is gratifying evidence of its continued usefulness to those for whom it was written, and revision does not appear to be necessary."

A glance through the pages of this edition gives one a different impression. As evidence of this it may be mentioned that the specific gravity of magnesite is given on p. 50 as 2·17, that of hydromagnesite as 3, and that of meerschaum, on p. 57, as reaching 3·4.

Under chromite there is no mention of Rhodesia; under manganese no mention of India, Russia, or Brazil; and under bismuth no mention of Bolivia. Instances could be multiplied to show that, however useful the book may be to prospectors, the statement that "revision does not appear to be necessary" is hardly justified.

BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE DOMINIONS, COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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VOL. XVI NO. 3

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

TROPICAL GRASSES AS PAPER-MAKING MATERIALS

In connection with reports published in previous numbers of this BULLETIN (1912, **10**, 372; 1913, **11**, 68; 1916, **14**, 163; 1918, **16**, 127) on the suitability for paper-making of grasses from various countries, reference has been made to the important part these grasses may play in the paper industry in the future, especially as substitutes for wood pulp. The following reports relate to lalang grass from the Malay States and bamboo grass from Australia.

(1) LALANG GRASS FROM THE FEDERATED MALAY STATES

LALANG grass (*Imperata arundinacea*, Cyr.) is a troublesome weed in certain countries, particularly Malaya and Ceylon. It covers large areas in Johore and other States in the Malay Peninsula, in Papua, North Queensland, etc., and often occurs to the exclusion of other plants. On account of its abundance it has been suggested from time to time that the grass might be utilised for paper-making. In 1891 a concession was granted to a company for working the grass in Johore (*Agric. Bulletin of the Straits and Fed. Malay States*, 1908, **7**, 177), but no developments appear to have taken place. Experiments made at that time by paper-makers in England showed that the grass is eminently suitable for paper-making. It gave a good yield of pulp, which bleached readily, and it was considered that when used alone it would be suitable for making high class printing papers, and in conjunction with 20 per cent. of rags would produce excellent writing-paper (*Agric. Bulletin of the Straits and Fed. Malay States*, 1907, **6**, 379).

A sample of half-stuff prepared from lalang grass was favourably reported on (*Kew Bulletin*, 1909, p. 56) by a well-known British firm of paper-makers in 1905.

As already pointed out in this BULLETIN (1918, **16**, 127), great interest is now being taken in the possibility of using tropical grasses as sources of paper and pulp, and in this connection a supply of lalang grass from the Federated Malay States was received for examination at the Imperial Institute in July 1917.

The sample consisted of dried grass from 36 to 54 in. in length, and of a greenish-brown colour. The leaves were folded longitudinally and measured up to 0·6 in. in width.

A chemical examination of the grass gave the following results:

	Per cent.	
Moisture	9·2	
Ash	4·0	Calculated on the dry material.
Cellulose	56·0	
Length of ultimate fibres	0·4 to 3·0 mm.; mostly 1·0 to 2·0 mm.	

The grass was submitted to treatment with varying quantities of caustic soda under conditions similar to those used for the production of paper pulp on a commercial scale, with the following results:

Experiment.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of air-dry grass.	Yield of dry pulp, expressed on grass as received.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temperature.		
			Hours.			*Per cent.*
D	8	4	6½	140° C.	7·0	46
A	10	4	5	140° C.	8·0	43
B	16	4	5	140° C.	12·4	41
C	20	4	5	140° C.	15·4	40

The results obtained indicate that lalang grass gives a good yield of long-fibred pulp which has excellent felting qualities and produces a strong opaque paper which does not shrink on drying.

The pulp obtained by treatment with 8 per cent. of caustic soda had a not unpleasant greenish-brown colour but did not bleach; with 10 per cent. of caustic soda the pulp was of a paler greenish-brown and only bleached to a cream colour. On treatment with 16 per cent. of caustic soda (*i.e.*, under conditions similar to those employed for the production of pulp from esparto grass) the pulp was of pale colour though not so pale as pulp from Algerian esparto grass; this pulp bleached easily to a pale cream colour. With 20 per cent. of caustic soda the unbleached pulp was of pale colour and bleached to a good white.

The results of these experiments show that lalang grass compares favourably as a paper-making material with Algerian esparto grass, but that it is inferior to Spanish esparto grass. Algerian esparto yields about 42 per cent., and Spanish esparto about 50 per cent. of pulp when treated under the conditions of experiment B, compared with a yield of 41 per cent. from the lalang grass. The lalang pulp is similar in character to esparto pulp, but is not quite so good as that obtained from the Spanish grass.

Lalang grass appears to require slightly more drastic treatment than Algerian esparto if the pulp is to be bleached and used for the manufacture of white paper. Unbleached pulp of good quality suitable for the manufacture of strong wrapping paper or cardboard can, however, be produced from the grass by comparatively mild treatment; this pulp is of a characteristic greenish-brown colour, but it is not likely that this would prove a serious objection to its use.

Owing to its bulky nature the lalang grass could not be exported as such from the Federated Malay States, as it would only be worth about the same price as Algerian esparto grass which sold under pre-war conditions at from £3 10*s.* to £4 2*s.* 6*d.* per ton in the United Kingdom (June 1914). It should, however, be possible to convert the grass into pulp in the Federated Malay States, and to use the pulp locally for the production of paper or to export it.

(2) Bamboo Grass from the Northern Territory, Australia

The bamboo grass which is the subject of this report was forwarded to the Imperial Institute by the Administrator of the Northern Territory in March 1917, in order to ascertain its suitability for use as a paper-making material. The botanical identity of the grass is being ascertained.

The sample consisted of brownish-yellow reed-like stems with hard nodes at intervals of 6 to 10 in., the internodes being filled with soft pith. The stems measured 0·2 to 0·3 in. in diameter at the base, and bore leaves, about 1 in. in width, at the nodes.

The material was submitted to chemical examination at the Imperial Institute with the following results :

	Per cent.
Moisture	9·9
Ash	12·2 } Expressed on
Cellulose	48·9 } the dry grass.
Length of ultimate fibres . . .	up to 4·0 mm.; mostly from 1·0 to 2·0 mm.

The grass was converted into paper pulp by treatment with caustic soda under conditions similar to those used on a commercial scale, with the following results :

Experiment.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed by 100 parts of grass.	Yield of dry pulp expressed on the grass as received.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temperature.		
			Hours.			Per cent.
A	16	4	5	140° C.	9·2	43
B	20	4	5	140° C.	14·6	39

The grass thus gave a very fair yield of pulp and furnished a fairly strong opaque paper of light brown colour, which did not shrink appreciably on drying. The pulp, however, did not bleach to a good colour, and it contained numerous brown particles which caused undesirable specks in the paper. This defect was apparently caused by the nodes, which are hard and do not soften so readily on boiling as the other portions of the stems. Further experiments were, therefore, made in order to ascertain whether the pulp could be improved by crushing the nodes of the grass before treatment, and the following results were obtained :

Experiment.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed by 100 parts of grass.	Yield of dry pulp expressed on the grass as received.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temperature.		
			Hours.			Per cent.
C	12	4	7	140° C.	8·4	43
D	16	4	5½	140° C.	9·2	42
E	20	4	5	140° C.	14·0	40

The unbleached pulps obtained in these three experiments were of pale brown colour and free from specks, and the products obtained on bleaching the pulps produced in experiments D and E were superior in colour to the bleached pulps obtained by similar treatment from the whole grass without crushing the nodes. It is therefore clearly advantageous to crush the nodes (*e.g.*, by passing the grass through heavy rollers) before subjecting the material to treatment with caustic soda.

This bamboo grass can be treated by the usual methods employed for the manufacture of paper pulp, and gives a yield of pulp about equal to that obtainable from Algerian esparto grass. The unbleached pulp obtained from the grass is of fair quality and suitable for the production of fairly strong brown paper, whilst if the nodes of the grass are crushed and the material is then boiled with 20 per cent. of caustic soda the pulp could be used, after bleaching, for the production of white or cream-coloured paper of good quality.

The grass should be quite suitable for the manufacture of pulp or paper in Australia either for local use or for export.

THE CULTIVATION OF EDIBLE BEANS IN BURMA

In previous numbers of this Bulletin (1914, **12**, 355; 1915, **13**, 196; 1916, **14**, 150) an account was given of the results of investigation of beans produced in the course of experiments carried out at the Mandalay Agricultural Station and the Natywagon Sub-station in Burma. One of the objects of these experiments was to ascertain whether it is possible to cultivate profitably in Burma better varieties of beans than those commonly produced there for export to Europe for human consumption. The experiments were continued in Burma in 1915–16 and 1916–17, and samples of beans grown in these years, which were sent to the Imperial Institute for examination, are dealt with in the present report. They include forms of *Phaseolus lunatus* (Madagascar beans, Rangoon beans, etc.), *P. vulgaris* (haricot beans) and *P. acutifolius* (Tepary beans).

The extent of the cultivation of beans in Burma in recent years is indicated in the following table extracted from the annual *Season and Crop Reports of Burma*:

	1912–13. Acres.	1913–14. Acres.	1914–15. Acres.	1915–16. Acres.	1916–17. Acres.
Pègyi (large white)[1]	100,144	120,553	126,824	171,261	92,281
Pèbyugale (small white)[1]					191,325
Pègya (red)[1]	147,486	157,989	174,594	212,257	127,440
Pèyin[2]	20,155	21,222	26,580	32,184	16,628
Others	223,179	244,059	261,067	200,021	235,195
Total	490,964	543,823	589,065	615,723	662,869

The increased cultivation of white beans in Burma during the war is due largely to the great demand for beans of this kind in the United Kingdom. In 1913–14, out of a total export of 19,565 tons of beans of all kinds from Burma, 5,967 tons (30 per cent.) were shipped to this country, whereas in 1916–17, out of a total of 67,629 tons exported, this country took 56,901 tons (84 per cent.).

Madagascar Beans

The Madagascar bean, which is known in Burma as *pe-byu-gyi*, was supplied by the Imperial Institute for trial cultivation in Burma in 1912, 1913 and 1914. The three sets have been kept separate, and ten samples of beans grown from them at Natywagon and Mandalay in 1915–16 were forwarded for examination in December 1916, and ten further samples grown in the following season were forwarded in August 1917. In 1915–16 the season was unfavourable, and the plants were attacked by a root fungus (*Rhizoctonia solani*) and by black aphis; the yield of beans was consequently poor, both at Natywagon and Mandalay. In 1916–17, however, the conditions were more favourable, and the average yield was 426 lb. per acre, the best yield, *viz.*, 632 lb. per acre, being obtained from seed sown in July at Mandalay; at Natywagon, from seed sown in August, a yield of 569 lb. per acre was obtained, while the July sowing at this station gave a yield of 361 lb. and the August sowing at Mandalay a yield of 142 lb. per acre. The soil at Natywagon is a sandy loam, and that at Mandalay a stiff clay.

It is interesting to note that in 1914–15 one plant at Natywagon gave nothing but red seed which was speckled and marbled like that of the ordinary red Rangoon

[1] *Phaseolus lunatus.* [2] *P. calcaratus.*

bean. This result was obtained in the third generation of the seed imported in 1912, and it is stated that no coloured beans grew in the immediate neighbourhood. In 1915–16 26 plants were raised from this coloured seed, and of these, 5 produced white seed like the original seed, 1 gave greenish-yellow seed, and 20 yielded seeds of colour and markings more or less like those of the seeds sown. Considerable variation in the shape and size were noticeable in these coloured seeds; most of them were irregular and much smaller than the original white seed. It is also stated that a single plant grown at Mandalay in 1916–17 from seed raised from the 1912 set of beans, gave nothing but red and speckled beans. The behaviour of all these coloured Madagascar beans is being further studied.

The samples received at the Imperial Institute were as follows:

(A) *Forwarded in December* 1916

	Sample.	Original seed supplied in	Season of Cultivation.	Colour.	Average weight of 100 beans.
					grams.
No. 1A	4th year's produce from Natywagon.	1912	Aug. 30, 1915–April 6, 1916.	Cream to yellowish-cream, with yellowish-brown markings in some cases.	102
,, 2A	,, ,,	,,	Oct. 28, 1915–Mar. 29, 1916.	Rather more yellow than No. 1	89
,, 3A	,, ,,	,,	Nov. 12, 1915–Apr. 6, 1916.	,, ,,	82
,, 4A	3rd year's produce from Natywagon.	1913	Oct. 29, 1915–Apr. 6, 1916.	Cream to yellowish-cream as in No. 1, with yellowish - brown markings in some cases.	85
,, 5A	,, ,,	,,	Nov. 12, 1915–Mar. 29, 1916.	,, ,,	74
,, 6A	2nd year's produce from Natywagon	1914	Aug. 30, 1915–Apr. 6, 1916.	,, ,,	101
,, 7A	,, ,,	,,	Oct. 28, 1915–Mar. 29, 1916.	,, ,,	83
,, 8A	,, ,,	,,	Nov. 12, 1915–Mar. 29, 1916.	,, ,,	76
,, 9A	3rd year's produce from Mandalay farm.	1913	Nov. 4, 1915–Mar. 30, 1916.	,, ,,	69
,, 10A	2nd year's produce from Mandalay farm.	1914	,, ,,	,, ,,	69

(B) *Forwarded in August* 1917

	Sample.	Original seed supplied in	Season of cultivation.	Colour.	Average weight of 100 beans.
					grams.
No. 1B	5th year's produce from Natywagon	1912	July 16–Dec. 28, 1916	Of equally good colour as the 1st year's produce from Natywagon, but not so white as the original seed beans from Madagascar supplied by the Imperial Inst.	121
„ 2B	„ „	„	Aug. 17, 1916–Jan. 6, 1917	„ „	98
„ 3B	4th year's produce from Natywagon	1913	July 16–Dec. 28, 1916	Good white, with occasional yellow discolourations and pink eyes, but not of such good colour as the original seed	97
„ 4B	„ „	„	Aug. 17, 1916–Jan. 6, 1917	„ „	99
„ 5B	3rd year's produce from Natywagon	1914	July 16–Dec. 28, 1916	Of good white colour equal to that of the original seed	100
„ 6B	„ „	„	Aug. 17, 1916–Jan. 6, 1917	Creamy-white with occasional yellow discolourations and pink eyes, not so good as No. 5B, but slightly better than the first year's crop	90
„ 7B	4th year's produce from Mandalay farm	1913	July 18, 1916–Feb. 5, 1917	Of good white colour equal to that of the original seed. Occasional slight yellow discolourations were present.	72
„ 8B	„ „	„	Aug. 13, 1916–Feb. 28, 1917	„ „	85
„ 9B	3rd year's produce from Mandalay farm	1914	July 18, 1916–Feb. 5, 1917	Of good white colour equal to that of the original seed	96
„ 10B	„ „	„	Aug. 13, 1916–Feb. 28, 1917	„ „	95

The samples were submitted to chemical examination in order to ascertain the percentage of prussic acid which they yielded, and the results are shown in the following table in comparison with those recorded for the crops of previous years and for the original seed beans :

	Prussic Acid yielded by				
	Original seed beans.	Produce at Natywagon.		Produce at Mandalay Farm.	
		Year.	Yield of prussic acid.	Year.	Yield of prussic acid.
	Per cent.		Per cent.		Per cent.
Seed supplied by the Imperial Institute in 1912	0·0025	1st	0·005	—	—
		2nd	0·008	—	—
		3rd	0·004	—	—
		4th [1] (No. 1A)	0·005	—	—
		,, (No. 2A)	0·004	—	—
		,, (No. 3A)	0·0025	—	—
		5th [2] (No. 1B)	0·003	—	—
		,, (No. 2B)	0·003	—	—
Seed supplied by the Imperial Institute in 1913	0·002	1st	0·008	1st	0·007
		2nd	0·003	2nd	0·003
		3rd [1] (No. 4A)	0·0025	3rd [1] (No. 9A)	0·003
		,, (No. 5A)	0·002	—	
		4th [2] (No. 3B)	0·003	4th [2] (No. 7B)	0·002
		,, (No. 4B)	0·002	,, (No. 8B)	0·002
Seed supplied by the Imperial Institute in 1914	0·0025	1st	0·0025	1st	0·0025
		2nd [1] (No. 6A)	0·002	2nd[1] (No. 10A)	0·0025
		,, (No. 7A)	0·0015	—	—
		,, (No. 8A)	0·0015	—	—
		3rd [2] (No. 5B)	0·0035	3rd [2] (No. 9B)	0·0025
		,, (No. 6B)	0·0015	,, (No. 10B)	0·003

[1] *Samples now under report,* 1915–16 *crop.*
[2] *Samples now under report,* 1916–17 *crop.*

The beans of the 1915–16 crop yielded on the whole about the same amounts of prussic acid as the corresponding produce of the previous year. In appearance they had further deteriorated, the colour being inferior to those of samples from the previous crops, and the size, with the exception of samples 1A and 2A from Natywagon, somewhat smaller than before.

The percentage of prussic acid yielded by the beans of the 1916–17 crop does not differ materially from that of the previous year. The amount is in every case very small, and practically the same as in the original seed beans grown in Madagascar, the differences in this respect between the last three years' crops and the original seed beans being negligible.

The largest yield of prussic acid from these Madagascar beans grown in Burma was in the Natywagon crop for the season 1913–14, *viz.* 0·008 per cent., but even this amount is harmless, and in the three subsequent crops the percentage has been on the average less than half as much.

The most noticeable feature of the 1916–17 crop is the great improvement in colour over the produce of all the previous years. The beans grown at Mandalay had a slight advantage in colour both in 1915–16 and in 1916–17 over those grown at Natywagon, but in five out of the ten samples grown in 1916–17 at both places the colour is equal to that of the original seed beans grown in Madagascar. Further, the size has improved, though it is still inferior to that of the seed beans grown in Madagascar and of the first year's produce in Burma.

The results of the examination of the 1916–17 crop are thus very satisfactory, showing that beans comparing favourably in colour with beans grown in Madagascar can be produced in Burma, and that after five years' cultivation in Burma the yield of prussic acid is not materially higher than in beans from Madagascar. The latter, however, have the advantage in size, and it remains, therefore, to improve the size of the Burma produce, and at the same time to maintain the standard of colour reached in the 1916–17 crop.

It will be noticed that where more than one crop has been grown in the same locality in the same season there is a tendency for the later sown crop to yield a smaller amount of prussic acid. This may, perhaps, be connected with the age of the plants, as in most cases the period of growth of the later sown crops in a particular season is shorter than that of the earlier sown crops.

Samples, Nos. 3B, 7B, 8B, 9B and 10B (of the 1916–17 crop) were submitted to a firm of merchants in London, who stated that beans represented by Nos. 3B, 9B and 10B, should sell without difficulty in the United Kingdom. The present controlled price of such beans is £58 per ton c.i.f. London (Nov. 1918), the pre-war price being £16 to £20 per ton. The firm considered it probable that beans represented by samples 7B and 8B would not find such a ready market on account of their small size.

Pè-ngè Beans

A variety of *Phaseolus lunatus* with small white seeds, which was introduced from the United States and to which has been given the name *pè-ngè,* has been cultivated experimentally during the past three seasons. In 1914–15 about half the crop was destroyed by *Rhizoctonia,* but the remaining plants gave a good yield. The average yields at Natywagon and Mandalay in 1915–16 and 1916–17 are shown in the following table:

	Natywagon. Average yield per acre. *lb.*	Mandalay. Average yield per acre. *lb.*
1915–16	515[1]	659
1916–17	716	916

[1] *Excluding two very small plots, which gave yields of* 150 *and* 100 *lb. respectively.*

These yields are much better than those of Madagascar beans (see p. 276), but like the latter the seeds produced were smaller than the original seed beans.

As with Madagascar beans, the white *pè-ngè* beans produced some plants bearing coloured seed. In the first season three plants produced coloured seeds, and from these 51 plants were raised in 1915–16, of which 38 produced red and speckled seed and 13 white seed. In 1915–16 four other plants raised from white seed yielded coloured seeds; these are to be the subject of further study.

Two samples of *pè-ngè* beans grown in 1915–16 were forwarded for examination in December 1916, and two samples from the 1916–17 crop in August 1917. They were as follows:

"*No.* 11*A. Second Year's Produce from Natywagon* (1915–16)."—This sample consisted of creamy-white beans, with brown discolourations in some cases. They were of slightly better colour but somewhat smaller than those of the first year's crop at Natywagon which are dealt with under the name of Lima beans in this Bulletin (1916, **14,** 153). The average weight of 100 beans was 33·4 grams.

"*No.* 12*A. First Year's Produce from Mandalay Farm* (1915–16)."—These beans were of a good creamy-white tint, and were superior in this respect to the above sample

No. 11A, and to the first year's produce from Natywagon. The average weight of 100 beans was 36·2 grams.

"*No. 11B. Third Year's Produce from Natywagon (August to November* 1916)."—These beans were creamy-white and slightly larger than those in sample No. 11A above, representing the second year's produce at Natywagon, though not quite so large as those of the first year's crop. The average weight of 100 beans was 37 grams.

"*No. 12B. Second Year's Produce at Mandalay Farm* (1916–17)."—These beans resembled those of the above sample, No. 12A, representing the first year's crop at Mandalay (1915–16). The average weight of 100 beans was 36·2 grams.

The four samples were chemically examined at the Imperial Institute in order to determine the percentages of prussic acid which they yielded. The results are shown in the following table in comparison with the yield obtained from the beans of the first year's crop at Natywagon (*loc. cit.*):

Sample representing	Yield of prussic acid. *Per cent.*
First year's crop at Natywagon (1914–15) . . .	0·0045
Second year's crop at Natywagon (No. 11A, 1915–16) .	0·0055
Third year's crop at Natywagon (No. 11B, 1916) . .	0·0025
First year's crop at Mandalay Farm (No. 12A, 1915–16) .	0·0030
Second year's crop at Mandalay Farm (No. 12B, 1916–17)	0·0055

The percentages of prussic acid yielded by the present samples are thus seen to be satisfactorily low, as was also the case with the first year's crop grown at Natywagon. This is a good feature, as *pe-byu-galè*, the white variety of *Phaseolus lunatus* commonly grown in Burma, yields usually from 0·016 to 0·03 per cent. of prussic acid.

The beans were submitted to a firm of merchants in London, who stated that they would be readily saleable in large quantities. The present (controlled) price of such beans is £40 per ton c.i.f. London (Nov. 1918), compared with a pre-war price of £7 to £8 per ton.

The results so far obtained with this bean in Burma seem very satisfactory. The five crops so far grown, representing three years' cultivation, have been of good colour and appearance, and have yielded only small amounts of prussic acid.

White Rangoon Beans

Experiments with white Rangoon beans, known as *pe-byu-galè*, which are largely grown in Burma for both local consumption and export, were conducted at Natywagon and Mandalay in 1916–17. The average yield at the former station was 657 lb. per acre, and at the latter 1,094 lb. per acre. Samples of these beans were forwarded in August 1917 and are dealt with below.

"*No.* 14. *Produce from Mandalay Farm.*"—These were rounded oblong beans, tapering at one end, 0·3 to 0·5 in. in length, and of cream colour with slight brown discolourations in a few cases. On the whole the beans were fairly plump. The average weight of 100 beans was 27 grams.

"*No.* 15. *Produce from Natywagon.*"—These beans were similar to those of sample No. 14, but plumper, and the brown discolourations were rather more pronounced. The average weight of 100 beans was 28·5 grams.

The samples were submitted to chemical examination at the Imperial Institute in order to ascertain the amount of prussic acid which they yielded, and the following results were obtained :

No. 14 gave 0·016 per cent. of prussic acid.
,, 15 ,, 0·018 ,, ,, ,, ,,

A previous sample of these beans from Burma yielded 0·03 per cent. of prussic acid.

The amounts of prussic acid yielded by these beans, although undesirably high, would not, in view of past experience, be considered dangerous. It is of interest in this connection that the newer varieties of beans grown in Burma, such as Madagascar and *pè-ngè* beans, yield a lower percentage of prussic acid (see pp. 279 and 282), whilst the *bó-sá-pè-apyu*, *pè-daung-shè-apyu* and Tepary beans yield no prussic acid (see pp. 285 and 287).

Haricot Beans

The haricot or kidney bean is cultivated in many places in Burma, but chiefly as a market-garden crop, in the vicinity of towns, and not for export. Both the green, immature pods, and the ripe seeds are eaten. According to Thompstone and Sawyer (*The Peas and*

Beans of Burma, Bulletin No. 12, 1914, *Dept. Agric., Burma*) the general name for this bean in Burma is *bó-sá-pè*, whilst a variety known as *bó-sá-pè-apyu* is grown in the Bhamo district. The latter bean was grown experimentally at Mandalay in 1916–17, as well as one from Lashio, Northern Shan States, which is described in the *Annual Rep., Agric. Stations, Burma*, 1916–17, under the name *pè-daung-shè-apyu*. Samples of the two beans were received at the Imperial Institute in August 1917, and both proved to be typical haricot beans, although it should perhaps be mentioned that according to Thompstone and Sawyer (*loc. cit.*), the name *pè-daung-shè-apyu* is applied in Lashio to a form of *Vigna Catjang*, the cow pea.

"*Bó-sá-pè-apyu. Produce from Mandalay Farm* 1916–17."—These were long, narrow kidney-shaped beans, from 0·6 to 0·75 in. in length and about 0·3 in. wide. A few smaller beans were also present. They had a thin, hard, brittle seed-coat of a good white colour, with a narrow brownish-red streak adjoining the brown hilum. The interior of the beans was firm and of a light buff tint. A few of them showed slight brown discolourations, but otherwise they were in good condition, plump and free from insect attack.

The beans were submitted to chemical examination, and the results are given in the following table in comparison with the figures for other beans from Burma previously examined.

	Present sample. *Per cent.*	Madagascar beans.[1] *Per cent.*	Tepary beans.[1] *Per cent.*	Haricot beans.[2] *Per cent.*
Moisture	9·5	12·5	12·0	14·0
Crude proteins	23·6	25·7	23·6	23·0
Consisting of—				
True proteins	21·2	22·8	20·6	—
Other nitrogenous substances	2·4	2·9	3·0	—
Fat	1·8	0·9	1·3	2·3
Starch, etc. (by difference)	57·2	53·9	57·2	52·3
Fibre	4·3	3·4	2·7	5·5
Ash	3·6	3·6	3·2	2·9
Nutrient ratio[3]	1 : 2·6	1 : 2·2	1 : 2·5	1 : 2·5
Food units[4]	121	120	119	116

[1] *Samples from Burma analysed at the Imperial Institute.*

[2] *Figures recorded by Church.*

[3] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[4] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The beans yielded no prussic acid.

The above results show that these *Bó-sá-pè-apyu* beans have a high food value, being rich in protein and similar in composition to haricot, Tepary and Madagascar beans. A good feature of these beans is that they yield no prussic acid.

The beans were submitted to a firm of merchants who stated that they would have to be sold as "coloured beans," their present value under Government control being £36 to £37 per ton c.i.f. London (Nov. 1918).

"*Pè-daung-shè-apyu. Produce from Mandalay Farm* 1916–17."—These were small white kidney-shaped beans, 0·3 to 0·45 in. long and 0·2 to 0·3 in. broad. The seed-coat was thin, hard and brittle, and the interior firm and light buff in colour. A few beans showed a slight yellowish tint. The beans were plump, clean, and of good appearance, and free from insect attack.

The beans were submitted to chemical examination, and the results are given in the following table in comparison with the figures for beans previously examined:

	Present sample. *Per cent.*	Madagascar beans.[1] *Per cent.*	Tepary beans.[1] *Per cent.*	Haricot beans.[2] *Per cent.*
Moisture	9·5	12·5	12·0	14·0
Crude proteins	28·7	25·7	23·6	23·0
Consisting of—				
True proteins	24·0	22·8	20·6	—
Other nitrogenous substances	4·7	2·9	3·0	—
Fat	2·0	0·9	1·3	2·3
Starch, etc. (by difference)	51·1	53·9	57·2	52·3
Fibre	4·3	3·4	2·7	5·5
Ash	4·4	3·6	3·2	2·9
Nutrient ratio[3]	1 : 1·9	1 : 2·2	1 : 2·5	1 : 2·5
Food units[3]	128	120	119	116

[1] *Samples from Burma analysed at the Imperial Institute.*
[2] *Figures recorded by Church.*
[3] *For meaning of these terms, see p.* 284.

The beans yielded no prussic acid.

The above results show that these beans have a high food value and are richer in proteins than Madagascar, Tepary and haricot beans. They are of very good appearance, slightly larger and of better colour than Tepary beans, and yield no prussic acid.

The beans were submitted for valuation to a firm of merchants in London, who considered that the nominal value of the beans in London under the existing conditions (June 1918), as compared with the Government fixed prices, might be £43 per ton.

Tepary Beans

These beans, which are yielded by *Phaseolus acutifolius*, A. Gray (see this Bulletin, 1916, **14**, 154), have been grown experimentally in Burma since 1914. The yield has been poor, especially in 1914–15 and 1915–16 when the plants were attacked by *Rhizoctonia*, the best yield, 175 lb. per acre, being obtained at Mandalay in 1916–17 from seed sown in November. Compared with the other beans grown, the Tepary bean has so far proved unprofitable in Burma.

Samples representing the crop grown at Natywagon and Mandalay in 1915–16 and at Mandalay in 1916–17, were forwarded to the Imperial Institute in December 1916 and August 1917, respectively. They were as follows:

"*No. 13A. Second Year's Produce from Natywagon* (1915–16)."—These beans were white, but with a cream or greenish tint. They were not of such good appearance as the first year's produce from Natywagon (*loc. cit.*, p. 154), and were rather smaller and less plump. The average weight of 100 beans was 11·3 grams.

"*No. 14A. First Year's Produce from Mandalay Farm* (1915–16)."—These beans were white, but showed brown discolourations in many cases. They were inferior in size, plumpness, and colour to the first year's crop from Natywagon, and about equal in these respects to the second year's crop described above (sample No. 13A). The weight of 100 beans was 11·5 grams.

"*No. 13B. Second Year's Produce from Mandalay Farm* (1916–17)."—These beans were of good white colour with an occasional greenish tint. They were slightly smaller but of better colour than the beans of the first year's crop at Natywagon, and of much better appearance than the beans of the first year's crop at Mandalay Farm described above (sample No. 14A). The weight of 100 beans was 12·2 grams.

The samples were submitted to chemical examination at the Imperial Institute in order to ascertain whether they yielded prussic acid. A negative result was obtained in all three cases.

The beans were submitted in June 1918 for valuation to a firm of merchants in London, who stated that it was practically impossible to assign a definite value to them at that time, as the market was controlled by the Government and the current prices were more or less artificial. They considered the nominal values of the samples in London under the conditions then existing, as compared with the Government fixed prices, to be as follows:

Sample.	Price per ton.
Tepary Beans No. 13A from Natywagon (1915–16)	£34
,, ,, No. 14A from Mandalay Farm (1915–16)	£36
,, ,, No. 13B from Mandalay Farm (1916–17)	£40

These three samples of Tepary beans, representing the second year's crop at Natywagon and the first and second years' crops at Mandalay were, like the first crop of these beans grown in Burma, free from substances yielding prussic acid. The beans representing the second year's produce from Natywagon and the first year's produce from Mandalay (both grown in the season 1915–16) are somewhat inferior in appearance to those of the first year's crop from Natywagon, whilst those of the second year's crop from Mandalay (grown in 1916–17) are superior in colour but slightly smaller.

THE MYRTLE WAX OF SOUTH AMERICA.

The ripe fruits (berries) of various species of Myrica are covered with a layer of hard wax, which can be extracted by boiling the berries in water, and skimming off the wax which rises to the surface. The wax, after being purified by remelting, is utilised chiefly in the manufacture of candles. It is produced along the Atlantic coast of North America from the berries of *Myrica cerifera*, Linn., and *M. carolinensis*, Wild.; in South America from those of *M. arguta*, Kunth, and *M. caracassana*, Humb., Bonpl., et K.; from *M. jalapensis* in Mexico (cf. this

BULLETIN, 1909, **7**, 410), and from *M. cordifolia*, Linn., and possibly other species in South Africa (see this BULLETIN, 1906, **4**, 300).

In March, 1918, a sample of wax prepared in Colombia from the berries of *M. arguta* was received for examination. According to a report forwarded to the Imperial Institute by the Director of the Tropical Agricultural Station at San Lorenzo, Colombia, this plant is indigenous in the cold regions of that country at an elevation of from 8,000 to 10,000 ft. It grows fairly abundantly in the valley of the Quindio, and in the vicinity of Pereira; in the Department of Cauca it is found in profusion on the estates of La Pedregosa, La Cohetra, and La Aurelia. At one time it existed in the last-named region in very large quantities, but is now scarce owing to the periodical burning of the pasture lands. The plant is a shrub, 6 to 12 ft. in height, and in its natural state is usually surrounded by thick undergrowth. It is not cultivated in the strict sense; the most that is done is to clear away some of the surrounding growth to facilitate the collection of the berries. The plant appears to require a certain amount of shade, as it is stated that it does not thrive on completely cleared ground.

The berries are collected when they begin to assume a light grey colour, at which stage the yield of wax is higher and the wax of a yellower colour than when the fruits are fully ripe. In Colombia the wax is extracted by placing the berries, contained in bags made of Furcræa or Agave fibre and holding about 1 kilo. each, in boiling water. The berries are boiled until the wax begins to exude, when the bags are removed from the water and the mixture of wax and water extracted by means of a crude press consisting of two planks of wood hinged at one end. The wax which rises to the surface of the water is carefully removed and placed in moulds.

The wax is employed locally for the manufacture of candles and soap, and it is thought that if it could find a use in Europe, its preparation would be a profitable industry, as the plant is abundant, the fruits can be gathered easily and cheaply, and the extraction of the wax is not difficult.

The sample forwarded to the Imperial Institute consisted of yellowish-buff-coloured wax which had a peculiar odour similar to that of myrtle wax from South Africa ("Cape berry wax").

The material as received contained 0·31 per cent. of moisture, and only 0·17 per cent. of dirt. It yielded 0·06 per cent. of ash.

The wax was submitted to chemical examination with the following results, which are shown in comparison with corresponding figures for a sample of South African myrtle wax examined at the Imperial Institute and those recorded for commercial myrtle wax (this BULLETIN, *loc. cit.*):

		Present sample from Colombia.	South African myrtle wax.	Commercial myrtle wax.
Melting point		45° C.	40·5° C.	40° C. to 48° C.
Solidifying point of fatty acids		46·4° C.	—	46° C.
Acid value[1]		21·2	4·1	3 to 30·7
Saponification value[1]		216·7	211·1	205 to 217
Iodine value	*per cent.*	1·03	1·06	1·95 to 3·9
Unsaponifiable matter	,,	0·4	—	2·5

[1] *Milligrams of potash for 1 gram of wax.*

From these results it will be seen that this myrtle wax from Colombia possesses the general characteristics of commercial myrtle wax, of which *Myrica arguta* is stated to be one of the usual sources in South America.

A firm of importers in London stated that consignments of this wax would probably be worth about £100 to £110 per ton (May 1918), compared with a pre-war value of about £40 to £45 per ton. Owing to its low melting point, this wax could not be used for all the purposes of Carnauba wax, for which there is a very large demand at present, especially for the manufacture of cartons to be used as food containers.

PITA FIBRE FROM COLOMBIA

A SAMPLE of "pita" fibre from Colombia was received at the Imperial Institute for examination in March 1918. It was stated to be derived from an undetermined plant belonging to the Natural Order Bromeliaceæ, which grows in great abundance in various parts of the Lower Magdalena region, and in other parts of Colombia. The fibre is said to be held in high repute locally for its strength and durability.

The sample consisted of clean, well-prepared, soft, lustrous fibre, of pale straw tint. The fibre possessed good strength and varied from 8½ to 10½ ft. in length.

The fibre was examined at the Imperial Institute with the following results :

	Per cent.
Moisture	9·8
Expressed on the dry fibre :	
Ash	0·6
α-hydrolysis, loss	12·6
β- ,, ,,	16·8
Acid purification, loss	2·7
Loss on washing in water	2·1
Cellulose	74·7

Length of ultimate fibres : from 1·7 to 6·1 mm. ; mostly from 3·0 to 4·2 mm.

Commercial experts who reported on the value of this fibre for the Imperial Institute stated that it was somewhat similar to Sisal hemp obtained from *Agave Cantala* in the Philippines and the Dutch East Indies, and that the strands were fairly fine, of good strength, and thoroughly well decorticated. They considered that this fibre could be used as a substitute for Sisal hemp, Manila hemp, or other hard fibres, and they valued it at the current Government maximum price for such fibres, *i.e.* £99 to £100 per ton (May 1918), adding that the pre-war value would have been from £28 to £30 per ton.

SPECIAL ARTICLES

THE DEVELOPMENT OF THE TRADE OF BURMA

By A. S. Judge,

Lately Chief Collector of Customs, Burma

In an article published in this Bulletin (No. **1** of 1918, p. 40) Sir Harvey Adamson has discussed the present position and potentialities of the material resources of Burma. It is intended in the present article to describe the trade relations of Burma and to consider their possibilities of development.

The area of Burma is approximately 261,899 square miles, of which 169,000 are under direct British administration and 68,000 belong to independent and semi-independent native states. The province is connected with India on the north-west; the adjoining country is, however, wild and hilly. There is no railway communication between the two countries, the whole of the trade being carried on by sea. The main geographical feature of the country is the series of rivers and hills, running from north to south, with fertile valleys in between, until they reach the Deltaic Plains, a level alluvial tract containing the mouths of the Irrawaddy and other rivers.

The deltaic districts of Lower Burma have a mean rainfall of 117 in., and 124 inhabitants to the square mile. In respect to its soil and rainfall, Lower Burma is perhaps unsurpassed by any part of India; but the density of population, though greater than that of any other part of Burma, is a mere fraction of that found in the Lower Ganges Valley. Rice is the staple crop grown in the deltaic districts, and there is always a large available surplus for export.

The climate of Upper Burma is in marked contrast with that of the delta; it has a scanty rainfall of 38 in., its soil is, however, fertile, and it enjoys a considerable irrigation, which can be extended. It has a population of 93 to the square mile, and raises a variety of crops, of which cotton, oil seeds, millets, pulses, tobacco, and rice in the irrigated valleys are the most important. The oil-fields, which have proved such a source of wealth to the province, are situated in this part of Burma.

Arakan, on the Bay of Bengal, has a very heavy rainfall; the surface of a great part of this division is broken and hilly and not fit for cultivation. Rice is the staple crop grown in the plains, and large quantities are exported from Akyab. Tenasserim on the south also has a heavy rainfall, fairly well distributed throughout the year. This division has recently attracted attention on account of the suitability of its soil and climate for rubber-growing, and also on account of the discovery of large deposits of wolfram. The population is rapidly growing by the influx of labour required to work the new industries.

The Shan States possess a fine climate, with a mean rainfall of 82 in. No agricultural statistics are available; the area fit for cultivation is, however, extensive. The country is sparsely inhabited, and the means of communication are limited. This country has a great future ahead when it has been opened up by roads and connected by rail with Rangoon. Wheat, potatoes, and other crops, as well as English fruits and vegetables, can be grown, and there is excellent pasturage throughout the year for raising stock. It is, in fact, an ideal country for agricultural development. The mineral resources of the States are said to be great, but have not yet been fully tested. At Bawdwin in the Northern States, the Burma Corporation possess very valuable mines containing lead, silver and zinc.

The population of Burma in 1911 was 12,115,217, and it was mentioned in the Census Report that the province was capable of supporting at least three or four times its present population. Between 1872 and 1911 the population of Lower Burma had grown by 135 per cent., and that of the whole province, including Upper Burma, which was annexed in 1886, by 37 per cent. since 1891. The foreign element is very strongly represented in Burma; there are over 600,000 Indians, more than 100,000 Chinese, nearly 25,000 Europeans, and many Jews, Armenians and others. The Burmans and other indigenous races are mainly engaged in agriculture, the commercial and industrial progress being largely due to the initiative of the foreign element, and principally to the enterprise of British merchants and the industry of Indian coolies. Chinese and Indian traders, and Chetty bankers from Madras, are to be found in all parts of Burma, and have helped to open up the country and develop trade.

Extent of Trade

The great resources of Burma, which have only been partly developed, and the growing volume of its trade are not generally recognised. This is due to the fact that Burma is always treated as a part of India, and, although the trade returns of the province are separately recorded, the statistics of the foreign trade of the whole of India, including Burma, are usually read, and no account is taken of the trade between India and Burma. Only those who are acquainted with the conditions prevailing both in India and Burma are aware of the great difference in the average standard of living and material prosperity of the peoples of the two countries. The greater prosperity of the peasantry of Burma, as compared with India, is due to the following facts: the average size of the agricultural holdings in Burma is larger than in India; Lower Burma is a most fertile tract of country, and is in fact one of the finest granaries in Asia; it does not suffer from periodical droughts, as is the case in many parts of India; rice is a very profitable crop, and, owing to the extensive area under cultivation in proportion to the population, there is always a large surplus available for export. It will, therefore, be of interest to compare the trade of Burma with that of India.

In 1911, the population of the whole of British India, including the Native States, was 315,156,396; the population of Burma was 12,115,217, or 3·8 per cent. of the total population. The value of the foreign sea-borne trade, exclusive of treasure and Government stores, of India, including Burma, and of Burma alone, in 1913–14 was:

	India, including Burma. £	Burma. £
Exports	165,819,218	15,938,530
Imports	122,165,288	10,667,546
Total	287,984,506	26,606,076

Burma's share of the trade was 9·2 per cent. These figures do not represent, however, the whole of Burma's trade. The province carries on a very large trade with India, sending rice, kerosene, teak and other products, receiving in return coal, gunny-bags, provisions, cotton yarn and piece-goods, and other articles. In order to arrive at a true comparison of the trade of India and Burma, the value of the coasting trade between the two countries should be taken into consideration :

	India, including Burma.	Burma.
	£	£
Foreign trade	287,984,506	26,606,076
Trade between India and Burma .	16,272,387	16,272,387
Total	304,356,893	42,878,463

Burma's share of the total trade was 14 per cent. The population of India, without Burma, is 303,041,179, and the value of her trade, excluding Burma's share, is £261,478,430, equal to 17*s.* 3*d.* per head, against an average of £3 10*s.* 9*d.* per head in Burma. If the trans-frontier trade with China and Siam, valued at £1,500,000, is added to the total, the average value of the trade per head of population in Burma amounts to £3 13*s.* 3*d.* This rate, though much lower than the trade of the principal countries of Europe, compares more nearly with the conditions prevailing in Southern Europe.

	Population.	Value of trade.	Per head.		
		£	£	*s.*	*d.*
Burma	12,115,217	44,400,000	3	13	3
Spain	20,000,000	80,000,000	4	0	0
Portugal	6,000,000	23,000,000	4	3	0

The agricultural classes in Burma probably live and dress as well as the peasantry in parts of Southern Europe, and they have ample funds for amusements, for the adornment of pagodas and shrines, and the maintenance of a numerous priesthood. A comparison of the percentage of importations into Burma of what may be considered to be luxuries to the total of similar importations into British India clearly shows the great difference in the style of living in the two countries. For instance, whereas the population of Burma is but 3·8 per cent. of the combined population of India and Burma, Burma's share of the total imports of the following luxuries into British India was—salted fish 85 per cent., condensed and preserved milk 63 per cent., biscuits and cakes and canned and bottled provisions 42 per cent., enamelled iron-ware, domestic hardware and cigarettes 40 per cent., silk piece-goods 34 per cent., boots and shoes 30 per cent., farinaceous foods, liquors and soap about 25 per cent., articles imported by post 18 per cent., matches 17 per cent.; there are several other articles, such as woollen goods, haberdashery, umbrellas, toilet requisites, etc., of which Burma's share is about 15 per cent. When it comes to wheeled vehicles imports are restricted; Burma's share of carts and carriages is less than 6 per cent., and of motor-cars and cycles about 8 per cent. Motor-cars are to be seen in great numbers in Rangoon, and wherever the roads permit of their use. If Burma was equipped with metalled roads like the older provinces of India, there would have been a great demand for motor-cars and other vehicles. The want of roads is the great grievance of Burma; the economic development of the country has been checked by the absence of metalled roads and consequent means of transport. There are many parts of Burma from which the produce of the land, forests and mines cannot be sent profitably to the market. The financial arrangement under which the province is worked does not allow of the construction of roads on an adequate scale. If the large undeveloped resources of Burma are to be made available for the benefit of the province and of the world generally, then a generous policy should be adopted and grants made for the construction of roads and bridges for motor transport. The trade of the province has hitherto been mainly dependent on the railway between Mandalay and Rangoon, with certain branch lines, and on the splendid service of river steamers and launches maintained by the Irrawaddy Flotilla Company on the Irrawaddy and other rivers and creeks which find outlets at Rangoon.

Development of Trade and Sea Ports

British trade relationship with Burma may be said to date from 1790 when the East India Company established a factory at Rangoon, supported in 1798 by the appointment of a British resident. Trade was carried on principally with Calcutta, teak being the chief commodity exported, and European and Indian cotton piece-goods the most valuable article imported. Trade restrictions and the exactions of Burmese officials did not allow of any great expansion of business. In 1820, the gross charges on a vessel of 420 tons visiting Rangoon amounted to 1,961 rupees, only a little less than the charges now for a vessel of 5,000 tons. Up to the time of the first Burmese war, the average number of vessels that cleared from Rangoon was only 56 in the year. Rangoon was taken in 1824 and held until 1827, when it was evacuated in accordance with the Treaty of Yandoon. By this treaty Arakan and Tenasserim were ceded to the British. These two countries were found to be almost depopulated; the first census taken by the British in Arakan in 1829 made the population to number 121,288. As soon as British rule was established, numbers of Arakanese, who had fled to Chittagong and other places when their country was conquered by the Burmese, returned to their homes. Land again came under cultivation, and Akyab from a small fishing village rose to be an important trading centre. Shipments of rice were made in 1830, and in 1845 the exports amounted to 74,000 tons. When the second Burmese war broke out in 1852, the population of Arakan had grown to 352,348, and the trade of Akyab was of considerable importance.

Tenasserim once had a large population, but the constant wars between Burma and Siam for the possession of this fertile country had resulted in the decimation of the population and the ruin of the land. In 1826, the population was estimated at 70,000. Moulmein was a small fishing village with no trade, but with British occupation trade was developed. At first the export trade was almost entirely in teak; this trade was, however, of such importance that Moulmein soon became a flourishing town. Shipbuilding yards were early established, and, between 1830 and 1855, 123 ships were launched. The largest was the *Cospatrick*, of 1,418 tons, launched in 1855 and subsequently burnt on a voyage between

England and Australia; the next largest was a steamer of 1,300 tons. The shipbuilding industry declined subsequently with the advent of iron ships, and may be said to have come to an end in 1877. The first saw mill was erected at Moulmein in 1833, but it was not until 1860 that the first rice mill was established. The exports of rice commenced, however, earlier, and in 1850 18,000 bags of rice were shipped to Europe. At the outbreak of the second Burmese war, Moulmein was the premier port in Burma. Teak was exported in large quantities, and the rice trade was growing. Moreover, owing to the settled condition of British territory, Moulmein had attracted trade from parts of Burma which could have been better served by Rangoon.

Rangoon was taken for a second time in April 1852, and since that time has remained in the possession of the British. At the close of the war, Lower Burma was annexed, and with it the two ports of Rangoon and Bassein. The country had been devastated by continual wars, and large areas had gone out of cultivation. The unsettled condition of the country and the prohibitions against the export of rice were the chief deterrents against cultivation of land. Dhani (nipa palm), used for thatching, was the chief product of the delta. The Rangoon district, as first constituted, had an area of 10,000 square miles; in 1853 the area under rice was 68,000 acres, and in 1858 it had risen to 228,000 acres. In 1855, the population of the occupied territory was estimated at 631,640, but by 1862 the number had risen to 1,244,385 by the influx of people who came from other parts of Burma to cultivate the fertile lands when they knew that life and property were secure under British rule. Immigration was fostered by the great facilities given for obtaining land and by fixed taxation and the cessation of all irregular and uncertain collections. All restrictions on trade were removed, with the result that there was a rapid increase in the area brought under rice. The removal of the embargo on the export of rice immediately resulted in the establishment of rice mills at Rangoon and Bassein.

Rangoon is the natural outlet for the trade of Burma; it is served by the Irrawaddy, which runs from north to south through Upper and Lower Burma, and is navigable at all seasons of the year, and by a net-work of waterways in the delta. In these circumstances it is not surprising that, under an enlightened and settled Government, the trade of the port rapidly went ahead, and soon surpassed that of Moulmein. In 1856–7, the value of the sea-borne trade of Rangoon, exclusive of treasure and Government stores, was ten million rupees (£666,000), and in 1881–2 it had increased by over 1,000 per cent. to 110 million rupees (£7,333,000). The trade has continued to advance by leaps and bounds, until in 1913–14 it stood at 557 million rupees (over £37,000,000). These are astonishing figures, and are the strongest evidence of the progress made by the country under British rule. The trade has been open to the world, and while it is true that British and Indian traders, as well as those from foreign countries, have benefited, the people who have gained the greatest advantages by the expansion of trade, rendered possible by a settled and equitable administration, are the agricultural classes of Burma.

In 1862, the three provinces of Pegu, Arakan and Tenasserim were united, and Rangoon was made the headquarters of the new province of British Burma. Every endeavour was made to foster trade with the country under Burmese rule, but the unsettled state of Upper Burma and the misrule of the Burmese Government checked any great expansion of trade. In 1886 Upper Burma was annexed, and since then the province has made wonderful progress.

Agricultural Resources

Burma is essentially an agricultural country, about 72 per cent. of the population being engaged in agriculture. In 1915 it was estimated that the area occupied in British Burma was 18,116,000 acres, of which 14,089,000 acres were cropped during the year. The culturable waste was estimated at 23,300,000 acres, so that only about one-third of the land available for cultivation was under cultivation. The following table shows the distribution of land in the various divisions of the province :

	Net area cropped. *Acres.*	Total area occupied. *Acres.*	Reserved forests. *Acres.*	Not available for cultivation. *Acres.*	Culturable waste. *Acres.*
Arakan .	1,006,527	1,146,236	12,800	6,158,799	4,547,643
Lower Burma	6,094,244	6,466,966	4,004,367	3,776,401	2,944,101
Tenasserim .	1,935,183	2,100,937	2,752,761	11,473,892	6,652,612
Upper Burma	5,053,540	8,515,023	9,209,800	18,976,966	9,156,361
Total .	14,089,494	18,229,162	15,979,728	40,386,058	23,300,717

It will appear from the above statement that Lower Burma is the only part of the province in which cultivation has been carried out on a systematic scale, and even here, though the best rice lands have been taken up, there is room for further extension. Within recent years there has been little increase in rice cultivation in Arakan ; it is probable, therefore, that the large area shown as culturable waste in this division represents land fit for crops other than rice, or land which, owing to want of transport facilities, cannot be profitably brought into cultivation. In Tenasserim less than 10 per cent. of the total area is under cultivation, and the forest reserves occupy 12 per cent. ; over 18,000,000 acres are unoccupied. Many parts of this division, especially in the south, are practically unexplored, and it is therefore impossible to estimate with any degree of accuracy the area which can be made available for cultivation. There is evidence that the mainland was at one time extensively cultivated, and that the large islands in the Mergui Archipelago, many of which are now uninhabited, were once occupied and cultivated. There are great agricultural possibilities in this division when the country is opened up by the construction of roads. In Upper Burma less than 19 per cent. of the total area is occupied, and about 20 per cent. is covered by forest reserves. There is much land still available for cultivation or grazing, and with the growth of population and extension of irrigation a much larger area will come under cultivation.

Rice

The area under rice in Burma in 1915 was 10,150,000 acres, or 72 per cent. of the total cultivated area. In Lower Burma, 93 per cent. of the cultivated land was under rice, in Arakan 91 per cent., in Tenasserim 87 per cent., and in Upper Burma 42 per cent. In Lower Burma, Arakan and Tenasserim the crop is dependent on the rains, which fall with unfailing regularity. In Upper Burma rice is mainly cultivated in irrigated areas, and most excellent results are obtained. The normal yield of paddy (unhusked rice) per acre in the province is 1,600 lb., the best returns being obtained in Lower Burma. During recent years the average annual out-turn has been 6,800,000 tons of paddy, more than one-half of which is available for export. The local demand for rice will increase with the growth of population; there is every reason to expect, however, that new land will be opened up, and that larger yields will be obtained by improved cultivation, as the land is now being worked far below its producing capacity. The marvellous regularity of the seasonal returns is the outstanding feature of the rice crop, which is a continual source of wealth to the country. For the eight years 1908–9 to 1915–16 the average quantity of paddy and rice exported was 2,355,000 tons, of an average value of £15,034,000. The largest quantity exported in one year was 2,744,000 tons in 1913–14, and the smallest quantity 2,174,000 tons in 1911–12. In addition to paddy and rice, the average annual exports of rice-bran amount to about 200,000 tons, valued at £500,000.

To deal with the enormous quantity of paddy available for export, rice mills have been established at Rangoon, Bassein, Akyab and Moulmein; there are also many small mills, owned principally by Chinese and Indian millers, in other places. Out of 326 rice mills worked with mechanical power in British India, 245 are situated in Burma. The majority of the large mills at Rangoon and minor ports are owned by European firms, and are equipped with modern machinery capable of producing white rice. At the outbreak of war, German firms held an important share of the rice-milling industry, but the mills owned by them have since been sold, and are now being worked by British firms. Germany was the principal supplier of rice-milling machinery, and for the two years preceding the war her share was £56,000 out of the total imports valued at £72,000. Before the war a very large quantity of "cargo" or partially-milled rice was sent to Germany and Holland, where it was remilled and distributed. There appears to be no reason why British firms in Burma should not themselves undertake the whole of the milling and distributing trade in rice. The question of milling rice flour will also have to be considered, as the use of this flour appears to be coming into favour.

Other Crops

The principal crops, other than rice, grown mainly in Upper Burma are millets, maize, beans, ground nuts, sesamum, gram, peas, chillies, onions and other vegetables, cotton, tobacco, and sugar-cane to a small extent. Fruit cultivation is of much importance, and the betel nut and betel vine are also extensively cultivated. Considerable quantities of millets, maize, beans and other pulses, chillies, cotton and tobacco are exported; on the other hand, the value of imports of agricultural and farm produce and of provisions far exceeds the value of the exports. The average value of the imports and exports of agricultural produce, other than rice, for the five years ending 1913–14 is as follows:

	Imports. £	Exports. £
Grain and pulse (excluding rice)	607,000	373,000
Fruit and vegetables	270,000	16,000
Oil seeds	119,000	139,000
Tobacco, manufactured and unmanufactured	443,000	131,000
Sugar	403,000	—
Cotton, raw	—	452,000
Spices	486,000	33,000
Oil-cakes	—	100,000
Vegetable oils	317,000	1,000
Provisions	771,000	1,000
Total	3,416,000	1,246,000

In recent years there has been a great demand for beans, and in 1916–17 the exports amounted to 73,000 tons, of which 58,000 tons went to the United Kingdom. The aggregate value of grain and pulse, other than rice, exported in 1916–17 was £900,000. The exports of raw cotton declined considerably in 1915–16, on account of a fall in prices, with the result that beans and other crops have replaced cotton to some extent. There was, however, a recovery in the following year, when the total yield of the province was estimated at 45,000 bales of 400 lb. The war also checked the export of ground nuts, but this was to the advantage of the local oil-crushing industry, which is being developed on sound lines by leading European firms. This industry is in a strong position, as Burma produces about 300,000 tons of sesamum, ground nuts and cotton seed, all of which are now being crushed locally. There is a local market for all the oil produced, and Burma further imports large quantities of vegetable oils from India. Owing to the operations of the local mills, imports of oil from India are declining; ten years ago nearly 3,000,000 gallons of sesame and ground-nut oil came from India, whereas now less than one-third of that quantity is imported. The oil-crushing industry is of great importance to the province, as it should encourage the cultivation of oil seeds, and, with prevailing high freights, it is economically sound to crush the seeds locally and export the more valuable products, viz. oils and oil-cakes. In 1916–17, 74,000 gallons of cotton-seed oil and 493,000 gallons of ground-nut oil were sent to the United Kingdom; it is to be hoped that this is the commencement of a large export business. In the same year Burma exported oil-cakes to the value of £150,000.

Burma now imports annually coconut oil to the value of £100,000 and coconuts worth £60,000. At present there are only 11,000 acres under the coconut palm in Burma, and there is a small copra industry at Mergui, but it should be possible to extend the cultivation in the Mergui district and islands of the Archipelago, by giving leases of land on favourable terms to those who are prepared to plant on a large scale.

Rubber-growing is one of the most promising industries in Burma. About 60,000 acres of land have been taken up, of which a large area has been planted, and further extensions are being made. Hevea rubber seeds, obtained by Sir Joseph Hooker from Brazil, were planted at Mergui about 1875, and the trees grown from these seeds are still flourishing. Rubber-planting was, however, only taken up about 1903, and since then some progress has been made. The climate and soil of the Mergui district are very suitable for rubber; the climate is healthy, food supplies are plentiful and cheap, and Indian labour is readily attracted. It has been stated that there are at least 300,000 acres of land suitable for rubber in this district. The older plantations are giving excellent yields, an average of over 400 lb. per acre being obtained from mature trees. These results are obtained notwithstanding the fact that during the heavy rains in July and August tapping operations have to be stopped. The trees appear, however, to benefit by the enforced rest, and very heavy yields are obtained later. The cost of production is not high, and it should be possible for a fully-matured estate to ship its rubber at *7d.* per lb., f.o.b. Rangoon. In 1916–17, 2,301,000 lb. of rubber, valued at £293,000, were exported; the out-turn will rapidly go ahead as the planted area, most of which is still immature, comes into bearing. When the advantages of this country are more fully known, fresh capital will be introduced and a large extension in the planted area may be expected. Within a few years Burma will be reckoned among the large producers of rubber.

The cultivation of the areca-nut palm has hitherto attracted little attention, although the value of the imports of betel-nuts, principally from India, Ceylon and the Straits, has averaged over £400,000 a year. The palm grows well in Burma, and is in evidence everywhere near the coast. It should be possible to grow it on a commercial scale to meet, at least, local requirements. The Tenasserim division is probably best suited for the cultivation of the palm.

Forest Resources

Teak

The forests of Burma are one of the most valuable assets the province possesses. Teak has been a great source of wealth in the past, and it was in fact due to the abundance of this timber that British traders were first attracted to Burma. During the early years of the

British occupancy of Burma, teak was the chief article of trade; after the development of the rice trade it held the second place until, within recent years, it was displaced from that position by the export trade in mineral oils. The volume of the export trade has declined in recent years; in 1896–7 the exports amounted to 273,000 cubic tons, but there has been a great appreciation in prices. This rise in price has taken place notwithstanding the fact that less first-class timber is now obtained. The best timber goes to Europe for shipbuilding and construction of railway carriages, and the poorer qualities to India. The total quantity exported in 1903–4 was 169,000 cubic tons, valued at £1,053,000, of which 72,000 cubic tons, or 42 per cent. of the total shipments, went to Europe, and the balance to India. In 1913–14 the total shipments amounted to 161,600 cubic tons, valued at £1,230,000, of which 48,500 cubic tons, or 30 per cent., went to Europe. In 1913–14 the average value per cubic ton of the shipments to Europe was £10 3*s*., and to India £6 13*s*. Moulmein was once the chief centre of this trade, but in recent years Rangoon has been shipping about three-fourths of the total trade. The forests still contain large reserves of teak, but the difficulties of extraction are greater; these will be overcome, however, when communications are improved.

Other Woods

There is a great deal of valuable timber, other than teak, to be found in the forests of Burma, but until quite recent years very little attention was devoted to these woods. In 1903–4 the value of exports of woods other than teak was only £38,000, whereas in 1913–14 the exports amounted to 48,000 cubic tons, worth £233,000. There is little doubt that this trade will be largely developed, as there is a great demand in India for timber for building purposes and for box-planking.

To deal with the large quantities of timber exported, saw mills have been established at Rangoon and Moulmein, and also at other centres. Out of 127 saw mills worked by mechanical power in British India, 114 are situated in Burma. These mills are mainly owned by the European firms employed in the extraction of timber from the forests.

Both at Rangoon and Moulmein, shipbuilding was an important industry about fifty years ago, before iron superseded wood in the construction of ships. There are indications now of a revival of this industry at Rangoon, where a wooden sailing ship of 1,000 tons' burden was recently launched, and a similar vessel was under construction. All the materials required for the construction of these ships (with the exception of the copper sheathings) are produced locally, and the work is being carried out by Burmese and local Chinese artisans.

Minor Forest Products

In connection with the forests, there are great prospects of the development of trade in dyeing and tanning substances, and in pulp for paper manufacture. One of the most valuable forest products now exported is cutch, which has hitherto been mainly used for dyeing fishing-nets and cordage. Fifteen years ago the exports averaged 130,000 cwts., valued at £150,000; the exports gradually fell away, until in 1913–14 they amounted to only 79,000 cwts., worth £95,000. In 1915–16 there was a great demand for cutch, and exports, which surpassed all previous records, amounted to 170,517 cwts., with a value of £204,000.

Mineral Resources

Mineral Oils

Burma contains a variety of minerals, but, with the exception of petroleum, they are mostly undeveloped. Although a good deal of prospecting work has been done, the want of transport facilities and lack of sufficient capital have so far hampered the operations required to prove the value of the mineral deposits known to exist in different parts of the province. Even in regard to petroleum the development is mainly confined to the Yenangyaung and Singu fields, and operations are still in the prospecting stage in other parts of Burma. It was only possible, after the annexation of Upper Burma, to work the oil-fields which were known to exist in that region. At an earlier period much capital was sunk in boring for oil at Kyaukpyu and other places in Arakan, and though oil was found these ventures were never paying propositions. The oil-fields of Upper Burma have, on the other hand, made marvellous progress. In 1897, the output of crude petroleum was 19,000,000 gallons; in 1903, 86,000,000; in 1912, 245,000,000; and in 1916, 292,000,000 gallons. The table below shows the quantity and value of petroleum products exported from Burma in 1903–4 and 1916–17.

		1903–4.		1916–17.	
		Quantity.	Value. £	Quantity.	Value. £
Kerosene . .	*gallons*	36,288,000	1,217,000	116,688,000	2,602,000
Benzene, petrol, fuel-oil, lubricating oil, etc.	*gallons*	3,616,000	165,000	39,191,000	842,000
Paraffin wax . .	*cwts.*	35,969	42,000	450,148	682,000
Candles . . .	*lb.*	3,049,000	60,000	11,236,000	212,000
Total value . .		—	1,484,000	—	4,338,000

There has been a great expansion in the volume of the trade, but a fall in the prices of kerosene and other kinds of oil.

There are several refineries in the vicinity of Rangoon owned by the producing companies. The Burma Oil Company, the pioneers of the industry, and the largest producers, have three refineries which are fed by a pipe line coming direct from the oil-fields. They also own steamers for the transport of the oil to India, where they have installations for the storage of oil at all the large ports. Kerosene is the principal item in this trade, and the whole of the shipments from Burma find a market in India, where it has displaced Russian oil. India now draws from Burma 60 per cent. of her total supplies of kerosene. India is also the best market for petrol and lubricating oils; she takes, in fact, 94 per cent. of Burma's trade in mineral oils. The United Kingdom draws large supplies of fuel oil from Burma.

Since the war the United Kingdom has been the principal market for paraffin wax. Japan has always been an important customer, and in 1916–17 took over

100,000 cwts. The manufacture of candles from paraffin wax is a growing business, and India is again the best market.

Lead and Silver

Galena is found in many parts of Burma, and lead has always figured among the exports from the province. For the five years ending 1913–14 the exports averaged 8,000 tons. In 1915–16, owing to the demand for munition purposes, the shipments amounted to 11,000 tons, valued at £239,000. In 1916–17 shipments were 500 tons less, but the value rose to £359,000; the United Kingdom took less than 2,000 tons, the bulk of the shipments going to Ceylon for tea-packing. The lead ore obtained at the Bawdwin mines is rich in silver, and in 1917 the refinery at Namtu produced 1,525,844 ozs. of silver, as compared with 105,603 ozs. in 1916, all of which was purchased by the Government of India.

Zinc Ore

The production of zinc ore at the Bawdwin mines gives promise of becoming of great value to Burma in the future. The development work at these mines emerged from the experimental stage in 1913–14 when 7,600 tons of zinc ore were sent to Germany and Belgium to be treated. The war put a stop to this trade, as the plant for concentrating and refining this ore, which contains a varying percentage of lead, existed on a sufficiently large scale only on the Continent. In 1916–17 Japan took 3,000 tons, from which it would appear that arrangements have been made to treat the ore in that country. According to recent information it has been decided to erect works in India for the production of spelter and sulphuric acid from the Bawdwin zinc concentrates.

Tin, Wolfram and Molybdenite

Tin-mining on a small scale has always been carried on over a considerable area in Tenasserim. The presence of wolfram with tin, when the former mineral was of little account, was a handicap to the industry, owing to the expense involved in separating the two ores. The demand for wolfram, which arose a few years ago, gave a great impetus to the mining industry in Tenasserim, and has attracted much British capital. In 1912–13 the exports of wolfram amounted to 1,763 tons, valued at £160,000; the quantity remained stationary until 1915–16, when, owing to the great demand for tungsten for war purposes, Government exercised more effective control over the methods of working the mines, with the result that the output for the year amounted to 2,629 tons, worth £374,000, and in 1916–17 to 4,600 tons, worth £700,000. The ore exported carries a certain proportion of tin; the surface deposits contain from 80 to 90 per cent. of wolfram, but lower down as much as 40 per cent. of tin is mixed with the wolfram. Burma is now the greatest producer of this mineral, and the most important centre of the mining industry is the Tavoy district, where the necessary plant for separating tin from wolfram has recently been set up. Before the war, Germany had control of the supplies, but now all the exports go to the United Kingdom. The extensive search which is being made for wolfram may, it is hoped, also result in the discovery of tin in paying quantities. Tin and wolfram ores are known to exist in the alluvial deposits of the rivers in the Tavoy and Mergui districts, but these have not been fully tested. It has recently been reported that large deposits of wolfram and molybdenite have been discovered in the Yamethin district and in the adjoining Southern Shan State. It is stated that a sample of the ore was found to contain 64·7 per cent. of tungstic oxide with no trace of tin. The molybdenite is found in close contact with the wolfram in nuggets embedded in the rock, and is said to be as plentiful as the wolfram. The extent and value of these deposits have yet to be proved. The place where the discovery was made is 42 miles from the nearest railway station, in a mountainous and roadless region.

Jade

The jade mines of Burma were known and worked long before the British occupation of the country. The produce of the mines has always gone to China, where the stone is cut and prepared for the market. Before the war, trial shipments were going to Germany, but the war stopped the development of this trade. In recent years, jade has been coming into fashion in Europe, and high prices are paid for good specimens of the stone; there is a possible opening in England for cutting and fashioning jadestone. In 1914–15 the exports were 4,200 cwts., valued at £55,000, equivalent to £13 per cwt.; in 1915–16 the exports were 4,400 cwts. and £36,000, averaging £8 per cwt. Little reliance can be placed, however, on the values declared at time of export, as the trade is practically a monopoly in the hands of a few Chinamen. The mining is carried out in a primitive manner, and a much larger output could be obtained should the demand increase. A considerable quantity of jadestone goes overland to Western China.

Other Minerals

Manganese, iron-ore and coal are known to exist in the province, but their value has not yet been proved. Rubies from Burma have always been famous, but these stones have gone somewhat out of fashion in recent years. In 1906 rubies weighing 326,885 carats and valued at £85,540 were produced, as compared with a value of £36,298 for 251,449 carats in 1915.

Fisheries

The fisheries of Burma are of considerable importance, as fish enters very largely into the diet of the people of the country. The river fisheries have been more fully developed than the sea fisheries; the fish obtained does not suffice, however, for local requirements, and very large quantities of cured fish, salted and unsalted, are imported. In 1913–14 the imports amounted to 268,000 cwts., valued at £410,000, of which 103,000 cwts. came from India, 140,000 cwts. from the Straits Settlements, and 25,000 cwts., worth £70,000, consisting of sardines in tins, from Portugal. The fisheries on the coast are capable of great development; there is an abundance of excellent fish to be found off the Tenasserim coast and in the

Mergui Archipelago. Shrimps and prawns are obtainable in very large quantities, and the preparation of shrimp paste and prawn dust is an important industry at Mergui. When these fisheries are more fully developed, and factories established for curing and canning fish, Burma should not only supply her own wants, but be in a position to establish an export trade in cured fish.

Sea-borne Trade

Total Trade

The sea-borne trade of Burma reached its highest level in 1913–14, after a steady progress, without a check, over a series of years. There was a set-back in 1914–15 owing to the war, but this is only of a temporary nature, and with new developments in many directions the trade will again go ahead. Rice accounts for more than half of Burma's export trade, and since it is largely a matter of accident in what proportions her supplies of this commodity are divided between Indian and foreign ports, it is sounder to consider the external trade of Burma as a whole, omitting only the purely coasting trade between ports within the province. On this basis the table given below has been prepared :

Total Sea-borne Trade of Burma

	1903–4. £	1913–14. £	1915–16. £	1916–17. £	Increase in 1913–14 over 1903–4. *Per cent.*
Foreign imports .	5,508,000	10,667,000	7,177,000	7,904,000	
Indian imports .	4,182,000	6,256,000	5,615,000	6,433,000	
Total . .	9,690,000	16,923,000	12,792,000	14,337,000	74
Foreign exports .	10,547,000	15,938,000	9,970,000	13,025,000	
Indian exports .	3,204,000	10,002,000	11,930,000	12,255,000	
Total . .	13,751,000	25,940,000	21,900,000	25,280,000	88
Total Imports and Exports	23,441,000	42,863,000	34,692,000	39,617,000	85

A comparison by values of the import trade of 1916–17 with that of 1913–14 is misleading ; the volume of the trade was much less, but the prices of most commodities were much higher.

During the same periods the quantity and value of rice exports were as follows :

		1903–4.	1913–14.	1915–16.	1916–17.
Quantity	tons	1,862,000	2,745,000	2,192,000	2,243,000
Value	£	9,649,000	17,214,000	13,145,000	14,758,000

The increase in 1913–14 over 1903–4 was 47 per cent. in quantity and 78 per cent. in value. In 1903–4 rice accounted for 70 per cent. of the aggregate value of exports as against 66 per cent. in 1913–14, 60 per cent. in 1915–16 and 58 per cent. in 1916–17. This decline has been brought about, not by any falling-off in the rice trade, but by the extension of trade in articles other than the staple, and is a healthy sign of the general development which is taking place in the province.

The following statement shows how the trade of Burma was distributed in 1913–14 :

	Imports. (£)	Percentage of total imports.	Exports. (£)	Percentage of total exports.	Percentage of total trade.
British Empire :					
United Kingdom	5,939,000	35·09	2,391,000	9·21	19·45
India	6,256,000	37·00	10,002,000	38·56	37·88
Straits Settlements	542,000	3·22	2,250,000	8·67	6·28
Hong Kong	246,000	1·45	314,000	1·22	1·30
Ceylon	14,000	0·08	475,000	1·84	1·14
Egypt	16,000	0·09	354,000	1·36	0·86
Australia	40,000	0·23	199,000	0·77	0·55
Other countries	24,000	0·12	509,000	1·95	1·54
Total British Empire	13,077,000	77·28	16,494,000	63·58	69·0
Foreign Countries :					
Germany	763,000	4·51	2,322,000	8·96	7·12
Austria-Hungary	160,000	0·94	1,400,000	5·40	3·63
Belgium	571,000	3·36	259,000	1·00	1·93
France	104,000	0·62	270,000	1·04	0·87
Italy	116,000	0·68	133,000	0·51	0·58
Holland	420,000	2·48	1,999,000	7·70	5·64
Other European countries	148,000	0·89	456,000	1·75	1·40
Japan	700,000	4·14	1,288,000	4·96	4·64
Java	326,000	1·93	261,000	1·00	1·36
China	128,000	0·75	118,000	0·45	0·57
Asiatic Turkey	7,000	0·04	347,000	1·30	0·80
Other Asiatic countries	13,000	0·08	139,000	0·51	0·35
United States	390,000	2·30	145,000	0·54	2·11
Other American countries	—	—	309,000	1·30	0·89
Total Foreign Countries	3,846,000	22·72	9,446,000	36·42	31·0
GRAND TOTAL	16,923,000	100·0	25,940,000	100·0	100·0

War conditions have made a great change in the distribution of the trade; Germany and Austria-Hungary have dropped out, and, owing to restrictions imposed by Government to prevent supplies reaching Germany, the trade with Holland and other neutral countries has been less. The United Kingdom is taking a much larger share of the export trade; she took in 1916–17 316,000 tons of rice, compared with 139,000 tons in 1913–14. The aggregate value of the export trade was £660,000 less in 1916–17 than in 1913–14; India, however, increased her share of the trade by £2,250,000. The value of the import trade was £2,586,000 less in 1916–17 than in the record year 1913–14. The value of imports from the United Kingdom fell by £1,156,000. The United States of America made a big advance to £821,000, principally in motor-cars and iron and steel goods. Japan also improved her position to nearly £1,000,000; she is making great endeavours to capture the trade formerly done by Germany and Austria, and has been successful with cotton hosiery, ale and beer, glassware, enamelled ironware, and several other lines of goods. Japan has also cut into Manchester's trade in cotton goods, and is competing with British manufacturers in other directions; she has, in fact, taken full advantage of the difficulties experienced by the United Kingdom in supplying the demands of customers.

Export Trade

The following table shows the value of the principal exports from Burma in 1913–14:

	£		£
Rice and paddy	17,214,000	Cutch	93,000
Rice bran	431,000	Lac	25,000
Grain (excluding rice)	181,000	Kerosene	2,435,000
Pulse (beans and peas)	233,000	Other mineral oils	503,000
Oil seeds (ground nuts, etc.)	275,000	Paraffin wax	440,000
Oil-cakes	144,000	Candles	243,000
Tobacco	162,000	Wolfram	181,000
Cotton (raw)	600,000	Lead	58,000
Rubber	110,000	Tin	39,000
Hides and skins	558,000	Zinc	31,000
Wood and timber	1,668,000	Jadestone	26,000

Mainly on account of shipping difficulties due to the war the exports of rice, teak, hides and cotton have declined. The export trade in hides and skins advanced from 77,000 cwts., worth £190,000 in 1903–4, to 160,000 cwts. and £558,000 in 1913–14. This is a promising trade capable of further development, as the number of cattle in Upper Burma and the Shan States is on the increase, and much larger supplies could be obtained overland from Western China. Oil seeds are now being crushed by the local oil-crushing mills, and the export trade has declined. The trade in kerosene and petroleum products has been fully maintained, and there has been an expansion in the exports of beans, rubber, oil-cakes and cutch. Much larger quantities of wolfram and lead are now being shipped; the present value of mineral exports, other than petroleum, exceeds one million sterling a year.

The following table shows the distribution of rice and paddy in 1913–14, 1915–16 and 1916–17 to the principal countries:

	1913–14. *Tons.*	1915–16. *Tons.*	1916–17. *Tons.*
Total exports	2,744,236	2,191,769	2,243,204
United Kingdom	139,251	289,773	316,429
India	889,236	1,231,908	1,027,927
Straits Settlements	280,922	182,934	252,882
Ceylon	44,723	74,707	192,868
Other British countries	74,974	68,622	54,079
Germany	297,563	—	—
Austria-Hungary	209,470	—	—
Holland	325,297	5,027	33,949
Japan	160,000	4,050	6
Dutch East Indies	41,696	97,298	155,387
North America	5,238	48,854	81,128

In 1913–14 the British Empire took 1,429,000 tons or 52 per cent. of the aggregate exports; in 1915–16 the amount was increased to 1,846,000 tons and 84 per cent. of the whole trade. It is also satisfactory to notice that Russia, Portugal and Cuba, countries which had formerly been largely supplied by Germany, dealt directly with Burma. Japan draws heavily on Burma when her own rice crop is short; during the last three years the crops in Japan have been good.

Import Trade

The import trade of Burma reached its highest level in 1913–14. The following statement gives the values of the principal articles imported in that year. The trade has been divided into four groups: (*a*) textiles; (*b*) food, drink and tobacco; (*c*) articles for domestic or personal use; (*d*) other goods.

	£
(*a*) *Textiles:*	
Cotton manufactures	4,136,000
Silk manufactures	600,000
Woollen manufactures	402,000
Jute manufactures	1,161,000
Flax and hemp manufactures	31,000
(*b*) *Food, Drink and Tobacco:*	
Provisions and oilman's stores	1,237,000
Fish, cured, in bulk	340,000
Fruit and vegetables	280,000
Grain and pulse	526,000
Oil seeds	56,000
Vegetable oils	206,000
Sugar	448,000
Salt	96,000
Spices	483,000
Tea and coffee	114,000
Sheep and goats	70,000
Liquors	345,000
Tobacco	643,000
(*c*) *Articles for Domestic or Personal use:*	
Hardware and cutlery	467,000
Earthenware and porcelain	127,000
Glassware	93,000
Haberdashery and millinery	150,000
Apparel	187,000
Boots and shoes	137,000
Leather manufactures	50,000
Umbrellas and fittings	137,000
Soap	110,000
Toys and requisites for games	43,000
Paper and pasteboard	120,000
Stationery	56,000
Matches	106,000
Instruments, etc.	114,000
Drugs and medicines	71,000
Motor-cars and motor-cycles	86,000
Toilet requisites, furniture, jewellery, clocks and watches, carriages and cycles, rubber manufactures, books, etc.	185,000
(*d*) *Other Articles:*	
Metals and manufactures of metals	1,123,000
Machinery and millwork	333,000
Railway plant	147,000
Ships, parts of ships, boats and launches	97,000
Building and engineering material	121,000
Timber and manufactures of wood	70,000
Belting for machinery	42,000
Paints and painters' materials	71,000
Cordage	73,000
Coir manufactures	55,000
Chemicals	62,000
Tallow and stearine	40,000
Coal, coke and patent fuel	460,000
Mineral oils	62,000
Articles imported by post	300,000

Textiles.—Cotton yarn and manufactures are the most important articles in the import trade, and represent on an average nearly 20 per cent. of the aggregate value of the merchandise imported. The following table shows the imports of cotton goods from Indian and foreign ports in 1903–4, 1913–14 and 1916–17:

Imports of Cotton Goods

	1903–4.		1913–14.		1916–17.	
	Foreign Trade.		Foreign Trade.		Foreign Trade.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		£		£		£
Twist and yarn . . . . . . *lb.*	5,718,000	301,000	2,949,000	188,000	1,107,000	96,000
Piece-goods, grey . . . . . . *yds.*	7,266,000	56,000	20,176,000	261,000	10,003,000	157,000
,, ,, white . . . . . . ,,	25,695,000	264,000	48,373,000	745,000	32,235,000	750,000
,, ,, coloured, etc. . . . . ,,	42,141,000	579,000	83,870,000	1,526,000	55,686,000	1,325,000
Other cotton manufactures	—	155,000	—	556,000	—	353,000
Total foreign trade	—	1,355,000	—	3,276,000	—	2,681,000
	Indian Trade.		Indian Trade.		Indian Trade.	
Twist and yarn . . . . . . *lb.*	10,281,000	265,000	10,810,000	372,000	13,823,000	450,000
Piece-goods, grey . . . . . . *yds.*	10,777,000	115,000	8,902,000	112,000	13,986,000	191,000
,, ,, white . . . . . . ,,	5,751,000	73,000	7,241,000	100,000	9,000,000	150,000
,, ,, coloured, etc. . . . . ,,	11,980,000	181,000	15,285,000	233,000	27,933,000	444,000
Other cotton manufactures	—	35,000	—	43,000	—	50,000
Total Indian trade	—	669,000	—	860,000	—	1,285,000
Total foreign and Indian trade . . .	—	2,024,000	—	4,136,000	—	3,966,000

The United Kingdom supplies the bulk of the yarn in the foreign trade, which has declined, however, in recent years. The trade in Indian yarns has been steadily maintained; about one-half of the imports go overland to Western China.

Between 1903–4 and 1913–14 the value of foreign piece-goods advanced by 180 per cent., whereas the Indian trade made little progress. The Indian trade includes foreign goods re-exported from India; the value of these goods was £160,000 in 1903–4 and £190,000 in 1913–14. Manchester supplied in 1913–14 93 per cent. of the grey, 95 per cent. of the white, and 75 per cent. of the coloured piece-goods in the foreign trade. Holland sent 14 per cent. of the coloured goods and Italy 5 per cent. Since the war, Japan has been competing in grey and coloured piece-goods. In 1916–17, while Manchester supplied 91 per cent. of grey and 98 per cent. of white piece-goods, her share of coloured goods was only 70 per cent. Holland was able, however, to send her normal supplies of coloured goods, and her share of the trade was 17 per cent., and that of Japan 6 per cent. India benefited by war conditions, and sent larger supplies of cotton goods, especially coloured piece-goods.

Before the war there was a considerable trade in cotton blankets, the value in 1913–14 amounting to £259,000, of which Germany contributed £112,000, and Belgium and Holland each £70,000; the share of the United Kingdom was only £4,000. In 1916–17 the value of the trade had fallen to £75,000, and Japan was the largest supplier.

The imports of cotton hosiery in 1913–14 were worth £152,000, Germany and Japan sharing the trade, the contribution from the United Kingdom being valued at £9,000. Japan has now obtained control of the entire trade.

Japan rules the business in silk piece-goods, and in 1913–14 sent goods worth £340,000, equivalent to 97 per cent. of the whole trade. Japanese silks are well finished and of very attractive colouring. There is a considerable silk-weaving industry in Burma, silk is produced locally and large imports are also made; in 1913–14, 650,000 lb.

of raw silk, valued at £230,000, came either by sea or overland from Western China. The home-woven goods are more durable, but not so well finished as the Japanese article, the colourings also are not so brilliant or attractive, though the patterns are often quite artistic.

The value of the imports of woollen goods in 1913–14 was double that of 1903–4. The United Kingdom does half the business, but German competition was very keen, and in 1913–14 her trade was worth £100,000, and she had secured control of the trade in yarns and shawls. This trade is capable of expansion especially in the direction of Western China.

The imports of jute manufactures consist mainly of gunny bags for the rice trade. Burma is one of the largest purchasers of gunnies from the Calcutta Jute Mills.

Food, Drink and Tobacco.—In recent years there has been a great advance in the trade in European provisions and oilman's stores; the value of this trade rose from £254,000 in 1903–4 to £620,000 in 1913–14. The principal articles and the values of imports in 1913–14 were, biscuits and cakes, £142,000; condensed milk, £165,000; farinaceous and patent foods, £85,000; sardines, £70,000; jams and jellies, £8,000; bacon and ham, £10,000; butter, £24,000; other canned and bottled provisions, £94,000. The share of the United Kingdom was £264,000; she supplied the bulk of the biscuits, jams and jellies, bacon and ham, and half the total imports of condensed milk. The farinaceous foods, consisting largely of Chinese vermicelli, were consigned from Singapore. Denmark supplied butter, and Holland sent large quantities of condensed skimmed milk. Germany was increasing her trade in biscuits and condensed skimmed milk when war broke out. Portugal had established a large trade in sardines. India supplied provisions to the value of about £600,000, the main items being biltong or dry meat, £240,000; ghi or clarified butter, £179,000; eggs, £54,000; and butter, £30,000. After the war began, the imports from Europe declined considerably, but the trade will revive when normal conditions are established.

Java is the main source of supply of the sugar consumed in Burma. The United Kingdom has a good business in confectionery, worth £25,000 in 1913–14.

In 1913–14 the United Kingdom supplied 1,145,000 gallons of ale, beer and porter, valued at £134,000, the only other serious competitor being Germany, whose trade was worth £32,000. In 1916–17 the trade was much restricted; the United Kingdom sent only 331,000 gallons. Japan supplied, however, 103,000 gallons of light beers, which had formerly been a German monopoly.

The value of all descriptions of spirits imported in 1913–14 was £152,000, the chief items being brandy, worth £46,000, from France, and whisky, worth £41,000, from the United Kingdom. Germany sent 14,000 gallons of imitation brandy, valued at £3,800, and 5,200 gallons of so-called whisky with a value of £1,400.

There is a very large and increasing trade in cigarettes, which are mainly supplied by the United Kingdom. In 1913–14 the trade was worth £100,000 and in 1915–16 £126,000. The rapid growth of the cigarette habit was largely due to the advent about the same time of cheap matches from Japan. The imports of pipe tobacco are also on the increase, as the Burman is taking to the pipe. Germany was sending large numbers of cheap briar pipes.

Articles for Domestic or Personal Use.—There has been a remarkable increase in recent years in the importation of various articles required for domestic or personal use. The receipts of hardware and cutlery were twice as large in 1913–14 as in 1903–4, but while the United Kingdom in the earlier period supplied goods worth £140,000, her share in 1913–14 had only advanced to £182,000. Germany and Austria were especially active in this trade, and had obtained control of the business in iron, enamelled ware and lamps, and Germany supplied more cutlery than the United Kingdom. This is a valuable and expanding trade; it behoves the British manufacturer, therefore, to pay closer attention to the Burma market, more especially as Japanese competition has now to be reckoned with.

There is a large trade in Burma for earthenware and porcelain and glassware; the United Kingdom has hitherto supplied the former, but glassware has come from Germany and Austria, and now Japan has taken up this business, and is also competing in earthenware.

The United Kingdom has a virtual monopoly of the supply of leather boots and shoes and other leather manufactures. Austria was building up a large trade in the supply of shoes made from materials other than leather. Haberdashery and millinery, apparel, umbrellas, soap, paper, stationery, drugs and medicines, chemicals, motor-cars and cycles, and toys and requisites for games are largely supplied by British manufacturers. All these trades are growing in importance, and there is keen competition from foreign countries. Japan is obtaining control of the trade in haberdashery. Her share of this trade rose from 32 per cent. in 1913–14 to 60 per cent. in 1916–17, whereas the share of the United Kingdom fell from 52 per cent. to 31 per cent.

Other Articles.—Owing to the general development of the province, and to the extensive building operations at Rangoon and other towns, there has been a great demand for the manufactures of iron and steel, especially for beams, pillars and girders, nails, rivets, galvanised sheets and other building materials. The imports of pipes, tubes and fittings, mainly supplied by the United States of America, have also advanced, owing to the activity of the oil industry. In 1903–4, the quantity and value of manufactures of iron and steel were 62,500 tons and £630,000, as compared with 71,000 tons and £960,000 in 1913–14. The United Kingdom contributed £471,000 or 74 per cent. of the total trade in 1903–4, against £625,000, and 65 per cent. in 1913–14. The United States, Belgium and Germany were the chief competitors before the war. In 1916–17 the volume of the imports as compared with 1913–14 fell by 139 per cent.; the total value was, however, only 24 per cent. less. The United Kingdom and the United States of America supplied practically the whole trade in the proportion of 43 per cent. and 53 per cent. respectively. India is sending increasing quantities of cast and wrought iron, which formerly came from Europe.

The lines on which the industrial development of Burma is taking place are well illustrated by the description of the imports of machinery and mill work. In recent years these have consisted of machinery and plant for mining and oil-wells, rice and flour mills, saw mills, oil-crushing and refining, candle-making, match-making and metal-working. The United States of America supplies most of the mining and oil-well plant; Germany has supplied the bulk of the rice-mill machinery; the United Kingdom has, however, the largest share in this trade. In 1913–14, the number of sewing and knitting machines imported was 18,306, valued at £73,000, of which the United Kingdom supplied 13,667 and Germany 2,549.

Overland Trade

The overland trade between Western China and Burma is at present of no great value, but, with improved communications between the two countries, it is capable of great expansion. So far back as 1869, the attention of the Rangoon mercantile community was drawn to the possibilities of the trade between Bhamo and Western China, and a party of merchants from Rangoon visited Bhamo in the first steamer which proceeded so high up the river. In the Trade Report of British Burma for the year 1869–70, Bhamo was described as "the mart to which the produce of the vast provinces which lie between the Irrawaddy and the Yangtsekiang River are brought for disposal." The future prospects of the trade route were considered to be very bright, and little difficulty was anticipated in resuscitating "the trade which enriched the Golden Peninsula in the olden time." These hopes have never been realised, as the country between Bhamo and Têngyüeh, a large trading centre in Western China, has always remained more or less in an unsettled state, and no attempt has ever been made to improve the road communications between the two places, and all goods have to be conveyed on pack mules. Since 1904, with a view to encouraging this trade, a drawback of seven-eighths of the import duty paid at Rangoon has been granted on goods exported via Bhamo to Têngyüeh. This concession has had little effect in increasing the volume of the trade, which can only be developed on large commercial lines by the improvement of communications. The principal imports by this route are raw silk, hides, orpiment, stick-lac and silver. In 1915–16, silver to the value of £460,000 entered Burma. The chief exports are cotton twist and yarn, cotton piece-goods, raw cotton, woollen goods and cured fish.

The overland trade between Burma and Siam is not of great importance. The imports consist principally of teak, cattle and silk goods, and the exports are mainly cotton yarn and piece-goods. About 300 years ago, the port of Tenasserim was the outlet for a considerable trade from Siam and China, for which trading vessels came from India, Ceylon and the Persian Gulf. It is doubtful whether this trade can ever be revived, as the main communications of Siam are now with Bangkok. The trade between the two countries is capable, however, of expansion when the Tenasserim division is opened up and equipped with roads.

Chief Ports

The province has a long coast-line and is fortunately well provided with ports to deal with the sea-borne trade. The Customs ports of Burma are Rangoon and Bassein in the delta of Lower Burma; Akyab, Kyaukpyu and Sandoway in Arakan; and Moulmein, Tavoy, Mergui and Victoria Point in Tenasserim. Besides the Customs ports there are several small places on the Tenasserim littoral and islands, which will grow in importance when the country is further developed.

Rangoon, the chief port of Burma, is situated on the Hlang or Rangoon River, 21 miles from the sea. Skilled pilotage is required for the navigation of the river between the sea and Rangoon, but the difficulties of the river are not to be compared with those of the Hooghly. The only troublesome bar is the Hastings Shoal, at the entrance of the port, and at the point where the Rangoon River meets the waters of the Pozundaung Creek and Pegu River. Owing to insufficient water at neap tides, vessels have frequently to go below the shoal to complete their loading. This question is occupying the serious attention of the Port Authorities, and extensive surveys are being made with the object of formulating a scheme to remedy the evil. In the meantime dredging operations are continuously being carried on to improve the channel.

The port is administered by a port trust, constituted under the Port Act, 1905, which supervises the buoying, lighting and pilotage of the river, and provides and maintains wharf and warehouse accommodation. When the Port Commissioners entered on their duties, trade was rapidly expanding, and the existing port facilities were inadequate to deal with it. The appointment of Mr. G. C. Buchanan, now Sir George Buchanan, as Chairman and Chief Engineer of the Port Trust led to the adoption of a progressive policy. Loans were raised for the construction of wharves, fitted with hydraulic cranes, at which ocean steamers could lie and discharge their cargoes into commodious receiving sheds. Warehouses were constructed and the approaches to the wharves by rail and road were modernised. The lighting and buoying of the river were overhauled and brought up to date. Fixed and swinging moorings were laid down to cope with the increasing number of steamers visiting the port. Within seven years the port was entirely remodelled on modern lines, and, by the purchase of foreshore property, provision was made for future extensions. The question of providing a dry dock for ocean steamers was under consideration when war broke out. The revenue of the port advanced from £120,000 in 1903–4 to £365,000 in 1913–14. The most important question which faced the Port Trust on its first constitution was the danger which threatened the existence of the port by the diversion of the channel of the river. The channel of the Rangoon River, above the town, was changing its course, and, in order to bring it back to the position it formerly occupied, proposals were made for the construction of a training wall. The plans and estimates for this work, prepared by Sir George Buchanan, were sanctioned in October 1910, and the work was practically completed early in 1914. The estimates provided for a half-tide wall to cost £1,000,000, but the actual cost of a high-water wall with superstructures was only £922,000.

The construction of the training wall was a very fine piece of engineering work, and was a complete success in turning the channel of the river into its proper course. The magnitude of the work may be estimated from the fact that 28,000,000 cubic feet of stone were used in the construction of the wall.

Port dues are levied at the rate of 4 annas a ton on vessels entering Rangoon, and a river due at the rate of 6 annas a ton is charged on all goods landed or shipped. Charges are also made for the use of the wharves, jetties, cranes, moorings and other conveniences provided by the trust. Pilotage from the pilot brig to Rangoon varies according to the draught of water a vessel is drawing. The following is a statement of the expenses for discharging and loading the cargo of a steamer of 5,000 net tons: Port dues, Rs. 1,250; harbour-master, Rs. 80; moorings, Rs. 175; wharfage, 6 days, Rs. 400; night work, Rs. 300; cranage, Rs. 550; pilotage, in and out, Rs. 500; removals, Rs. 32; total, Rs. 3,287 or £219 2*s*. 8*d*.

About 85 per cent. of the maritime trade of Burma passes through Rangoon, and the history of the commerce of the province is little more than the history of the progress of the port of Rangoon. The aggregate number and net tonnage of vessels entering and clearing from Rangoon in 1913–14 was 2,956 vessels and 5,915,615 tons, and in 1916–17 the number of vessels had fallen to 2,001, and the tonnage to 4,168,630, a decline of about 30 per cent. As the volume of the trade had not decreased to this extent, it is evident that, under war conditions, greater use was being made of cargo space. The British India Steam Navigation Company supplies nearly half the tonnage; the great development of the port is, in fact, largely due to the enterprise of this company in maintaining a splendid fleet of steamers and providing regular services between Rangoon and Indian ports, and also with Penang and Singapore and the outports of Burma. The trade and passenger traffic between India and Burma are mainly carried by the steamers of the British India Steam Navigation Company. The number of passengers who arrived at and departed from Rangoon in 1913 was 575,000, the large majority of whom were

Indian coolies from Madras and Bengal. This total is exceeded by few ports in the world. The Asiatic Steam Navigation Company are also engaged in the trade between India and Burma, and the local oil companies own several steamers for the conveyance of oil either in bulk or in tins to Indian ports. The Bibby and Henderson Lines maintain regular fortnightly services with the United Kingdom, and the City and Hall Line has now entered the trade. Before the war, steamers of the Hansa and Austrian Lloyds Lines regularly visited the port, and a Scandinavian company was about to establish a regular monthly service. Direct communication with Japan is maintained by the Nippon Yusen Kaisha Company, and with Java by a Dutch line. Chinese steamers trade regularly between Rangoon and the Straits Settlements. The port was, in fact, well served by various lines of steamers when war broke out. The bulk of the rice was shipped in steamers specially chartered for the purpose, which usually arrived in ballast.

The mercantile community of Rangoon is made up of many nationalities, British firms predominating. The development of the trade and industries of Burma is largely due to British enterprise and capital. Foreigners, especially Germans, followed and reaped the benefits of an established and progressive trade. The Rangoon Chamber of Commerce, mainly British, is an influential institution; it is represented on the Burma Legislative Council and the Port Trust, and takes an interest in all public affairs. There was a numerous German colony in Rangoon before the war, largely interested in the rice trade, and in introducing German manufactures. They had their own club house, and, unlike the Dutch residents, did not as a rule join in the social functions of the British community. The trade with India is, to a large extent, in the hands of Indian merchants. The Bank of Bengal and other Indian banks, as well as all the Indian exchange banks have branches at Rangoon. Though banking facilities are good, more capital is still required for the development of the province. Trade has brought great wealth to Rangoon, and within the last few years it has been practically rebuilt and transformed from a town of wooden houses and oil lamps to a city equipped with modern buildings and electric light.

The port of Bassein on the Bassein River is 67 miles from the sea. Skilled pilotage is provided, but the navigation of the river is not difficult. It is the best natural port in Burma, including about 13 miles in length of the river, with excellent holding-ground and a foreshore alongside which large vessels can lie at all states of the tide. Bassein is not, however, a distributing centre of any importance, so that direct importation of goods is small, the requirements of the hinterland being supplied from Rangoon by river steamers. The port is, however, of importance as a centre of the rice trade, and several large mills have been established here. The exports average between 250,000 and 300,000 tons a year, and the trade is growing. Bassein will never be a rival of Rangoon for the trade of Burma, but it may grow in importance if it can attract a regular line of steamers. The rice trade is at present of a seasonal character, the bulk of the shipments being made between January and June in steamers, which arrive either in ballast or partly laden from Moulmein.

Akyab is situated on the Bay of Bengal; the approach to the harbour is easy, and there is good anchorage at which vessels load their cargoes. The chief importance of Akyab is as an exporter of rice, the average shipments amounting to about 200,000 tons a year. In recent years the supplies of paddy have not advanced, as the rice lands accessible to the port have already been brought under cultivation. There is much land in the Arakan division still available for cultivation, and, when communications are improved, trade should expand. Akyab has a considerable trade with India, especially in rice, but has little direct trade with foreign countries, supplies of foreign commodities being sent by sea either from Calcutta or Rangoon.

Kyaukpyu and Sandoway are quite unimportant ports on the coast of Arakan. Their trade is mainly carried on with Akyab and Rangoon.

The port of Moulmein is situated some distance up the Salween River, and, on account of the difficulties of navigation, its importance has declined in recent years, and there has also been a decrease in the population of the town. Several rice and saw mills are established at Moulmein, and there is a considerable export trade in rice and teak. In 1875–6 the foreign trade was nearly as large as it is to-day, and the tonnage of vessels entering the port was greater than the average tonnage for the four years 1911–15. The railway recently constructed between Rangoon and Moulmein has not brought any trade to the port. The development of Tenasserim, now taking place, will not help Moulmein, as the trade will be attracted to the small ports on the coast. Owing to the conditions of the river, steamers have often to leave Moulmein with part cargoes and complete their loading either at Rangoon or Bassein.

Tavoy, Mergui and Victoria Point are minor ports on the Tenasserim coast. At present only small coasting steamers visit these ports, the trade being carried on mainly with Rangoon and to a lesser extent with Penang. Owing to the extension of rubber cultivation, and to the development of the mining industry in Tenasserim, these ports are coming into prominence, and facilities for the landing and shipping of goods are being provided. Victoria Point is situated on the western side of the Isthmus of Kra, which may in the distant future provide a shorter route to the Far East.

BRITISH GUIANA AND THE PROBLEM OF ITS DEVELOPMENT [1]

By Sir Walter Egerton, K.C.M.G., LL.D.

The first European settlement in the territory now known as British Guiana was established by the Dutch so long ago as 1616. Three years previously King James I

[1] A paper read before the Royal Society of Arts. Reprinted from the *Journal of the Royal Society of Arts* (1918, **66**, 453, 459).

had issued a patent granting the whole of Guiana, from the Orinoco to the Amazon, to Robert Harcourt, an ancestor of the present Lord Harcourt, who, as Mr. Lewis Harcourt, was Secretary of State for the Colonies from 1910 to 1915. Robert Harcourt, however, failed to establish a settlement. The Dutch possession was maintained, though frequently challenged, and for short periods with success, by the Portuguese, French and British, until in 1803 it was finally occupied by us, and we were confirmed in possession at the peace of 1814. Though held by Europeans for over three centuries, and in the possession of the British Crown for over one, the territory is still undeveloped and in great part unknown.

Why is this? It would be a mistake to compare its history with that of other lands in the temperate zones colonised and developed from these islands. There is little similarity between the Government and development of equatorial jungles and the lands of Canada and Australia, where our race reproduces itself in all its pristine vigour, and the new population soon becomes fitted for self-government. Let the comparison then be with other lands in the tropics.

British Guiana has an area of 90,277 square miles, of which only the odd 277 are under cultivation, and this in a climate where the sun and moisture force vegetation to its maximum luxuriance and productiveness; where the indigenous forest, covering not less than seven-eighths of its extent, abounds in valuable timber and other forest produce, and is in itself a proof of the fertility of the soil; where large areas are known to be highly mineralised, from which gold and diamonds to a considerable value have been and are being won by most primitive methods of mining.

Can I make you realise its emptiness? Let us compare the population of the Colony with that of some of our other tropical Colonies.

The population of the British West Indies, in one-eighth the area, is 1,800,000—six times that of British Guiana.

In Ceylon, 4,500,000. British Guiana, three and a half times as large, has only one-fifteenth of Ceylon's total.

The Straits Settlements and Federated Malay States, one-third the size, boast a population of 2,000,000. Fifty years ago that population was only a little more than that of British Guiana.

Why has one developed so wonderfully whilst the other has been practically standing still? It may be said that the failure of the Colony to progress is due to its want of population. That is so; but why has the population not grown more in the century of British administration? Firstly, because, though vast sums were spent on immigration, they were spent chiefly on introducing men to labour on the plantations, with little appreciation of the vital necessity of bringing women also if a permanent increase was to be attained, such an increase as would render immigration ultimately unnecessary. Then, until recently, and partly on account of the excessive number of males, but chiefly owing to insanitary conditions, the death-rate generally exceeded the birth-rate.

Is its stagnation due to its form of government, its climate, or the inherent difficulties of its physical formation? I think each of the three is partly responsible; that one, the second, has been partly overcome, and that, given a successful termination of the present war, a little sympathetic help from the Mother Country, coupled with more firmness and more active interest in its peculiar problems, should take away the reproach that undoubtedly can now be levelled at us—that after over a century's possession of a country equal in size to Great Britain, only an area less than one-fifth the size of Kent is under cultivation, and most of the remainder is still trackless forest and savannah, unoccupied except by a few nomadic Red Indians.

The coast of British Guiana faces north-east, and looks out on the North Atlantic with no land intervening between it and Greenland in the far distant north. Starting from the Venezuelan boundary in $8\frac{1}{4}°$ N. latitude, it runs south-east for 270 miles to within 5° of the line where the Corentyne River forms the boundary with Dutch Guiana. Inland the Colony extends southwards to within 1° of the Equator. It is therefore well within the equatorial belt of perpetual summer. The climate is damp and hot, and the average temperature on the coast practically the same as in places in similar latitudes in Asia and Africa, such as Colombo, Singapore, Accra and Lagos. In British Guiana, however, the heat is rendered much less oppressive by the refreshing North-East Trades blowing straight in from the sea. The Colony, however, was, until the latter end of the nineteenth century, considered one of the deadliest for Europeans, and its vital statistics were appalling. Recurring epidemics of yellow fever used to sweep off the non-immune portion of the population, and malarial fever was a constant scourge.

The discovery that mosquitoes are the propagators of both yellow fever and malaria—first guessed at by a British Guiana doctor in 1850—and that quinine, used as a prophylactic, is a great preventive, has changed this and rendered the Colony quite a healthy one, for those living under proper sanitary conditions.

There is some confusion of thought in speaking of climates as healthy or unhealthy. That of British Guiana is not unhealthy where the sanitation is good and the precautions modern medical science prescribes are taken. In recent years much more attention has been paid to sanitation, and year by year the insistence of the excellent medical officers of the Colony is bringing home to all classes of its inhabitants the advantage of taking such precautions.

Administration

The administration of the Government is in the hands of a Governor and Executive Council, consisting of the heads of the principal departments and unofficial members nominated by the Governor and chosen from the leading members of the community.

Legislation is entrusted to a Court of Policy, consisting of official and elected members, in which the Government has a bare majority. This legislature, however, has no power to deal with any measures involving the raising or expenditure of public revenue, which is in the hands of a third body, called the "Combined Court," formed of the members of the Court of Policy with six elected financial representatives. In this Council the Government responsible for the welfare of the community is therefore in a considerable minority. This anomalous position is further accentuated by the Governor being excluded from all participation in the discussion of the Annual Bill for the raising of the revenue of the ensuing year, his place being taken on that occasion by the senior elected member present.

The Governor is generally an officer who has risen in the Home or Colonial Civil Service—trained throughout his life to grapple with all the problems of administration—in receipt of a very large salary, treble that of any other official, and yet the Colony is deprived of his experience and guiding voice in framing the most important enactment of the whole year. All real power—that of the purse—is placed in the hands of the elected members without giving them also the steadying burden of responsibility.

The marvel is that the Colony has done so well under such a Constitution, but under it no well-considered and settled policy for the future can be followed. Only the present is thought of, and everything is dependent upon ever-changing popular clamour.

Many of the best men in the Colony are fully alive to the desirability of a change in the Constitution, but it is unlikely that the Imperial Government will ever face the outcry that would be raised in some quarters, both in the Colony and here, to any scheme for the introduction of the usual Crown Colony administration. The grant of self-government is admittedly impossible. A middle course would be to transfer the administration of the interior to the Governor and Executive Council, leaving the coast strip to be administered as at present; this, however, would throw a considerable burden on the Imperial Exchequer for a good many years. A third suggestion, put forward recently, is federation with Canada. Undoubtedly, if such federation is ever effected, the Canadian Government would establish a local administration which had not only the responsibility for the welfare of the community, but also the power to carry out the measures considered necessary to ensure such welfare and the development of the resources of the rich interior.

Georgetown

Along the whole coast-line stretches a wide belt of shallow water, with numerous sandbanks, so that steamers pass out of sight of land.

The Essequebo, Demerara, and Corentyne rivers are all navigable within tidal limits, but it is only at Georgetown, at the mouth of the Demerara, that ocean steamers now call. Here, at spring tides, ships cross the bar on a draught of 18 to 19 ft., dragging through a foot or two of soft mud. Delay is not infrequent, but damage, except choking of condensers, almost unknown.

Mr. G. O. Case, the engineer called in to advise as to the best method of defending the coast against encroachment by the sea, and whose firm is now carrying out works in reinforced concrete to protect the most exposed portion of the coast, has recently prepared a scheme for deepening the entrance by the construction of an eastern mole two miles in length, of the same material, at a cost, including purchase of a dredger, of £250,000. For this expenditure a depth of 20 ft. at ordinary tides is expected to be secured.

The first indication of approach to the land is the change in the colour of the water from the deep blue of the Atlantic to that of pea-soup; then the masts of the wireless station and tops of the chimneys of sugar-estate factories appear, followed by the lighthouse and Old Fort. The ship as it enters the river towers above the low land.

Practically all buildings in British Guiana are of wood, and Georgetown is a wooden city. It is, however, a fine-looking, well-laid-out town, with wide and straight streets.

Georgetown boasts of being the largest town in the British West Indies, with a population of 55,000, or more than one-sixth of that of the whole Colony. The site is reclaimed tidal swamp well below the level of spring tides, and the problem of giving it an efficient sewerage scheme is as yet unsolved. The town is, however, well drained by a system of sluices opening on to the river at low tide.

Although well laid out in rectangular blocks, the intentions of the original planners of the city have, alas! not been followed. The riverside is overcrowded with warehouses, shops, factories, timber yards, and the poorer parts of the town have been allowed to become covered with small dwellings, with the result that from time to time disastrous fires occur, the last, in 1913, destroying a considerable part of Water Street, the chief business thoroughfare, and some thousands of tons of sugar stored in one of the premises awaiting shipment.

Fires are the great danger in all parts of the town, but, where the buildings are properly separated, they can generally be confined to the place of outbreak. This was well shown in the case of the beautiful Roman Catholic cathedral, burnt in 1914, owing to the upsetting of a brazier in the tower. It is now being replaced by one in reinforced concrete, a most suitable material, and one which should in time take the place of wood in the whole of the business quarter.

The principal streets formerly had canals running down the centre, with avenues of trees on each side of these canals and on their outer sides, making four rows in all. The Victoria Regia lily was a beautiful sight in some of the canals, with its fine flowers and tray-like leaves, but the canals were also choked with grass, weeds and refuse; the water in them was stagnant, and as breeding-places for mosquitoes they were a danger to health. They have within the last few years, with few exceptions, been filled in, and both the health of the city and its general appearance have much improved. In place of the canals are grass-bordered gravel paths, much appreciated by foot-passengers.

The Coastal Region

Georgetown is on the right or east bank and close to the mouth of the Demerara River, which is about half a mile wide, with a swift-running stream. For ten miles above the town on each side of the river are large and valuable sugar estates. Crossing the river a fair road runs along the coast for twenty miles, paralleled by the railway, to Parika on the Essequebo. It passes through populous villages, chiefly of East Indian people, who work on adjacent sugar estates and also cultivate large areas in rice, their numbers being augmented, since the lowering of the river ferry fares, by others from Georgetown and its vicinity during the rice season. It is one of the most cheerful districts to drive through. For most of the distance until the Essequebo is approached, the high sea-dam shuts out the view seawards, and at high tide the roar of the surf is heard and the spray seen shooting up above the top.

Standing on the railway wharf at Parika one looks across one channel of the Essequebo at the island of Leguan, the corner of Hog Island and, far upstream, Fort Island. The estuary is here twenty miles in width. The local steamer leaves daily for Suddie on the Essequebo coast. From Suddie a succession of sugar estates formerly stretched twenty miles westward. Now only a few remain, but these are large, formed by the amalgamation of several. A large portion of this coast is now cultivated in rice. Here, too, may be seen some of the best coconuts in the Colony. Only quite recently the coast road has been extended and turned inland to meet the Pomeroon River, and give land access to the small settlements along its banks, where coffee and ground provisions are cultivated.

On both sides of the Pomeroon River and on to the Venezuelan boundary is an expanse of swamp, intersected by many river channels of deltaic formation, awaiting reclamation to transform it into sugar or rice land. It is practically untouched. Morawhanna, the headquarters of the district, is a pretty little station. The district is highly mineralised, and there are indications of petroleum on the coast near Morawhanna. It is chiefly in this district that there is the greatest possibility of an increase in sugar cultivation. Some miles up-river from Morawhanna is the Government experimental station of Issarora, with a few acres of Para rubber. The trees have made as quick growth as is usual in Malaya, and have been proved to yield as generously.

From Georgetown eastwards stretches sixty miles of similar low coast, of which the first twenty-five miles to Mahaica is thickly populated, and here some of the best sugar estates and largest villages are located. Then the Berbice River is crossed to the town of New Amsterdam, with 8,000 inhabitants, beyond which lies another sixty odd miles of flat coast lands before the Corentyne River and the Dutch boundary. Nowhere, except on the chief rivers, does the occupation extend beyond a few miles from the sea. Some ten miles of the coast on either side of the Berbice River is fairly well occupied, but the remainder of the Corentyne coast and a long stretch of that between Mahaica and Berbice are very thinly settled and require drainage before cultivation is possible.

Railways

The only railways in the Colony are two coast lines, one on each side of the Demerara River, owned by the Demerara Railway Company, and a light railway eighteen miles in length built by Sproston's Shipping Company, connecting Wismar, at the head of steamer navigation on the Demerara, with Rockstone on the right bank of and above some dangerous falls in the lower Essequebo.

The eastern line of sixty miles runs from Georgetown to Rossignol on the Berbice, some two miles below its designed and natural terminus at Blairmont, opposite New Amsterdam. The first section of twenty-five miles of this line was built in the middle of the nineteenth century, and is probably the oldest in South America. Much of its rolling-stock is also, I should say, of nearly equal antiquity.

Until the West Coast line was built and this line extended some fifteen years ago, the company paid good dividends, having a remunerative contract with the sugar estates and a considerable passenger traffic. Its experience with the extensions has been unfortunate. The cost was —it is difficult to say why—very much in excess of estimate. The lines, being ill-equipped, and the termini on the West Coast and in Berbice being in unsuitable positions, without wharves or modern facilities for handling and storing goods, failed to attract the traffic expected. The capital cost of the whole system is in the neighbourhood of £16,000 a mile, and the receipts, even with the Government guarantee of $60,000 per annum, have often been insufficient to do much more than meet the dividends due on the preferred stock. This position has lately been somewhat improved by the cheapening of the Demerara ferry fare and the extension, with Government assistance, of the West Coast line three and a half miles to Parika, on the Essequebo, at a mileage cost of only £3,500. This extension from the former terminus, in a swamp nearly a mile from the sea, to the river-bank has rendered the joint railway and steamer route the most convenient for travellers to and from the Suddie district on the other side of the wide estuary of the Essequebo.

The provision of a wharf and shipping facilities at Georgetown and the extension of the eastern line to Blairmont, the intended terminus, with similar shipping facilities, would probably, notwithstanding its inflated capital, again place the line on a remunerative basis.

A proposal of Mr. Buck, the Colonial Director of Public Works, to carry the eastern line across the Berbice River to New Amsterdam, if possible for anything approaching his estimate, is preferable to extension to Blairmont, would be of immense benefit to the Colony, and would facilitate extension along the Corentyne coast, any such extension being then certain of remunerative traffic.

In the Colony there has always been great dislike and opposition to Government undertaking works of public utility of a possibly remunerative nature, and this extends to the acquisition of existing railways or the construction of new. The success of such a policy in Trinidad, in Jamaica, in West Africa, in Ceylon, Malaya, and elsewhere in the British tropics, is ignored, but within the last year there have been signs of a change in public opinion. It is to be hoped the change *has* occurred, and that it may be permanent, for the Colony would be well advised to acquire and retain complete control of its internal communications both by land and water, so that such facilities may be used and developed solely for the public benefit and the capital and energies of local and outside capitalists focussed on developing the trade, agriculture and undoubted mineral riches of the country.

Population

The first adventurers found in the Guianas only scattered tribes of Red Indian nomads. They are a pleasant and interesting race, but have always shunned newcomers, whether white or coloured.

European missionaries have laboured long and devotedly amongst them and induced a few to live near their mission stations, but the bulk of the Red Indians still remain nomadic, and prefer to live, seldom more than two or three families together, in the forest or savannah far distant from men of any other race. All, and especially those who take any interest in the Colony, should read Sir Everard im Thurn's delightful book, *Among the Indians of Guiana.*

At present they are free to roam over all the interior, and, in addition, considerable areas near the coast and on the lower reaches of the Berbice and Corentyne Rivers have been exclusively reserved to them.

At the census of 1911 they were enumerated to the number of 6,950, but the number in the Colony is certainly not less than double.

The rest of the present population of the Colony is the result, not of spontaneous immigration, but of the efforts of the European settlers to obtain labour for their estates—efforts which might have met with much more permanent success had care been taken to introduce the sexes in fairly equal numbers.

The census of 1911 gave a total population of 296,041, increased by the end of 1916 to 313,814, and thus estimated: Aborigines, 6,952; Europeans (exclusive of Portuguese), 3,705; Portuguese, 9,884; Chinese, 2,827; black and coloured, 152,307; East Indians, 137,850; race unstated, 336. In the twenty-one years 1891–1911 inclusive, the excess of births over deaths was only 5,332, or only 206 per annum! In the following five years to the end of 1916, a natural increase of 8,338, or 1,627 annually, took place, so that, though still very great improvement is needed, the last quinquennium shows a much better position.

Labour

The most difficult problem that has confronted the Colony from the time of the first Dutch settlements has been the increase, even the maintenance, of its population and the supply of sufficient labour for the sugar estates. At first the supply was maintained by slave importation from West Africa. When slavery was abolished other sources had to be looked for, and Madeira, China and India have all been drawn upon for immigrants to labour on the plantations.

The curse of slavery still hangs heavily over the Colony, and accounts for the antagonism between blacks and whites. The slaves were brought from many parts of the West Coast of Africa, but chiefly from Nigeria, the Congo and the Gold Coast. In their native lands, living under a strict communal system, under chiefs with absolute powers of life and death, they led industrious lives and were excellent agriculturists.

In the last twenty years the small farmers of the Gold Coast have, unaided, created the biggest cocoa-growing industry in the world, with an export in 1916 of 72,000 tons, value £3,847,720. In Southern Nigeria the natives have, unaided, developed the palm oil and palm kernel trade to an even larger annual value.

Wonderful results, but even in these their native countries, living still under the control of their hereditary chiefs and the restraint of ancient customs, it is more than doubtful if the West Africans would be willing to labour day in and day out for a fixed wage for a European planter. The Germans have tried the experiment on cocoa plantations in the Cameroons with indifferent success, even with the help of harsh laws enacting compulsory labour with heavy punishments for defaulters—laws that would never be tolerated in a British colony.

The blacks in British Guiana cannot be relied on to supply the steady continuous labour required on a sugar estate. They do excellent work from time to time in cutting canes and in supplementing the East Indian labour in the fields, but they dislike regular work, and have a most disastrous habit of trying to take advantage of an employer as soon as they think their labour indispensable.

It must not be supposed, however, that the negro in British Guiana has not his useful place in the community, or that he always shirks heavy labour. He supplies the police and the labour for the wharves, he is an excellent mechanic, he does all the carpentering and house-building, supplies drivers for engines, motors, carriages and carts. He provides all the labour for the mines and the balata industry. The teaching staff of the schools, many of the legal profession and some of its most successful members, are blacks. The black population takes an absorbing interest in local politics, and the black elector controls the elections. The blacks, too, are the best-represented race in the Combined Court, and rival in the fluency and length of their speeches members of our House of Commons.

The Portuguese immigrants were useless on the estates. As might have been expected, the climate proved too hot for field labour by men of European descent, and the Portuguese soon drifted into the towns and villages. They now form the wealthiest section of the community—are merchants, shopkeepers, lawyers, clerks, etc., and have secured a monopoly of the spirit trade.

The Chinese, perhaps the best agricultural labourers in the world, were introduced chiefly between 1860 and 1866. Other shipments arrived in 1853, 1874 and 1879. Fourteen thousand in all were brought, but of these only 14 per cent. were females.

The voyages averaged no less than 102 days in sailing ships, fitted very differently from the immigrant steamships of to-day. Sickness and mortality were great, and the small number of females rendered impossible any substantial permanent increase to the population by their introduction. Only present needs were thought of; the labour required was obtained; it was satisfactory, and no one troubled much about the future. Thus the Chinese population has gradually dwindled until in 1911 we find the sexes approximately equal, with a total of only 2,619. Then in 1912 Chinese births first exceeded the deaths. It is satisfactory to note that this excess has since continued.

Any one interested in the subject of Chinese immigration to the Colony should read Mr. Clementi's admirable history of the subject in his book, *The Chinese in British Guiana.*

It is, however, on East Indian immigration that the great sugar industry has for the last fifty years depended for its labour. The immigrants have been drawn from both Bengal and Madras, but principally from the Ganges Valley. They have proved most excellent immigrants, not only on the estates, but afterwards as free citizens.

The system has been one of five-year contracts, and, after ten years, free return passages. Many, however, preferred to remain in the Colony. Here again the benefit to the Colony and to the planter would have been much greater had the numbers of the sexes of the immigrants been more nearly equal. Without doubt more would have settled in the Colony, and the natural increase would also have been greater. At present there are 20,000 more men than women in the total of 137,000, and although the female births annually exceed the deaths, such is, naturally, not the case as regards males.

It is satisfactory to note that the vital statistics of the East Indians on the sugar estates are far better than those of the rest of the population, showing that they live under healthy conditions and are not overworked.

At present the East Indians in the Colony take little interest in local politics; their numbers are steadily increasing, and are already 44 per cent. of the total.

In addition to being chiefly responsible for the sugar production, they have created the rice industry, referred to later, and are gradually acquiring more and more land and taking the lead in agriculture generally.

The rapid development of the Colony of the Straits Settlements and the Malay Peninsula has been due to Chinese and East Indian immigration. The Chinese and the East Indian are the races which have so far been found to supply satisfactory immigrant labour for the development of the equatorial tropics. I know of no other races that can compete with them either as labourers for hire on plantations or on their own account. For thousands of years each of these races has learnt habits of thrift and industry in the struggle for life in thickly populated and civilised communities.

Unfortunately the Colony is threatened with a denial of immigration from either India or China, in each case as the result of ill-considered political agitation.

From India, on account of agitation in that country by a few well-meaning but ill-informed persons, and by a larger number of disloyal agitators using misrepresentations of the indentured system of immigration as a means of creating disaffection to the Indian Government. We have here the curious position of a Government sending a mission consisting of a senior civil servant and a prominent native gentleman to examine into the working of the immigration system, praising it highly and reporting strongly in favour of its continuance, and the same Government immediately deciding to put an end to all such immigration.

From China, because the cry of "Chinese slavery" raised in this country in connection with immigration of that race to the Transvaal was so effective a party cry that no Colonial Secretary will now face the possible political risk of approving indentured, or even free assisted, Chinese immigration to British Guiana, notwithstanding the fact that as labourers they proved efficient, that those remaining are orderly and prosperous citizens, and that with our improved cordial relations with China, the quicker and cheaper voyage by steam in lieu of sailing ships, the actual shortening of the distance from 12,310 to 10,910 miles by the completion of the Panama Canal, the voyage being reduced from an average of 102 days to not more than forty-five, such immigration could be so much more easily organised.

Let us hope that the difficulty will be overcome, that if indentured immigration is forbidden from Eastern countries it may be possible to arrange for free immigration.

But there is the further problem of keeping in the Colony the population which is there, assuring its natural increase and attracting capital and immigrants of European race to infuse new energy and wider views into the creole population.

At present the best of British Guiana's sons leave it to seek their fortune elsewhere; many go to Canada or to the States, others to the civil services in our Colonies in West Africa. I found many good and efficient officers in Nigeria recruited from the service in British Guiana. British Guiana also furnished some of the managers and assistants on the sugar estates of the Malay Peninsula in my early days, and has done the same on the more recent rubber plantations. The confined life in the small coast strip occupied has no attractions for the best of the youths; they leave the Colony and seldom return, shunning the eternal disputes between the elective section of the Legislature and the Government. All this would be altered with access to the interior.

Requirements for the Development of the Colony

The chief problems awaiting solution are:

1. Conservation of the present population and increase of the rate of natural increase by improved sanitation, especially in the towns, where the death-rate habitually considerably exceeds the birth-rate.

2. Preservation of infant life.

3. Provision of good water-supply both in town and country, now for the first time made easily available by the discovery of large reservoirs of pure artesian water.

4. Execution of drainage schemes to increase the area of land in the present occupied coast strip suitable for rice and sugar cultivation.

5. Improvement of existing railway by providing it with shipping and storage facilities at Georgetown. It is the oldest railway in South America, and has worse facilities for shipping and landing cargo than when it was built in the middle of the nineteenth century.

6. An immigration scheme to provide, at the Colony's expense in the first instance, immigration of East Indians and Chinese of both sexes in equal numbers.

7. Construction of a railway from Georgetown to Rupununi Savannah, and the Brazilian frontier, tapping *en route* the entrance to Potaro Valley. This would at once make cattle-ranching in the Savannahs, British and Brazilian, profitable, and create a large export trade in

frozen meat from Georgetown. By immensely cheapening working in the interior, it would foster mining development in Potaro and Essequebo. Men working in the interior could then take their wives and children with them, and settlement in the interior would commence. An immense amount of land would be available for settlers from outside the Colony, who, not accustomed to the semi-amphibious life of the drained coast lands, might be attracted by the more congenial conditions of the interior.

A great development of the timber industry would result, as the line would pass through two hundred odd miles of forest, much of it containing greenheart timber.

The time required for a trip to the Kaieteur Fall would be decreased by one-half, and the expedition made much cheaper and less arduous. Where one tourist now visits the Colony to see the fall, a hundred would as soon as the railway is completed. Every visitor is a possible settler and provider of capital for developing the Colony's resources.

The line is essential for the development of the Colony, and can be justified on this ground alone; but if constructed it can hardly be doubted that, either by private enterprise or the Brazilian Government, it would be produced one hundred miles to a point on the Rio Branco navigable by large steamers, and later to Manaos on the Amazon; and in the more distant future it would certainly be linked up with the South American continental railway system, a counterpart of the nearly realised Cape to Cairo line, which twenty years ago looked an equally impossible achievement.

8. The improvement of Georgetown harbour. Some immediate improvement is necessary, but the Colony's efforts and resources should be concentrated on obtaining the interior railway. To deepen Georgetown bar to admit ships drawing, say, 25 ft., would probably cost more than the railway, and, although there is much grumbling now, ships big enough for the present tonnage inwards and outwards are easily provided to cross the existing bar. Deep water is only reached seven miles outside the entrance, and erection of moles for that

distance would take many years. It should, however, if possible, be included in the railway scheme.

9. And, lastly, such a change in the system of government as may be necessary to ensure a continuous and settled policy incapable of being defeated or obstructed by every passing gust of political agitation.

The present position makes healthy development, and the carrying out of large schemes that require certainty of action and careful finance for a long period, quite impossible. At present responsibility rests with the Government, but all power with the elected members of the Legislature, elected by only a small fraction of the community. It is a position one would expect to find in a Gilbert and Sullivan opera; but not in a British settlement. The position is very similar to expecting a Ministry in England to carry on in a considerable minority in the House of Commons. The experiment has been tried for over one hundred years, and the result is seen in a land the size of Great Britain only cultivating an area one-fifth the size of Kent. If the community is capable of self-government, then self-government should be given. If it is not, then the rational alternative is to place some other authority in a position to carry out, "without fear or favour, affection or ill-will," such measures as, in consultation with the Colonial Office, may be considered desirable for the healthy development of this valuable and rich province, for the welfare of which the British Crown and people are responsible.

Land Settlement

The system of land settlement adopted by the Dutch and continued since was the same in the rivers and on the coast. There were no roads, and access to estates was at first by water only; hence each lot was given a frontage on the river or foreshore, and the land behind left unalienated. Owing to extension of cultivation, sea encroachment on front lands, or their gradual exhaustion, owners applied for and obtained title to additional "depths" behind their original allotments, so that now a lot may be only 100 or 200 yards wide, but anything up to five or more miles in depth. The land, when first opened, was covered with courida or mangrove on the frontage, with heavy forest behind. The adopted method of opening up was always the same. Deep and wide trenches or canals were cut from the sea or river inland, one on each side of the lot for drainage, and one down the centre for irrigation and navigation.

The earth excavated formed raised banks or dams, which prevented influx of water from either side. At the river or sea front and at the back other dams were thrown up, so that the estate was completely enclosed. Subsidiary trenches and dams, parallel to front and back dams, divided off the land into rectangular fields of convenient size, so that access by water was facilitated to all parts. In the earlier days all transport was by water. All internal estate transport is still so conducted, and the canes never have to be carried more than about 100 yards. The names of the estates perpetuate the memory of the successive occupation of the Colony by Dutch, French and English. Thus adjacent estates in Demerara bear the names of Mon Repos, Triumph and Beterverwagting.

To control the drainage and irrigation water numerous sluices—for which the old Dutch name of *koker* still persists—had to be constructed. The chief were those in the river or sea dam to allow passage of boats bringing supplies and taking away produce and to provide for drainage. A belt of mangrove and courida was always left to protect the front dams.

Water was required for irrigation. The back dam obstructed the flow of the inland water, and as a long line of estates grew up the continuous back dams held up this water, and it was admitted to the cultivation as required. But this supply was unreliable and insufficient, so that gradually estates combined together and, with the help of the Government, the land behind the estates was also empoldered, and the shallow reservoirs thus constructed now run back to where undulating country commences, and effectually prevent the inland extension of cultivation or settlement. A very efficient system of irrigation has thus been created.

Georgetown and the estates and villages depend on these reservoirs for water for domestic purposes, supplemented by rain-water collected from roofs.

In 1911 the autumn rains failed and a great drought occurred. At the instance of Sir Charles Cox, the acting Governor, the first deep-boring machinery was ordered, since supplemented by much additional plant. Deep artesian wells have been sunk and ample supplies of exceptionally pure water struck in Georgetown and on the greater part of the coast, but so far they have not been fully utilised, owing to the absence of a staff skilled in the fixing of strainers and other apparatus for preventing the choking of the tubes. Most of these wells are "gushers," and the best supplies have been found at depths from 500 to 800 ft.

Sea Defence

So long as the foreshore is left untouched it changes little, and the tendency is towards gradual silting and extension seawards, but the alteration of the natural drainage, the more recent concentration of this drainage into a smaller number of outlets with greater discharge, the cutting down of the protective belt in some places and its erosion in others, have led to constantly increasing trouble with the sea defences. So serious has this become that the coast is now divided up into sea defence districts, for which bodies of commissioners, presided over by the Director of Public Works, are responsible. A general sea defence acreage tax is levied, the proceeds of which are supplemented by large Government grants and loans. The most exposed portions of the coast are now being permanently defended by reinforced concrete facing to the dams, and groynes of the same material are being run out seawards to stop erosion.

Roads and Water-ways

At first the only method of communication was by water, but the earth thrown out of the canals formed raised dams easily converted into roadways, and each estate was compelled by law to maintain a road across its frontage connecting with similar sections made by the adjoining estates. The bits of road were often not in the same alignment, and then connecting links had to be constructed on the dams running at right angles. From time to time encroachments of the sea compelled retirement, and new sections had to be formed with similar connecting links joining on to the old portions left in use. Until the advent of motors this zigzag track was negotiated by vehicular traffic without much danger, but a drive now with a negro chauffeur at the wheel, oblivious of the laws of centrifugal force, is not without excitement. Cars are frequently overturned; many have been the immersions in the deep roadside trenches, and even fatal accidents are not uncommon.

In the whole of this coast zone there is no stone. In places along the coast are what are known as "shell beaches," banks of finely broken up shells from the shell-fish that live and breed in the adjacent mud flats. The surfacing of the dams which form the coast road with hard material suitable to withstand wheeled traffic was therefore a difficult problem. It was solved by the early Dutch settlers in a simple and excellent way. They burnt heaps of the clay soil into brick earth, which spread on the roads—coarse lumps below with finer material on top and faced where possible with shell from the beaches—gives a really excellent surface not unlike the laterite roads of Ceylon and Malaya.

For heavy traffic, however, something harder is now required, and broken granite is brought to Georgetown from the quarries up the Essequebo at Dalli and Mazaruni.

When slavery was abolished the bulk of the black population ceased to labour on the estates, and many of them were abandoned. Some were bought by philanthropists in England and presented to the former labourers; some were otherwise acquired by the negroes. Village sites were laid out on the front lands and the people settled on them. The land adjoining the village was kept as common grazing-land, and the back portion of the old estate divided up into farms, to which journeys are made by canoe. This location of dwellings far away from cultivation is very disadvantageous, facilitates predial larceny, and encourages careless and insufficient cultivation, as so much time has to be spent in journeying to and from the farm. Residence on a farm, however, is objected to under present conditions, owing to the certainty of increased contamination of the drinking water. So extensive is the canal system of each estate and village that a pleasant day can be spent "going aback" in a punt or canoe.

The only way of travelling into the interior of the Colony is still by water. The mighty Essequebo and its tributaries furnish the chief arteries of communication, running right through the Colony. Above tidal influence, rapids, cataracts and falls abound, making travelling slow and very expensive. The country is one huge forest, with patches of wet savannah or grass within twenty-five miles of the coast, and in the far interior, on the borders of Brazil, larger tracks of dry savannah, extending to a total of some 10,000 square miles and affording excellent grazing for cattle and horses. These savannahs adjoin a much larger area of similar country over the border.

At present only a few ranching titles, terminable, as is usual, within a short period, should the land be required for closer settlement, have been issued. Three or four ranchers own large herds of cattle and a few horses. They would be well off if they had a market, but it is impossible to take the beasts to the coast, and sale over the boundary in Brazil is prevented by a prohibitive duty. A few are smuggled over the border.

A fresh attempt is now being made to cut a practicable track from the Kaieteur plateau through the forest, down which the cattle could be driven to a point on the Essequebo or Demerara, from which water transport can be provided. The problem is not an easy one. It is not merely a question of the provision of a practicable track, but also of grazing and resting-places on the way.

Journeys to the interior on business are tedious. In all the rivers, as soon as tidal influence ceases, rapids begin, and ridges of rocks run across, holding up the water behind. The fall may be only a few inches or it may be many feet. The boat has frequently to be dragged through the rapid or unloaded and dragged overland round a fall. Thus boats generally travel two or three together, so that the crews may help one another. Ten miles upstream is a good day's journey. Even the return journey is slow, as it is not safe to "run" many of the falls.

To those on pleasure bent, with ample time, such trips are full of enjoyment. There is an ever-changing scene of forest and hill and mountain. Large flowering trees of many colours, blue and scarlet macaws screaming overhead or in the trees on the banks, duck and other water birds, including the great Muscovy duck, are frequently seen. Otters, in schools, race up the stream on the appearance of a boat, until, wearying of the struggle, they dive and reappear a quarter of a mile below. At night you may be wakened by the howling of the great red baboons—if near, a truly astonishing noise, and plainly audible for many miles—or by day a glimpse may be got of a group in the top of one of the highest trees. Day after day the traveller passes on with thick forest on either bank.

The trees on the riverside are clothed, choked, in an impenetrable tangle of creepers, the yellow allamanda and a purple bignonia being most striking objects. Once or twice in a day you may pass a small Indian clearing on the bank, or, in the mining districts, a "landing," with a Chinese shop and a scarcely visible foot-track leading to a mining location, or, perched on a high bank, a balata company's supply depot.

Mining

Over a very large part of the interior, from the Venezuelan border to the valleys of the Essequebo and Potaro, gold and diamonds have been found in rich and shallow alluvial deposits. Most of the mining has been and is done by small men washing the river gravels in the primitive way common over all the world. These miners are almost entirely recruited from the black population. In places, European prospectors, attracted by the rich finds of alluvial workers, have located lodes. Companies have been formed, capital raised and expensive machinery taken at immense cost up the rapids ; generally the capital has been dissipated in preliminary expenses, machinery, houses and other equipment, leaving little for working expenditure, and gold has not been secured in sufficient quantity to pay the great cost of running a mine in the interior of a country without communications, without facilities for transport of men or material, and where all food and other supplies must be imported and brought up from the coast. Two companies in fairly accessible localities in the Potaro district have done well in dredging in the Minnehaha and Konawaruk ; and the former has also a very promising proposition at Eagle Mountain, with a large quantity of proved alaskite formation similar to that of the Yukon district. Its development awaits the conclusion of the war.

The chief river valleys exploited up to the present are the Barima and Barama in the North-West District, Cuyuni and Mazaruni, both affluents of the Essequebo, and the valleys on both sides of the watershed dividing the Mazaruni and Essequebo, and again the valleys in the watershed between the Essequebo and lower Potaro, below the great Kaieteur plateau. No successful mining has been done east of Essequebo, though some gold has been found.

Gold-mining has now been carried on since 1884, when 250 oz. were exported. The output rapidly increased, until, in 1891, over 100,000 oz. were produced, and the annual export continued to exceed that figure for twelve years. It has never reached it since, but at the same time seems likely to continue above an average of 50,000 oz. As recently as 1913 some rich new deposits were located, with the result that the output jumped up to over 82,000 oz. Since the war gold-mining has much decreased, owing to the great rise in cost of supplies and the much higher wages to be earned on the coast.

The free adventurous life on the rivers and in the forest has a great attraction for the young blacks of the labouring classes, and the Negro, like the European, is content to work for little and undergo great hardships if there is a remote chance of sudden riches by a lucky find.

At Christmas all these men insist on returning to their homes on the coast, and Georgetown and its vicinity is then full of them driving about in hired carriages, decked out in fine clothes, and determined to make up for the privations and dullness of their bush life.

Since 1884 over 2,500,000 oz. of gold, valued at more than £9,250,000 sterling, have been exported, nearly all of it the produce of shallow placer workings. Only 70,000 oz. have been obtained by quartz milling.

Diamonds are found in the far interior of the Mazaruni and other rivers, often together with gold. At first they were not recognised. The production since 1901 has totalled 125,000 carats. The output has varied greatly, from only 2,000 carats in 1907 to a maximum of 16,400 in 1916, probably due to prohibition of export in 1915, but the average of the four years 1913–16 was in excess of 11,000 carats. This weight is greater than the total of any previous year, so that production tends to increase. That an increase should occur during the war is extraordinary, as the cost of maintaining supplies on the distant diamond-fields has at least doubled.

It must be remembered that all this mining—gold and diamond—is being carried on in a thick tropical forest country by black prospectors, natives of the Colony, who start without the slightest knowledge of geology and acquire all their skill from their fellow-workers. Gradually a class of very efficient prospectors and workers has been evolved, but they work with very inefficient appliances, are unable to sink much below water-level, and in a country where the most highly trained white prospector would find the greatest difficulty in discovering and following up indications of the metal or stones. Few of the mining districts can be reached in less than a week, and some require two, three or even four weeks' toilsome journey. These journeys, after the first day, are done in small open row-boats, very strongly built, similar to the "surf" boats used on the open sea beaches in West Africa, and manned by a crew of eight or ten paddlers. Oars are never used, as they could not be manipulated in the rapids or in the narrow channels of the smaller "creeks," as the affluents of the main rivers are locally called. It is in this river traffic that the aboriginal Indians alone mingle in the life of the Colony and forsake their habitual isolation. Some of the boats have Indian crews, and more have Indian or "Boviander" steersmen. A "Boviander" is a man of mixed Indian and Dutch blood. On the skill of the steersman and bowman the safety of the travellers depends, especially in "running" the numerous rapids. They all pass strict tests, and no boat can be taken up or down without certificated men.

All supplies for the mines have to be taken from the coast. Most are imported. Biscuits, salt pork, beef and fish are the chief staples. There are no towns, no villages, no settlements from the time the tidal influence is left behind, no means of land transport except on men's backs. At the most-used landings and at the larger locations there are shops, generally kept by Chinese, at which supplies may be bought and gold-dust sold or advanced upon. That is all. Where mining has been going on in one place for some years a few vegetables may be seen growing, but it is one of the most regrettable features of British Guiana mining that it has led to absolutely no opening up and settlement of the interior, and this is entirely due to the difficulty and costliness of living there and of maintaining communication with the coast under present conditions. The mining locations are spread over so great an area, are so shifting, and the country is so broken and cut up by rivers, that nowhere has wheeled communication been made possible, nor can beasts of burden be introduced. A considerable sum was spent in cutting a track for sixty miles, through the forest of the watershed between the Essequebo and Mazaruni, from Bartica on the navigable Essequebo to the Caburi minefield. This is known as the Caburi road. It has never been used except by a few foot-passengers, being quite impracticable for wheeled traffic, and there are no resting-places. The traffic still goes by the river route.

A similar history attaches to other attempts at road-making in the interior. As soon as mining ceases in any locality the place is deserted, the tracks from the rivers close up again, landings become overgrown, and King Jungle resumes his sway.

Bauxite

Although mining has hitherto been confined to gold and diamonds, the prospect of the rapid development of a branch of this industry, much more profitable to the Colony, is now in sight, owing to the discovery in British and the other Guianas of some of the largest and richest deposits of bauxite in the world.

As long ago as 1897, and again in 1910, Professor Harrison, the eminent geologist, who has long held the appointment of Professor of Science and Agriculture, reported the existence of extensive deposits of exceptional purity. The discovery attracted little attention, however, until five years ago, when the Northern Aluminium Company of America applied for leases of areas containing such deposits. Aluminium has, since the outbreak of the war, been found to be so essential for munition and aircraft purposes that the British Government stipulated that any company working the deposits must be under British control. After long negotiation a company has been formed by the Americans interested to meet Government requirements, and the first cargo of bauxite has left the Colony. This company has acquired large areas of land from private owners and leases of a considerable extent of Crown land in the vicinity of Wismar, at the head of navigation on the Demerara River, near the terminus of the little railway connecting the Demerara and Essequebo Rivers. Ships drawing 16 ft. can reach the workings sixty miles above Georgetown.

The bauxite deposits have recently been traced almost from the Venezuelan boundary right through the Colony to the Dutch border. Further deposits have been located in Dutch and French Guiana, and the Guianas probably contain the most extensive deposits in the world, and some in very accessible positions. Should the industry develop on a large scale, local electrical treatment of the raw material with power obtained from one of the great waterfalls is sure ultimately to take place.

Balata

Another industry that draws men to the far interior is one known by the unpleasing title of "balata bleeding." Balata is the coagulated latex of the balata tree (*Mimusops globosa*), and is a very similar substance to and substitute for gutta-percha. It is used for machinery belting. The tree is found over wide areas of the forest right down to the farthest south, and as its value is generally higher than rubber its collection is a profitable work. The industry is controlled by the Consolidated Balata and Rubber Company, the survivor and absorber of many other companies. In the spring of each year parties are organised and sent up all the rivers of the Colony. They are kept supplied from up-river depots, and return in the autumn with the dried sheets of balata. Last year the total exports—the greater portion by this company—exceeded 1,500,000 lb., and as its present value is about 4*s*. a pound, the year's crop is worth about £300,000. The cost of collection, however, is considerable.

Timber

But mining and balata bleeding are not the only industries that take men into the forest. Timber-getting is carried on to a considerable extent for firewood, shingles, charcoal, sleepers, etc. In the case of greenheart the work extends even somewhat beyond the tidal belt. Difficulty of transport, however, confines this industry, except in the case of the Essequebo, to below the falls. Greenheart, the most valuable timber for all underwater structures, is largely exported, and was used for the Panama Canal works.

Crops

On the coast lands practically the only products that are much grown are sugar, rice, coconuts and limes. Coconuts do fairly well. The trees are seldom carefully cultivated, but left ill-drained and choked with grass, weeds, etc. Limes flourish all along the coast and river lands. There is some hope of success in production on a commercial scale of lime-juice and citrate of lime. An enterprising private firm has a factory in Berbice ; another factory is working on the Essequebo, and a Government factory in the Suddie district. With the assurance of a steady price lime cultivation should become a profitable and popular village industry. The length of the sea voyage to the States and Canada precludes the export of the fresh fruit.

In the lower river reaches are large areas suitable for coffee and cocoa, and except close to the coast, where the subsoil is sour and salt, practically the whole Colony, up to an elevation of 1,500 ft., is suitable for rubber cultivation. Whether, when the price of rubber falls to near the cost of production in Malaya, say between 1*s.* and 1*s.* 6*d.* a pound, it could be grown profitably with the dearer labour available in British Guiana may be doubtful, but the rubber industry has flourished now for over ten years, and there seems little danger of prices falling below 2*s.* for a considerable time. That rubber will grow as rapidly and yield as bountifully in British Guiana as in other countries in the same latitude has been proved both on the Government experimental plots and on a few small private plantations. Unfortunately, in no single case has a sufficiently large area been planted and maintained in cultivation until the bearing age to pay the cost of a superintending staff and estate organisation. In several cases areas have been cleared and planted, but have generally, owing to lack of funds, been allowed to relapse into jungle. In British Guiana only one plant is carefully cultivated, and that is the sugarcane. A recent example of the devotion to sugar, to the exclusion of other agriculture, is given in the alteration of the name of the Planters' Association to that of "The Sugar Planters' Association," apparently as an advertisement that no other branch of agriculture is worth local consideration.

This present attitude must be attributed to the great prosperity brought to the sugar industry and the Colony by the war. Before the war, although large and well-managed estates, with plenty of capital and well equipped with modern machinery, managed on a series of years to do well, others did not, and many men looked about, in a half-hearted way, for other products to take its place, with the result that both coconuts and rice cultivation extended. In 1884, 98 per cent. of the Colony's exports consisted of products of the sugar-cane—sugar, rum, molasses. All other exports only reached £43,000 in value! In the same year sugar-cane products exceeded in value £2,000,000. Then a change began.

From 1892 onward less than 80 per cent. of the total exports came from the sugar-cane. This was not due, however, to increased cultivation of other products, but to the rapid development of mining, to the growth of the timber industry, and to the decline in price of sugar. It is only within the last decade that the increased exploitation of balata and the very satisfactory development of rice cultivation have taken place.

The value of the sugar products exported in the three war years is considerably greater than in any year since 1884, beyond which my records do not go back. In 1916 it approached £2,750,000 sterling, other produce amounting to £630,000. While in 1884 produce of the Colony other than that derived from the sugar-cane only amounted in value to £43,000, in 1917 rice alone was exported to six times that total.

The history of the rice industry is a curious one, but there is not time to tell it here. Suffice to say it struggled slowly upwards to success against much opposition. It was created by the efforts of the East Indians, and now not only supplies the whole requirements of the Colony, but a surplus of over 13,000 tons for export to the West Indian Islands.

Kaieteur

No paper on British Guiana is ever likely to be written without a mention of the Kaieteur Waterfall. If access to the interior is ever made easier the Colony should become a favourite haunt of the tourist. There can be seen equatorial forest vegetation in all its pristine beauty. There, too, are sights not equalled elsewhere, and though in the damp heat of Guiana many may not care to take trips involving much physical exertion, given a few of the conveniences looked for in modern life thousands would certainly visit Kaieteur and some the more distant Roraima.

Only a brief mention of Kaieteur is possible here. The return trip from Georgetown takes nine days ; at present there is a good deal of "roughing it," and the cost is about equal to residence in a good New York hotel. The first day is spent in a small river-boat from 8 a.m. to 4 p.m. or later, on a sixty-mile run up the Demerara ; thence twenty miles on the little railway connecting this river with the Essequebo. The second day Tumatumari on Potaro is reached in a small and noisy motor-boat. On the third morning there is a run of two hours in a motor-boat, a walk of four miles round a series of rapids, and the remainder of the journey on that day and the fourth in an open boat with a crew of Indian paddlers. On the fifth morning, after a rather arduous climb of one and a half hours through heavy forest, the traveller emerges suddenly on the Kaieteur Plateau. The rest-house here and those occupied on the previous two nights are of a very primitive description, but it is to the enterprise of a private firm, Messrs. Sproston's, that the facilities, such as they are, exist on Potaro, and I fear their provision has not been a profitable work. Five minutes from the rest-house the edge of the fall is reached. The scene is astonishingly peaceful. There is a placid and clear river—like the Thames at Henley—quickening its pace as it nears the edge, with here and there a grass-covered rock piercing its surface ; the near bank is gently sloping rock partly covered with brushwood and low trees. On the far side high forest. There is no deafening roar as at Niagara, the bottom of the fall is so distant, over 800 ft. It is difficult to realise such a vertical height. Five times the height of Niagara, four times the height of the London Monument, or just twice the height of the top of Hampstead Heath above the level of the Thames ! Thus the sound is softened and rises and falls like the surge of the sea on a distant rocky shore.

After the first shock of the immensity of the drop the visitor's attention is drawn inevitably to the gorge. Thickly wooded hills rising well above the plateau press in on either side until they melt away in the dim distance. Nothing but forest, but such forest, and with light and shade playing on the varied hues of the foliage, this gorge forms a wonderful picture of tropical growth from a unique vantage-point of view. In the centre of the gorge below one's feet is a boiling basin, and beyond the apparently dry rocky bed of the river with an occasional pool. The river forces its way for some miles, out of sight and far below the huge rocks piled helter-skelter in the bottom of the gorge.

On the side the fall is approached—the left bank of the river—the plateau has been carved out in a rough semi-circle, so that by scrambling about half a mile through the forest a point can be gained almost facing the middle of the fall. Here one can sit on the edge of the precipice in comfort in the shade and see the full drop to the pool beneath, at a distance, I should say, of about one-third of a mile from the falling water. Sometimes the fall is hidden by the mist rising from below for days together, but the view generally clears between 10 a.m. and 3 p.m. I have travelled a fair amount, and never have I seen any sight approaching this in beauty. From this position the sensation is of being below the top of the fall, but this is deceptive, as is realised when it is noticed that the river is visible for the whole of the long reach above the fall. The setting is perfect; the forest is untouched; in the distance the highlands and some of the mountains barring the way to Roraima are visible; the placid river glides towards the edge and the amber-coloured water curves over, whitens and quickly breaks up again and again into arrow-headed gauze-like points which seem to descend slowly and dissipate into vapour before the boiling pool beneath is reached. At the sides it can be dimly seen that there is a great cavern behind the falling water, in which each night thousands of swifts take their rest. The photographic slide I shall show you gives but slight idea of the reality. Colour and movement are lost, and it is only to those who have been there—like our Chairman (Sir Everard im Thurn), who was the first European to visit the fall and the first to climb Roraima—that a photograph can recall the reality.

Roraima

Mr. Clementi, the present Government Secretary, has proved that the quickest and easiest way to Mount Roraima is via the Kaieteur Fall and a day's journey up the river to Holmi and thence overland.

Like Kaieteur, Roraima is unique. It is a flat-topped mountain over 8,000 ft. high, its sides rising some 5,000 ft. above the surrounding country, the top 2,000 ft. being a perpendicular cliff. It was long thought to be inaccessible until Sir Everard im Thurn found a way up along a narrow ledge. Mrs. Clementi accompanied her husband to the summit in 1916, and is the first woman to make the ascent. The journey beyond Kaieteur, after the first day on foot, is at an elevation of over 2,000 ft., and a cooler and more pleasant atmosphere is soon reached. The route is largely through savannah country.

Fish

The rivers of Guiana are full of edible fish of excellent quality. The chief are the lowlow, haimara, paku, arawana and arapaima. They are all as food fully equal to good sea fish. The arawana, still only procured by shooting with a bow and arrow, is excellent. I spent one afternoon in a canoe with two Indians, who thus secured four fish averaging about 5 lb. weight. To do this they had over twenty shots. The arrow has a long shaft; on a hit being made the fish dashes off, from the shallow where it has been sunning itself, into deep water. The shaft soon bobs up and is followed. When within reach a violent thrust downward is made to drive the barb well in. When again grasped the fish can be lifted out.

The arapaima is the great food fish of the Amazon, and is rarely found in the Colony outside the mouth of the Rupununi. In that river it is plentiful, as the Indians prefer the smaller and more delicately flavoured arawana, haimara, etc. The arapaima reaches the tremendous size of over 400 lb. It is caught with heavy lines like those used in sea-fishing, but I had an extraordinary afternoon's rod-fishing on my trip to the Brazilian boundary in connection with the proposed hinterland railway. We had two tarpon rods between three of us—my aide-de-camp, Mr. Bland, the railway engineer, and myself—and we landed seven fish, one weighing just 200 lb., and the seven just over half a ton. With heavy tarpon rods and lines each fish took on an average twenty minutes to land. Fortunately for my reputation I had a camera with me, and photographs of the catch accompanied an article I sent to the *Field* on the subject. On the following day I caught a 75-lb. fish with a salmon rod in about three-quarters of an hour.

Railway Development

The presence of arapaima in the Rupununi and of a very vicious little biting fly, one of the pests of the Amazon, are held to be proofs that once the waters of the Rupununi Valley drained into that river. Even now the height of the divide between the sea and the Amazon Valley is only some 250 ft., and in the wet season the waters of the two river systems approach within half a mile of each other, and Indians drag their canoes across the watershed. If ever the middle Amazon is to be given a route from Manaos, more than 1,000 miles shorter than the river route to the United States and Canada, surely it will be over this low watershed to Georgetown. If the line is constructed to Manaos its extension to meet the southern railway systems of Brazil and the Argentine can only be a question of time. The Takatu, on the Brazilian boundary, runs into the Rio Branco, one of the chief tributaries of the Amazon, joining that river near Manaos.

The British Guiana section, if taken from Georgetown to the junction of the Ireng with the Takatu, to which point launches easily ascend, would be some 340 miles. Its construction presents no engineering difficulties, and the cost of a metre-gauge line was estimated by Mr. Bland at only £3,500 a mile. Mr. Buck, the Colonial Director of Public Works, has recently investigated the problem afresh, and recommends a slight variation of the route at Georgetown end, but confirms Mr. Bland's estimate of mileage cost.

I will not here discuss the relative advantages of the two routes beyond remarking that by Mr. Buck's route the distance to the Takutu is increased by twenty-six miles, a very serious consideration as traffic increases, and that Wismar, the probable headquarters of a great bauxite industry, would be left without any other communication with Georgetown than the lengthy river route.

Mr. Nunan, the present Attorney-General of British Guiana, had done much to boom this attractive railway project before my arrival in the Colony, and succeeded in raising great enthusiasm on the subject. Many of the leading men see in this line, without the Manaos extension, a solution of the problem of the Colony's development. I agree with them, and I had hoped to return to England in August, 1914, to press the subject on Mr. Harcourt's attention. I knew he realised its importance, and it would have been fitting that he, one of whose distant ancestors received a grant of the country from James I, and twice attempted to take possession of his property, should be the Minister finally to render the development of its rich interior possible.

The question of financing its construction, however, bristles with difficulties. In the Colony there is much divergence of opinion. The planters of the coast fear the loss of their labour, and urge that the scheme must be accompanied by a costly supplementary one for the introduction of many thousands of settlers. Another section is against construction by Government, refusing to see that it is a project impossible for private enterprise, as there is no prospect of paying even working expenses for at least ten years. These people are misled by concession hunters, inexperienced and over-sanguine, to take a charitable view of their promises, who offer to construct the line on easy terms without having the remotest chance of finding capitalists to finance their proposals. The line, if built, must be built with Government money. The Colony cannot afford to carry out the work.

Here seems to me a project eminently worthy of the attention of the Empire Resources Development Committee, not, however, with a view to further development at the expense and for the benefit of the Mother Country, except indirectly. Where would Britain be without her oversea possessions? Taking the tropical Colonies alone, it would be instructive to calculate how many millions are annually poured into the Imperial Exchequer as income-tax, now swollen further by excess profits duty, on receipts by her citizens from their oversea properties, and, on their decease, by death duties thereon. Is it too much that in return the Mother Country should advance, as in the case of the Uganda Railway, the means of giving the people, both of the Colony and of the United Kingdom, a chance of proving their ability to take advantage of the opportunities so offered?

Until Mr. Chamberlain ruled at the Colonial Office our West African Colonies were in a much worse state of stagnation than British Guiana. Under his guiding hand, and with financial help from the Treasury, railways began to be pushed up from the coast in each of our West African possessions, with the result that nowhere is there more rapid progress to be seen than in those possessions. Without the progress so ensured we should now be without urgently needed vegetable fats, without our chief source of cocoa supply, and without the troops that have borne the brunt of the fighting in subduing Togoland, the Cameroons and German East Africa.

Within ten years of the completion of a railway to the savannahs in the interior the cattle traffic should alone be sufficient to cover working expenditure. But great development in mining, the timber trade and in the exploitation of other forest products may be looked for, as well as the beginnings of agriculture, nor is it likely that with a railway on the Takutu the Brazilians could long resist extending it to Manaos, or at least to a point on the Rio Branco, and thus secure the immense advantage of a direct route to the North Atlantic at Georgetown.

With such an extension there would be no further anxiety regarding the financial prospects of the line.

THE PINK BOLL WORM AND THE COTTON CROP OF EGYPT

By G. C. Dudgeon, C.B.E., F.E.S., etc.

Scarcely any work of greater urgency connected with the welfare of cotton growing in Egypt has been attempted than the study of methods for the eradication of its pests. It is of course true that the maintenance of purity of the existing types of cotton occupies a very prominent place, but in regard to this, the procedure to be followed, associated at any rate with the initial steps, is well known and can be carried on without hesitation, and the obstacles are generally apparent from the start. The case is different with regard to research in economic entomology. Each particular pest affects the host plant in a different manner; each species presents a new problem, owing to its different method of life and metamorphosis; in each case it is necessary to ascertain the natural influences which retard or accelerate its development, and in each it is probably necessary to have recourse to "first aid" or temporary measures to prevent a too rapid diffusion, while its particular problem is being studied. Added to this long list must be the ultimate formulation of remedial measures, so fashioned as not to offend the political sentiments of the country, and to be capable of being demonstrated in such a manner that the efficacy of the result is sufficiently conclusive to convince the administration and the cultivators at the same time. This latter is certainly not among the least of the difficulties to be faced.

The present paper includes a general account of work on the pink boll worm (*Gelechia gossypiella*, Saunders) which has been carried out recently by Dr. Lewis Gough, Director of the Entomological Section of the Ministry of Agriculture in Egypt. For details of the interesting experimental work connected with many of the points touched on here, reference should be made to Dr. Gough's paper, which is expected to appear shortly in the *Bulletin of Entomological Research*, Vol. IX., Part 4.

The pink boll worm is the name commonly applied to the caterpillar or larva of a small moth, which lays its eggs on the buds, flowers and fruiting capsules or bolls of the cotton plant. As soon as the young caterpillar is hatched it proceeds to perforate the bud, flower or boll, living inside the latter chiefly, during its period of growth, and injuring, not only certain sections of the boll in which it feeds, but the vitality of the whole boll to a certain extent, dependent on the moment of its attack. The weight and germinating power of the seed are affected as well as the weight of the lint covering the seeds.

The pest was first recorded from Egypt in 1910, and the first serious outbreak occurred in 1912, since when it has become established throughout Egypt as a major pest. The strongest evidence exists of it having been introduced in badly ginned cotton coming from India, and used in the Alexandrian Spinning Mill. The insect was originally described from India as a cotton pest as early as 1843. It now probably occurs in every country where cotton is grown, having recently reached the United States (*cf.* this BULLETIN, 1918, **16,** 263) as well as South America, and having been recorded from Palestine and Mesopotamia. The West Indies are still believed to be free, but can hardly remain so if the pest becomes more general in the United States.

Unlike all other insect pests which have appeared in the country, the pink boll worm, in accordance with certain conditions, passes through a period of prolonged inactivity or one of rapid development: its dormant period in the caterpillar stage may extend to nearly two years in certain circumstances, while in others the duration of the complete metamorphosis from egg to moth may last only a few weeks.

In examining the question of the annual increase since the year of its first record, and using for this purpose samples taken from the sowing seed selected every year for distribution by the Ministry of Agriculture, as the most comprehensive basis obtainable, Dr. Gough records the percentage of attacked seeds found with respect to each of the eight varieties of cotton seed distributed. The figures for three of these varieties are available for six consecutive years. The attack reached its maximum severity in 1916, when, for all varieties, out of every hundred seeds (not counting fragments), 15·1 in Lower Egypt and 3·2 in Upper Egypt were attacked. In 1917 the figures had fallen to 11·2 and 2·8 respectively. This reduction was the result of the vigorous campaign carried out in the end of the preceding season. Dr. Gough has stated that no further reduction may be expected in 1918 owing to the handicap which has been placed upon the execution of remedial measures by the war conditions; fuel famine having compelled the withholding of measures for the rapid destruction of infected plants after the crop was harvested, etc., and export of seed having been so dangerously delayed as to permit the emergence of moths which would otherwise have died in oversea transit.

A side issue appears in connection with the examination of the seed samples used in the test just referred to, which is, that the germinating power of cotton seed remains unimpaired at the end of six years, if proper precautions for storage be taken.

In discussing the amount of damage done by the pest, Dr. Gough has examined the question of the variation in weight of cotton seed and cotton lint from day to day, due to absorption or loss of moisture. He has pointed out that allowance for these must always be made. His first reference is to the amount of moisture lost by the seed after the picking of the cotton, which he has shown is both rapid and considerable. With respect to absorption he found that old seed behaved in exactly the same manner as that belonging to a recent crop, and it was apparently immaterial whether the seed were whole or damaged.

By an ingenious machine, specially devised for the purpose, the fluctuation in seed weight under varying conditions of humidity and temperature is recorded. The machine consists of a self-recording hygrometer employed with a self-recording chemical balance, the latter having a small mirror attached to the pointer close to the knife-edge, in such a manner that a ray of light from the mirror is thrown on a sheet of sensitised paper fixed to the drum of the hygrometer, to register the weight fluctuations.

The results showed that the weight of seed increased or decreased with the increase or decrease of humidity, but that there was a lag of about two or three hours in the registration of its effect. It was also found that changes in temperature might alter the form of the curve, and that small fluctuations in humidity were not recorded.

As regards lint, it was found that the absorption of moisture was rapid, and that the curve of lint weight, recorded in the same manner, followed exactly the fluctuations in humidity.

As seed and lint are sensitive to moisture in different degrees of rapidity, complex results were to be expected when the two were combined, and the weight of lint, expressed as a percentage of seed-cotton which comprises the percentage ginning outturn, on which so many calculations are made, is shown to be, in practice, a perpetually varying figure.

Dr. Gough shows that attack by pink boll worm in the early stages of the formation of a boll often leads to complete suppression of one or more seeds. This is one source of diminution of the crop caused by the attack; another is the effect on the vitality of the remaining seeds shown in the decreased weight of the sound seed. In this latter connection it is stated that the weight of lint fluctuates in close correspondence with the weight of the seed bearing it, and in consequence the ginning outturn is not altered in such cases by the attack of the pest.

The actual loss through an attack on the boll is dependent largely on the time when the boll is attacked. Thus, as stated above, a very early attack, which causes the complete suppression of a seed, also causes the complete loss of its lint; a little later the seed may be formed, but be eaten up to such an extent that little or no lint is produced on it. If, however, the seed is attacked late, the lint may be but slightly affected, although the seed be reduced to mere shell. Thus it will be seen in the first case both seed and lint are lost; in the second, little or no lint is formed (thus increasing the proportionate weight of seed to lint), whereas in the third case lint is not or only slightly affected, while seed is much reduced in weight (thus increasing the proportionate weight of lint to seed). In actual practice these are found to compensate one another, and the figure for ginning outturn remains unaltered from those attained in the times before the pink boll worm was present as a pest. Dr. Gough has given comparative tables to show how insignificant the effect of the boll worm attacks have been upon the ginning outturn.

With regard to the loss caused by boll worm attack, Dr. Gough has stated that even if all bolls are attacked by one worm each, the damaged seeds will not necessarily be more than 6½ per cent., and the total weight lost in such an attack will rarely exceed 20 per cent. The case is of course altered where more than one worm is present in a boll. It should be unnecessary to remark that it would be rare for all the bolls to be attacked except at the end of the season, when most of the crop has already been removed.

The extent of the damage done by the pink boll worm is represented by the following sum: Weight lost (by complete suppression of seed + by diminution in size of sound seeds + by diminution of weight of attacked seeds) + 50 per cent. (representing equivalent lint). The loss so calculated added to the actual weight of the crop is shown to be equal to a crop calculated as having contained only sound bolls. In one instance only, among the tests made, has the difference amounted to as much as 1 per cent.

The average loss Dr. Gough has found roughly proportionate to the percentage of bolls attacked in a ratio of 1 to 5, the loss being, in other words, about one-fifth of the weight of seed + lint in every boll attacked. Thus, for example, if 35 per cent. of the bolls are attacked, the loss in the weight of the crop may be put down at about 7 per cent.

The error which sometimes occurs in utilising this rough formula for estimation is due to a boll being occasionally attacked by two or more boll worms. This however rarely happens at all until nearly all the bolls on the plant have been already once attacked.

Dr. Gough has given an instance of a particular field, where he found the loss due to the pink boll worm in the first picking was from 11 to 16 per cent., and in the second picking from 17 to 20 per cent. But, he remarks, all this loss would not have been avoided had the conditions been made similar to those existing before 1912, as in that case the same amount of damage, or a good part of it, would have been done by the Earias boll worm, which has now practically disappeared as a major pest. Earias damage was annual and sometimes severe, and is stated by other observers as having reduced the crop by 18 per cent. in a bad year.

A fact which has not been noted in respect to the pink boll worm is that it has been chiefly responsible for the early maturity of the cotton in Egypt during the last four years. With the introduction of Sakellaridis cotton, it was found that its early maturity, in addition to its greater fineness, gave it an advantage over brown cottons, which previous to 1910 were being cropped from September to January. At the present time there is no cotton capable of being picked as late as November, and plants which mature their cotton late have practically all their seed destroyed by the pest, so that there is small chance of a late maturing plant having any descendants. On the other hand the earliest maturing cotton plant has the highest percentage of germinating seed, because the boll worm does not take a heavy toll of such cotton. The maximum chance of persistence remains, therefore, with those individual plants possessing an early maturing character. It might be supposed that the pest would adapt itself to any such developments, but the plant is one in a highly changeable condition, due to mixed parentage, and is easily adaptable to altered conditions, whereas the worm is a stable species, whose life history is controlled by temperature conditions, not vegetative production, and it cannot therefore rapidly suit itself to altered conditions.

Dr. Gough has confuted the statement made by an American writer in respect to the absence of the influence of artificial light in attracting pink boll worm moths, and has shown that enormous numbers are attracted and caught at different periods of the year. The information gained in this connection has been of the greatest value in relation to the proposals made for legislation regarding cotton seed remaining in the country. By these observations it was easy to ascertain the period during which stored cotton seed became a menace to the neighbouring fields, and during which time, therefore, it was necessary to keep it in wire-netted stores to prevent the exit of the moths. It was found that very few moths appeared between December and April, and it was therefore essential to urge the export of as much seed as possible before the latter month. As large numbers of hibernating worms and moths are present in the seed up to the end of October, it was rendered necessary to arrange for the destruction of these by means of hot-air machines, while stipulating that no seed shall remain in the country after the month of April, except that confined in netted stores. The hot-air treatment of seed combined with the destruction, by burning, of all bolls left on cotton trees at the end of October, and the confinement of cotton seed after April in wire-netted stores, formed the basis of the legislation introduced, which should eventually lead to a great diminution of the pest, enabling the later crops of cotton to be picked in a clean condition.

Two machines for the destruction of the pink boll worm in seed, by means of hot air, were approved, but the law compelling their installation in ginneries, which was promulgated in 1916, has not yet been enforced, owing to the position created by the majority of ginners in not adopting the measures recommended to obtain machines in time. The factories that installed machines in 1917–18 were six in number and all in Upper Egypt. The working of these machines was tested by Mr. Storey of the Entomological Section of the Ministry of Agriculture. Five of the factories had obtained machines of the Simons pattern, made in England, and one, a machine known as the "Delta," made in Egypt. All were run so that the seed registered a temperature of 55° C. just before reaching the sacks into which it was discharged. This temperature, Dr. Gough shows, was considerably below the safe maximum with respect to germination injury, for the time occupied by the seed passing through the machine, but it was the lowest safe temperature to ensure killing the worms. Mr. Storey found that germination of seed is not injuriously affected where the temperature is maintained between 60° and 70° C. under the same conditions with respect to time, and that this can even be extended to 73° C. without fatal effect on the germinating power.

No difficulty has been experienced in controlling the temperatures in the machines working in the six factories mentioned above, and none of the objections anticipated by the ginners in this connection have proved to be justified. Dr. Gough does not hesitate to recommend the employment of a temperature of from 60° to 65° C. rather than 55° to 60° C. previously fixed.

In order to test the effect of heat on the germinative power of seed, it was necessary to make laboratory arrangements on a much larger scale than previously. Dr. Gough has described the construction of the germinating room, and the method employed to maintain an unvarying temperature. The room actually has a capacity for 4,000 dishes, each containing 50 grammes, or about 500 seeds. By the heating system employed, the thermograph records show that the temperature only fluctuated to the extent of ½° above or below that aimed at, in the course of several weeks. In the old process, where Petri dishes were used in a Hearson's incubator, many samples were destroyed by mildew, but no such case has occurred in using the new arrangement referred to.

Dr. Gough has given his views regarding the importation of Egyptian seed by cotton growing countries, where pink boll worm does not already exist. Mr. Storey, in a Ministerial report, states that he considers it beyond human possibility to guarantee that seed treated in Egypt in large quantity shall reach its foreign destination absolutely without living pink boll worms in it. He warns us that the infection of a large quantity of seed by only 0·001 per cent. of live worms constitutes a great danger to the new country. Only small quantities of seed, capable of being sent out in soldered tins or in securely wrapped postal packets, can be guaranteed free from living pink boll worms. All packing in sacks, etc., where the contents can be easily reinfected during transport, must be regarded as dangerous to the importing country.

In spite of all reasonable care being taken, it does not seem likely that any portion of the cotton growing area of the world will escape infection by this pest; it remains to be seen, however, whether the natural enemies in the countries it enters will be sufficiently powerful to keep it down to the rank of a minor pest. Such is apparently the case with respect to India and West Africa, where it has been known to exist for many years without making headway or becoming of vital importance; but the opposite has occurred in Egypt, German East Africa and Hawaii, where, in the first case, artificial means for its control have to be employed, and in the last two, the complete cessation of cotton growing has resulted. The Sudan and Brazil are interesting fields in which to follow the development of the pest in the immediate future.

GENERAL ARTICLE

THE FUTURE OF THE TRADE IN CINCHONA BARK

The cinchona bark, used for medicinal purposes, is obtained from species of cinchona, of which the most important, from a commercial point of view, are *C. ledgeriana*, *C. succirubra*, *C. officinalis*, and certain hybrids. The first variety, and a hybrid of the first and second, are the chief sources of the so-called factory-bark, *i.e.* bark used for the manufacture of quinine sulphate, whereas the so-called pharmaceutical barks, for medicinal use as such, are obtained chiefly from *C. succirubra*, and to a much smaller extent and for special purposes from a hybrid of *C. officinalis* and *C. succirubra*, known as *C. robusta*.

For factory bark the desideratum is a high yield of quinine. For pharmaceutical bark a high yield of total alkaloid, a fair proportion of quinine and a good appearance are important factors in determining value.

Cinchona bark owes its importance to the presence of alkaloids, of which quinine is the best known, especially in connection with the treatment of malaria.

The cinchonas are natives of South America, where they are found in the forests of the Andes, in the zone between 10° N. lat. and 19° S. lat. at an elevation above sea-level varying from 3,000 to 9,000 feet. At the present time about 90 per cent. of the cinchona barks of the world are supplied by Java. Cinchona is, however, cultivated on a small scale in India, Ceylon, the West Indies, Bolivia and various parts of tropical Africa.

In the early years of its cultivation in Java, cinchona was in the hands of the Government of the Netherlands East Indies, which still owns and works extensive plantations. The Government were able to place the industry on a commercial footing by the year 1872. The methods of cultivation and harvesting were gradually improved by continuous experiments on grafting, hybridisation and selection of seed, and on methods of securing rapid renewal of bark, until at the present day the industry on its planting side is virtually a Dutch monopoly.

As regards composition, the principal alkaloids in the bark are: quinine, quinidine, cinchonine and cinchonidine. The demand in the chief consuming countries is for quinine, and the other alkaloids of cinchona bark have a very limited market. The chief demand is therefore for bark for the quinine factories, and for this reason the principal aim of all experiments in cinchona improvement is the raising of plants, the bark of which will ultimately yield the maximum of quinine and the minimum of alkaloids other than quinine.

Production of Cinchona Bark

The Netherland East Indies, and especially Java, have a virtual monopoly of cinchona bark production. According to the *Handboek voor Cultuur- en Handelsondernemingen in Ned.-Ind.* 1915, there are about 160 estates growing cinchona in Java and Sumatra.

So long as the production of cinchona bark was limited to South America, London, Paris, Hamburg and New York were the principal markets. Many difficulties were experienced in the trade. Owing to the collection of the bark in the forests, supplies were small and irregular, and the irregularity in the exports reacted on prices, which were, as a rule, very high. The transfer of production to the East by cultivation in India, Ceylon and Java, naturally changed this aspect of the trade. Not only did South America lose its monopoly, but the market was gradually transferred. The Indian and Ceylon barks were marketed in London; the Java bark found its way to Amsterdam.

Dutch East Indies.—It is difficult to ascertain the exact quantity of cinchona bark produced annually in the Dutch East Indies, but as most of the bark is exported, an idea of the growth of the industry may be obtained from a consideration of the export figures. In 1879 only 60 bales of bark were exported from Java, but in 1889 the exports had risen to 6,500,000 lb., and they continued to rise until 1910, when 20,270,000 lb. were exported. The figures for the four subsequent years were: 1911, 19,190,000 lb.; 1912, 19,210,000 lb.; 1913, 20,900,000 lb.; 1914, 15,315,000 lb.

There is a small production of bark in Sumatra, the exports, all of which went to Amsterdam, in 1910, 1911 and 1912 being 193,952 lb., 55,100 lb. and 88,160 lb. respectively.

To the above amounts must be added the bark used in the quinine factory at Bandoeng in Java. The average annual exports of quinine from Java in the years 1911 to 1913 amounted to about 182,000 lb. Assuming a yield of 6 per cent. of quinine sulphate from the Java bark, this quantity represents about 3,030,000 lb. of bark. The exports of bark in the same years averaged 19,850,000 lb., so that the total production may be taken to be at least 22,880,000 lb.

India.—Cinchona has long been successfully cultivated in parts of Southern India and in Bengal. Government plantations exist at Dodabetta, Kukal, Naduvatum and Hooker in the Nilgiris, Madras, and at Mungpoo and Munsong in the Darjeeling district, Bengal. There are also private plantations in Madras, as well as in Travancore and Mysore, but in recent years there has been little or no planting of cinchona on private estates in these regions. The area under cinchona on the private plantations in Southern India is shown in the following table:

	1911–12. Acres.	1912–13. Acres.	1913–14. Acres.	1914–15. Acres.	1915–16. Acres.
Madras . .	1,293	1,360	1,575	1,538	1,415
Travancore .	292	1	151	150	—[1]
Mysore . .	48	48	481	—	—[1]

[1] *Statistics not available.*

No figures are published showing the production of bark on the private estates in Southern India, but some idea of the output can be obtained from a consideration of the export figures given in the official Trade Returns for Madras and the amount taken by the Government quinine factory in Madras, as shown in the following table:

	1912–13. lb.	1913–14. lb.	1914–15. lb.	1915–16. lb.	1916–17. lb.
Exports of bark from Madras Presidency .	569,285	605,102	642,987	607,807	688,143
Quantity of locally produced bark purchased by quinine factory . . .	409,687	525,760	431,956	318,958	522,053
Total . .	978,972	1,130,862	1,074,943	926,765	1,210,196

The total production is probably in excess of the figures given above, as doubtless some is used locally as pharmaceutical bark.

Cinchona cultivation is also carried on under government auspices in Madras and Bengal, and the bark used for the production of quinine, etc., in the government factories. The principal varieties grown are *C. ledgeriana*, *C. succirubra*, *C. officinalis* and *C. ledgeriana* × *succirubra*. The total area in Bengal with a full complement of cinchona in 1915–16 was 2,295 acres. The estimated total number of trees was 3,091,100 during the same year, and the total bark crop was 569,337 lb.

The following table gives the production of cinchona on Government plantations in the two provinces in recent years:

Bengal.			Madras.		
Year.	Area under cinchona.	Bark crop.	Year.	Area under cinchona.	Bark crop.
	Acres.	*lb.*		*Acres.*	*lb.*
1911–12 .	1,558	299,380	1911–12 .	1,193	402,494
1912–13 .	1,779½	611,338	1912–13 .	1,111	460,965
1913–14 .	2,246	690,524	1913–14 .	977	445,737
1914–15 .	2,552	680,375	1914–15 .	916·6	349,451
1915-16 .	2,295	569,337	1915–16 .	1,002	352,165
1916–17 .	2,405½	499,417	1916–17 .	1,007	No figure available.

The Indian production, from both Government and private plantations, therefore amounted to about the following quantities in the years named:

	lb.		*lb.*
1912–13 .	2,050,000	1914–15 .	2,100,000
1913–14 .	2,270,000	1915–16 .	1,850,000

The average annual harvest of cinchona bark during the four years 1912–13 to 1915–16 was, therefore, over 2,000,000 lb. The figures relating to the production of cinchona in Bengal indicate that there was marked increase in the quantity of bark raised during the three years 1911–12 to 1913–14, since when there has been a slight falling off. The figures relating to the Madras production show some decline both in the area under cultivation and in the quantity of bark raised in Government plantations, whilst the corresponding figures for private plantations fluctuate from year to year, with, on the whole, an upward tendency. The figures for bark production, however, do not give a complete idea of the actual situation, as in certain years the authorities prefer to import bark for quinine manufacture to utilising the local crop; the reason for this is stated to be that it is cheaper and easier to make quinine sulphate of the required standard from Java bark than from the bark grown locally.

The Government factory in Bengal used, for a number of years, imported Java "Ledger" bark for the manufacture of quinine. The following figures show the percentages of quinine sulphate theoretically available and also the actual yield during the years 1909–10 to 1916–17 from the imported bark and from the locally grown bark:

Year.	Bengal Plantation Bark.		Imported Java Ledger or Hybrid Bark.	
	Percentage of quininesulphate theoretically available.	Actual percentage yield of quinine sulphate.	Percentage of quininesulphate theoretically available.	Actual percentage yield of quinine sulphate.
1909–10 . .	—	3·67	—	6·28
1910–11 . .	—	3·28	—	6·0
1911–12 . .	4·43	3·4	7·42	5·7
1912–13 . .	—	4·43	—	6·86
1913–14 . .	4·52	4·27	7·185	6·65
1914–15 . .	4·58	4·5	6·9	6·8
1915–16 . .	4·47	4·45	None used	—
1916–17 . .	4·69	4·51	None used	—

The table shows that the percentage of quinine sulphate is higher in the imported Java bark than in the Bengal plantation bark.

The next table shows the quantity of bark used and the quantity of quinine sulphate produced in the Government factories in Bengal and Madras during recent years :

Year.	Bengal.		Year.	Madras.		
	Bark used.	Quinine sulphate produced.		Bark used.	Quinine sulphate produced.	Percentage of quininesulphate obtained from the bulk.
	lb.	*lb.*		*lb.*	*lb.*	
1910–11 .	911,752	39,980	1910–11 .	736,500	26,750	3·63
1911–12 .	853,639	40,379	1911–12 .	755,900	30,489	4·03
1912–13 .	758,231	43,853	1912–13 .	569,000	26,070	4·58
1913–14 .	959,247	51,562	1913–14 .	564,762	26,516	4·7
1914–15 .	764,722	34,650	1914–15 .	683,054	29,422	4·31
1915–16 .	960,570	41,815	1915–16 .	793,277	32,688	4·12
1916–17 .	459,600	20,903	1916–17 .	1,184,000	52,513	4·23

It is shown later (p. 380) that the amount of quinine sulphate imported into India in the years 1915–16 and 1916–17, the only years for which figures are available, averaged 71,562 lb. The production in India in those years may be taken as about 75,000 lb. The consumption of quinine sulphate in India must therefore be over 145,000 lb. per annum, and it seems clear that there is room for a considerable increase in the production of cinchona bark and in the manufacture of quinine in India to meet home requirements, and to maintain even the present modest exports of bark.

Ceylon.—Cinchona was first introduced into Ceylon about 1860. The industry received a great impetus when the coffee industry was ruined by the attack of leaf disease and the exports, which amounted to 18,731 lb. in 1875, rose rapidly, until in 1887 13,113,067 lb. were exported. Owing largely to over-production, however, the price of the bark fell, and the cinchona industry in turn decayed, to be replaced by tea; at the present time the production of cinchona bark in Ceylon is insignificant. The extent of the industry at different periods may be gauged from the following table, which shows the exports of bark from Ceylon since 1875:

	lb.		lb.
1875	18,731	1900	590,692
1880	1,208,518	1905	152,397
1885	11,678,360	1910 [1]	61,913
1890	8,779,140	1915	20,393
1895	919,820	—	—

[1] *Year commencing July* 1, 1910.

Summary of World's Production.—The statistics of production of cinchona bark given in the preceding pages may be summarised as follows:

	lb.
Java [1]	22,880,000
India [2]	2,000,000
Other countries [3]	440,000
Total	25,320,000

[1] *Average for* 3 *years* (1911–1913).
[2] *Average for* 4 *years* (1912–13 to 1915–16).
[3] *Figure for* 1910, *from a pamphlet on cinchona published by the Netherlands East Indian Committee for the San Francisco Exhibition.*

It is clear from these figures that the Java production is by far the most important from the point of view of international trade, whilst the production in countries other than Java and India is insignificant. It may be mentioned that Tunmann in 1910 (*Apoth. Zeit.*, 1910, p. 565) estimated the world's annual production at about 22,000,000 lb.

Marketing of Cinchona Bark

Sales of cinchona bark are made on the results of chemical analysis, factory bark being sold at so much for each "unit" per cent. of quinine sulphate obtainable from a half-kilogram of bark.

The bulk of the trade centres in Amsterdam, but there is still a small market in London. The principal difference between these two markets is that the bark sold in Amsterdam comes almost exclusively from Java, while that sold in London comes from India, Ceylon and South America. In 1917, 12,806,750 lb. of bark, containing the equivalent of 782,483 lb. of quinine sulphate, were sold at the auctions in Amsterdam. In the preceding year 17,365,374 lb., containing 1,075,127 lb. of quinine sulphate, were sold.

An important step in the cinchona trade was the signing of an agreement by the Java cinchona producers and the manufacturers of quinine in Java, England, Holland and Germany in July 1913. Before that period, bark was sold by public auction in Amsterdam, and owing to over-production prices had fallen to a low level. This gradual decline in prices discouraged the planters, who began to replace cinchona by tea and rubber. Under these circumstances, the producers and manufacturers considered the possibility of jointly controlling the market, and as a result of continued conferences, an agreement was finally entered upon in July 1913, in which the combined quinine manufacturers guaranteed to take annually for five years running, bark equivalent to 515,000 kilos. of quinine sulphate from the combined Java producers, provided that all Java barks were brought under the contract at the rate of 5 cents (1*d.*) per unit of quinine sulphate in each half-kilo. of bark, so long as the price of quinine was not higher than that ruling at the commencement of the contract. As soon as the manufacturers raised the price of quinine, half of the rise would go to each party concerned, and all details as to the mode of working the agreement were stated to be duly arranged to the satisfaction of all parties. A central office, known as Het Kina Bureau, controlled the receipts, analysis and deliveries of bark, and also fixed quotations.

This contract improved the market conditions, so far as the production of cinchona in Java was concerned.

The original contract lapsed on July 15, 1918, and has been replaced by a new one which is to cover the period from July 15, 1918, to December 31, 1923, and which will apparently have the effect of strengthening the position of the Dutch quinine factories. The following particulars relating to the new contract are taken from the *Chemist and Druggist*, August 31, 1918, p. 43. The contract is between cinchona planters in Java and quinine makers in Holland and Java. The Kina Bureau is in future to consist of three representatives of the planters, and a like number of delegates from the factories, with an independent President, who will direct its operations. The Bureau is to take a more active part in the work of the syndicate, and among other things will fix the price of quinine and maintain a representative in Java. The basis of the new contract is to be the price of quinine. When this does not exceed 20 florins per kilo. the planters are to receive three-fifths and the quinine-makers the rest. Any advance on 20 florins is to be divided equally between the two parties. The price of bark is to be 6 cents per half-kilo. for each unit per cent. of quinine sulphate. This is to be paid to the planters by the factory on delivery of the bark, and the rest, on the basis mentioned above, will be paid by the Bureau when the price of the quinine is settled. In future the calendar year is to be the normal working period, and the makers are pledged to take bark equal to 515,000 kilos. of quinine sulphate each calendar year (*i.e.* the manufacturers concerned in the new contract are to take as much bark as was originally allocated to the quinine manufacturers of Germany, the United Kingdom, Holland and Java by the old agreement). The first period is to be July 15, 1918, to December 31, 1919, and in this they have guaranteed to take bark equal to 751,000 kilos. of quinine sulphate. These quantities appear to be minima, and the actual takings are to be settled each year in Holland or Java as may be arranged. Pharmaceutical bark is outside the scope of the agreement so long as it is sold by public auction in Amsterdam or direct in Java. Sold otherwise, it is not to be disposed of below prices 50 to 85 per cent. higher than those that would be obtained for it if it were considered as factory bark.

It appears that the whole of the cinchona planters in

Java are not included in this agreement, and that sales to quinine makers who are not parties to the contract are therefore still possible.

TRADE IN CINCHONA BARK AND QUININE

As already pointed out, most of the exports of cinchona bark come from Java. A small quantity is, however, exported from Madras to the United Kingdom, the average annual amount during the years 1912–13 to 1916–17 being 622,665 lb. (see p. 373). The imports of bark into the United Kingdom from all British Possessions during the same period averaged only 544,342 lb., according to the Trade Returns of the United Kingdom (see p. 381).

As regards the imports of cinchona bark into India, no separate figures are available before the year 1915. In April, 1915, this item of imports was sub-divided into "quinine salts" and "cinchona bark," but before that period, quinine, its alkaloids, and cinchona bark were all grouped together.

The following table indicates the imports of quinine and alkaloids thereof (including cinchona bark) into India during the years 1912–13 to 1914–15:

		1912–13.	1913–14.	1914–15.
Total quantity	*lb.*	104,765	117,088	89,034
,, value	£	71,509	102,441	85,178
From		*lb.*	*lb.*	*lb.*
United Kingdom		73,823	75,936	63,356
Straits Settlements (including Labuan)		3,465	2,644	2,285
Other British Possessions		2	1	—
Total British Empire		77,290	78,581	65,641
Belgium		3,065	2,479	815
France		336	705	18
Java		2,902	2,718	6,137
United States (Atlantic Coast)		7,666	6,003	3,139
Holland		—	325	—
Germany		13,142	25,700	13,190
Austria-Hungary		50	488	92
Other foreign countries		314	89	2
Total foreign countries		27,475	38,507	23,393

After 1914–15, imports are divided into quinine salts and cinchona bark. The following table shows the imports in these two sub-divisions for the years 1915–16 and 1916–17:

Cinchona Bark

		1915–16.	1916–17.
Total quantity	*lb.*	1,543	729
,, value	£	201	97
From		*lb.*	*lb.*
United Kingdom		1,458	729
Foreign countries		85	—

Quinine Salts

		1915–16.	1916–17.
Total quantity	*lb.*	95,333	47,790
,, value	£	109,509	107,017
From		*lb.*	*lb.*
United Kingdom		61,458	32,733
Ceylon		30	13
Straits Settlements (including Labuan)		2,395	1,056
Total British Empire		63,883	33,802
Germany		1,052	—
Holland		671	—
France		85	—
Italy		17	31
Java		15,666	12,001
Japan		2,151	100
United States		11,800	1,856
Other foreign countries		8	—
Total, foreign countries		31,450	13,988

Examination of these tables shows that, before the war, Germany played a much less important part than the United Kingdom in the import trade of quinine sulphate into India. As there was no distinct line of demarcation between the various items under the heading "Quinine and its Alkaloids," etc., in the official returns before the year 1914–15, it is difficult to say what proportion of the total imports was cinchona bark. The ultimate source of the bark may, in all cases, be attributed to the Dutch East Indies.

It may be of interest to quote here the figures given by Messrs. C. M. and C. Woodhouse, relating to destinations of quinine salts exported from Germany during 1911, 1912 and 1913:

Destination.	1911. *lb.*	1912. *lb.*	1913. *lb.*
Great Britain	28,600	37,837	48,838
Italy	90,200	76,119	27,281
Austria-Hungary	16,062	18,037	16,500
Russia	81,181	82,063	96,138
Turkey	20,900	13,481	7,481
British India	12,100	13,862	22,437
United States	124,738	122,319	137,500
Elsewhere	80,738	84,263	96,144
Total	454,519	447,981	452,319

From this it appears that the United States, Russia and Great Britain were Germany's best customers for quinine salts before the war.

The following tables indicate the imports, exports and re-exports of cinchona bark and quinine salts into and from the United Kingdom:

Imports of Cinchona Bark into the United Kingdom

		1913.	1914.	1915.	1916.	1917.
Total quantity	*lb.*	2,925,664	3,734,752	2,286,592	3,039,792	3,800,608
,, value .	£	58,003	75,234	55,819	128,168	227,177
From:		*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Netherlands . .		1,110,592	258,832	81,312	1,372,336	2,318,624
Java		1,168,720	2,643,088	1,781,248	370,160	837,872
Peru		23,296	12,432	17,024	208,096	108,416
Other foreign countries		80,528	43,792	80,640	178,640	370,048
Total, foreign countries . .		2,383,136	2,958,144	1,960,224	2,129,232	3,634,960
Total, British Possessions .		542,528	776,608	326,368	910,560	165,648

Re-exports of Cinchona Bark from the United Kingdom

		1913.	1914.	1915.	1916.	1917.
Total quantity	*lb.*	2,085,552	1,701,056	808,640	1,001,280	1,754,928
,, value .	£	54,846	32,008	20,638	39,397	109,343
To:		*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
India		1,545,376	—	—	—	—
Other British Possessions		—	—	4,592	23,968	16,464
Total, British Possessions . .		1,545,376	—	4,592	23,968	16,464
France		242,144	113,792	232,960	365,344	1,369,424
United States . .		2,912	14,448	14,224	352,912	229,600
Netherlands . .		24,528	1,433,936	419,552	71,680	—
Germany . . .		203,280	113,120	—	—	—
Other foreign countries		67,312	25,760	137,312	187,376	139,440
Total, foreign countries		540,176	1,701,056	804,048	977,312	1,738,464

The large quantity of bark shipped to India in 1913 does not appear to have entered the country, as the total imports into India in that year, according to the Indian official trade returns, were much less than the above figure (see table on p. 379).

Imports of Quinine and Quinine Salts into the United Kingdom

		1913.	1914.	1915.	1916.	1917.
Total quantity	*lb.*	151,434	116,782	286,353	232,939	313,748
,, value	£	102,102	102,401	320,992	519,197	554,137
From:		*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
France		—	174	2,942	1,840	303
United States		6,875	4,800	53,761	1,632	—
Netherlands		63,123	67,986	204,245	222,605	257,160
Java		24,400	15,415	16,512	—	55,919
Germany		56,812	26,714	—	—	—
Other foreign countries		224	1,688	7,496	5,387	366
Total, foreign countries		151,434	116,777	284,956	231,464	313,748
Total, British Possessions		—	5	1,397	1,475	—

Exports of Quinine and Quinine Salts from the United Kingdom (Home Manufacture)

		1913.	1914.	1915.	1916.	1917.
Total quantity	*lb.*	85,896	92,356	150,811	103,689	46,032
,, value	£	72,642	91,415	221,218	225,763	118,516
To:		*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
India		43,501	46,631	37,424	30,011	10,606
Ceylon		5,642	7,292	7,638	7,291	7,844
Australia		3,672	3,968	2,255	2,918	745
Other British Possessions		12,567	12,189	17,531	13,873	9,119
Total, British Possessions		65,382	70,079	64,848	54,093	28,314
Russia		1,216	5,916	28,711	13,015	3,425
Portugal		209	943	5,450	242	286
Italy		295	216	35,900	20,260	181
Turkey		6,192	5,567	119	15	—
China		4,472	3,310	3,148	4,752	1,313
United States		333	187	2,218	1,652	273
Brazil		850	594	5,328	4,283	6,820
Other foreign countries		6,947	5,544	5,089	5,377	5,420
Total, foreign countries		20,514	22,277	85,963	49,596	17,718

Re-exports of Quinine and Quinine Salts from the United Kingdom (Foreign and Colonial Merchandise)

		1913.	1914.	1915.	1916.	1917.
Total quantity	*lb.*	19,100	5,179	43,816	13,738	87,772
,, value	£	11,768	4,676	85,807	48,816	162,855
To:		*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
India		13,509	1,458	851	73	179
Other British Possessions		1,704	1,562	1,542	1,306	3,999
Total, British Possessions		15,213	2,020	2,393	1,379	4,178
Italy		—	—	11,046	1,251	69,495
United States		—	—	20,980	8,043	63
Russia		—	770	6,500	2,573	—
Other foreign countries		3,887	1,389	2,897	492	13,986
Total, foreign countries		3,887	2,159	41,423	12,359	83,544

Cultivation of Cinchona in Other Countries

In addition to Java, India and Ceylon, cinchona trees have been introduced into many other parts of the tropics, including West and East Africa, St. Helena, West Indies, Fiji, Madagascar, Réunion, Mexico, Central America, Colombia and Bolivia, but in no case as yet has the cultivation in these regions added appreciably to the world's supply of the bark. It has been shown, however, that bark containing a satisfactory amount of alkaloid can be produced in some of these countries, and in the following pages an account is given of the results of examination of samples of bark from St. Helena, and the former German colony in East Africa received recently at the Imperial Institute.

St. Helena

Cinchona was introduced into St. Helena on the advice of Sir J. D. Hooker in 1868, when seeds of *Cinchona succirubra* and *C. officinalis* were sown. By the end of 1869 some 540 plants, mainly of these species but including a few specimens of *C. calisaya* and *C. pahudiana*, had been set out in the partially cleared forest near Newfoundland Cottage on the south face of Actaeon's Peak. The locality is at nearly the highest altitude in the island, the Peak rising to a height of 2,700 ft. The soil varies in depth at different points, and is a rich black peat or vegetable mould, resting on a bed of reddish, soft volcanic rock. The plants made good growth, in spite of a prolonged drought just after they had been planted, and the Superintendent of Cinchona Plantations, in 1869, expressed himself as satisfied with the prospects. From 1870, however, the plantation was neglected, and afterwards totally abandoned.

At the present time it is estimated there are from 500 to 800 trees in the plantation. Their average height is about 20 ft. and some of the largest have a bole measuring 27 in. in circumference. In spite of the fact that little, if any, attention has been paid to the trees, they are said to be in a healthy condition on the whole, although some have become covered with moss, etc. The trees reproduce readily from naturally sown seeds, and the flourishing and healthy condition of the existing trees encourages the hope that their growth and propagation might be advantageously increased by systematic cultivation. It is considered that the present plantation could be greatly extended with small expenditure.

The two samples of cinchona bark from St. Helena, described in the following report, were received at the Imperial Institute for examination in September 1917.

No. 1.—This sample consisted of quills and pieces of bark up to 6 in. in length and of varying thickness. The outer surface of the bark was dark brown, and the inner surface pale yellowish-brown.

No. 2.—This also consisted of quills and pieces of bark up to 6 in. in length and of varying thickness. The outer surface of the bark was dark reddish-brown, and the inner surface mahogany-red.

The leaves accompanying the samples, together with specimens of the barks, were submitted to Kew for identification, but it was reported that the leaves could not be matched with any of the specimens there; they did not appear to be fully developed and may have been cut from young plants. A comparison of the barks with samples of cinchona from St. Helena in the Kew Museum suggested that No. 1 may be *Cinchona officinalis* and No. 2 *Cinchona succirubra.*

The barks were examined at the Imperial Institute with the following results, compared with those obtained in the case of two small samples of the barks received from St. Helena in April 1917:

	Present Samples.				Previous Samples.			
	No. 1.		No. 2.		No. 1.		No. 2.	
	Bark as received.	Moisture free bark.	Bark as received.	Moisture free bark.	Bark as received.	Moisture free bark.	Bark as received.	Moisture free bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·4	—	8·6	—	9·0	—	7·8	—
Total alkaloid	8·3	9·2	8·5	9·3	9·8	10·8	8·7	9·4
Yield of crystallised quinine sulphate	8·2	9·1	4·6	5·1	8·8	9·7	3·8	4·1
Equivalent to quinine (anhydrous)	6·1	6·7	3·4	3·7	6·5	7·1	2·8	3·0

The results of the present examination are in general agreement with those recorded for the small samples previously examined. The present sample of bark No. 1 contained less total alkaloid than the earlier sample, but the percentage of quinine was nearly the same; bark No. 2 contained about the same amount of total alkaloid as the previous sample and rather more quinine. In both cases the amounts of alkaloid are above the average for *C. officinalis* and *C. succirubra*. The alkaloid of bark No. 1 is principally quinine, whereas a much smaller proportion of quinine is present in bark No. 2. These facts are in agreement with the suggestion that No. 1 may be *C. officinalis* and No. 2 *C. succirubra*.

The barks were submitted for valuation to brokers and quinine manufacturers, who furnished the following reports on their quality and value:

(1) The brokers described No. 1 as well-grown bark which would be suitable for manufacturing purposes, and valued it at 1*s.* 8½*d.* per lb. in London (February 1918). They considered that No. 2, in the condition of the sample, would be worth 11½*d.* per lb. to manufacturers, but stated that if carefully prepared it might be marketable as *Cinchona succirubra* for druggists' use, when it would realise a higher price.

(2) The manufacturers stated that, judging from appearance, No. 1 represented *C. officinalis* bark and No. 2 *C. succirubra* bark, which in view of their richness in quinine would be worth about 1*s.* 6*d.* per lb. and 10*d.* per lb. respectively in London at the present time for manufacturing purposes. The firm added, however, that under normal conditions the *C. succirubra* bark would be saleable to druggists at a higher price.

It may be mentioned that the pre-war values of these cinchona barks for manufacturing purposes would have been about half the prices now quoted.

These cinchona barks from St. Helena were of good quality and there is no doubt that consignments similar to the samples would find a ready market in London at the present time.

East Africa

Cinchona is grown on several European plantations in the former German Colony in East Africa and also at the Amani Institute. According to the Annual Report of the latter Institute for 1912–13, about 60 cwts. of bark were produced there in that year (*Der Pflanzer*, 1914, **10**, 44). The four samples of cinchona bark from East Africa, described in the following report, were received at the Imperial Institute for examination in February 1918, and were stated to represent the barks of *Cinchona robusta*, *C. succirubra*, *C. ledgeriana*, and a hybrid between *C. ledgeriana* and *C. succirubra*.

No. 1. "*Cinchona robusta* B.L.I. Amani."—This sample consisted of quilled chips, somewhat broken and varying from moderately large to very small and thin. The outer surface of the chips was brown, and covered with lichen in a few cases, while the inner surface was a light warm brown colour.

No. 2. "*Cinchona succirubra.*"—This consisted of quilled chips, rather broken, and of variable size, chiefly fairly thick. The chips were of light warm brown colour, rather darker on the outer surface, and showed occasional patches of lichen.

No. 3. "*Cinchona ledgeriana.*"—This consisted of quilled chips, of mixed size, some pieces being fairly thick and others thin and narrow. The outer surface of the chips was of a warm brown colour and mostly covered with lichen, while the inner surface had a light brown colour. The sample was somewhat broken.

No. 4. "*Hybrid C. ledgeriana* × *C. succirubra.*"—This sample consisted of thick, large quilled chips, of a warm brown colour on the outer surface, which was mostly covered with lichen, and light brown on the inner surface.

The value of cinchona barks of these types depends chiefly on the amounts of quinine sulphate obtainable from them, and this in turn depends on the process used by the quinine manufacturer. For this reason samples of the barks were submitted to a British firm of quinine manufacturers for examination and valuation. The results of the chemical examination of the four samples are shown in the following table:

	No. 1. *C. robusta.*	No. 2. *C. succirubra.*	No. 3. *C. ledgeriana.*	No. 4. *C. ledgeriana* × *C. succirubra.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	8·1	7·9	8·9	7·5
Total alkaloid .	7·61	8·32	5·00	11·30
Quinine . .	2·66	2·54	3·81	8·41
Cinchonidine. .	3·51	2·05	nil	nil
Yield of crystallised quinine sulphate.	3·55	3·39	5·08	11·21

No. 1. *Cinchona robusta.*—The bark of this species generally contains 5 to 6 per cent. of total alkaloid, including 2 per cent. of quinine. The present sample therefore contains a high percentage of both total alkaloid and quinine.

No. 2. *Cinchona succirubra.*—This sample represents a good quality of *C. succirubra* bark, which usually contains from 1½ to 3 per cent. of quinine and about the same amount of cinchonidine.

No. 3. *Cinchona ledgeriana.*—This contains a rather low percentage of alkaloid for the species it represents, as Ledger bark usually yields about 7 per cent. of total alkaloid, about 5 per cent. of quinine, and little or no cinchonidine. These figures are sometimes exceeded, the total alkaloid reaching 12 per cent. and the quinine 10 per cent.

No. 4. *Ledgeriana Hybrid.*—The Ledgeriana hybrids are similar in composition to Ledger bark, containing high percentages of quinine and little or no cinchonidine. The present sample of hybrid bark is of very good quality, yielding 11·30 per cent. of total alkaloid and 8·4 per cent. of quinine alkaloid. This bark is the most valuable of the four samples received.

It is recorded in *Der Pflanzer* (1906, **2**, 336) that two samples of bark taken in 1906 from four-year-old trees of hybrids *C. ledgeriana* × *C. succirubra* at Amani yielded 6·47 and 6·80 per cent. of quinine sulphate respectively. In the latter sample the total alkaloid was 6·77 per cent., of which 4·84 per cent. was quinine. The present sample of the hybrid bark is therefore considerably richer in total alkaloid and quinine than these two samples of young bark.

The firm of quinine manufacturers to whom the samples were submitted reported that for their purpose the present values of barks of the composition shown in the table of analyses and ex London warehouse would be as follows:

	Per lb.		Per lb.
No. 1 . . .	$8\frac{3}{4}d.$	No. 3 . . .	1s. $0\frac{3}{4}d.$
No. 2 . . .	$8\frac{1}{2}d.$	No. 4 . . .	2s. 3d.

For comparison with these prices it may be stated that the normal approximate values of these barks on the basis of the prices current immediately before the war would be:

	Per lb.		Per lb.
No. 1 . . .	$3\frac{1}{2}d.$	No. 3 . . .	5d.
No. 2 . . .	$3\frac{1}{4}d.$	No. 4 . . .	$11\frac{1}{4}d.$

The manufacturers stated that sample No. 4, the hybrid from *C. ledgeriana* × *C. succirubra*, is one of the highest quinine-yielding barks they have examined, being fully equal to the finest Ledger bark from Java.

The results of this investigation show that these samples of cinchona bark from East Africa are all of good quality, and that the hybrid bark (No. 4) is exceptionally rich in quinine. There would be no difficulty in disposing of consignments of similar barks to quinine manufacturers at the prices given in this report, which are much higher than those ruling before the war, and represent about $2\frac{1}{2}d.$ per lb. for every unit per cent. of quinine sulphate yielded by the bark. The pre-war price was about 1*d.* per lb. per unit per cent. of quinine sulphate.

Under normal market conditions the *Cinchona succirubra* bark might be saleable for pharmaceutical use at a higher price than that quoted above, but recently there has been very little market for pharmaceutical bark.

NOTES

Production and Uses of Rice.—The following notes are supplementary to the article bearing the above title which was published in this BULLETIN (1917, **15,** 198):

India.—In dealing with the production of rice in Burma, it was stated (*loc. cit.*, p. 205) that in the deltaic region, where the main rice crop is grown, " owing to the rapid hardening of the soil after the rains are over, the cultivation can only be by means of irrigation." This statement was based on the following passage in a paper, contributed to the Third International Congress of Tropical Agriculture 1914, by Mr. A. McKerral, Deputy Director of Agriculture in the Southern Circle, Burma (*Trans. of the Congress*, vol. ii., p. 95): " The surface soil is in all cases characterised by the extreme rapidity with which it loses water as soon as the rains are over, so that attempts at cultivation without irrigation can only end in failure."

It has been represented that this statement, in the condensed form in which it appears in the BULLETIN article, may be misleading, and Mr. McKerral has been consulted as to what exactly is implied. He states in reply, " that while no irrigation is required for the rice crop, which is grown during the rains, the rice soils lose water so rapidly as soon as the rains are over, and become so hard, that if cultivation is attempted at that time of year irrigation is necessary. As a matter of fact very little cultivation of second crops is attempted, but near Rangoon and some of the bigger towns, vegetables are grown by means of well irrigation."

Sierra Leone.—In connection with the late Mr. T. J. Alldridge's statement quoted on page 221 of the BULLETIN from a paper read before the Royal Colonial Institute in 1905, the Director of Agriculture, Sierra Leone, has pointed out that the rice areas in that country are limited to alluvial flats along the banks of certain rivers and to land that becomes swampy in the rains. He further states that a large amount of " hill " or " dry " rice is grown, but this involves a considerable loss of soil fertility, as a large area of bush land is cleared each year for its cultivation, whereas this destruction of forest and bush would be stopped to a certain extent if crops of a permanent character were grown instead. The Assistant Director of Agriculture, also, has pointed out that " hill " rice is not a remunerative crop, and that the native is satisfied if on hill land newly cleared of bush a yield per acre of 20 to 25 bushels (1 bushel = 45 lb.) of paddy is obtained —a yield which can in no way compare with that obtained in countries where irrigation is practised. He considers that by means of irrigation Sierra Leone could produce large quantities of rice, but that at present this method of cultivation is not practicable.

Japan.—In the official statistics published in the *Financial and Economic Annual of Japan*, the production of rice is recorded, without stating whether unhusked (paddy), husked or cleaned rice is meant. Up to 1916 the United States Department of Agriculture, which gives in its *Year Book* a figure for the weight of cleaned rice produced in Japan, appears to regard the estimate issued by the Japanese Government as referring to paddy. In the Department's *Year Book* for 1916, however, the estimate has been revised to accord with the view that the official figures relate to cleaned rice, and this view was adopted in the BULLETIN article (p. 231). The International Institute of Agriculture at Rome, on the other hand, in its *Annuaire International de Statistique agricole* published in 1915, gives an estimate of the weight of "ríz brut" produced in Japan, which seems to indicate that the International Institute regards the Japanese estimate as referring to neither paddy nor cleaned rice, but to something between the two, possibly "cargo rice."

In order to clear up the apparent confusion, the Imperial Institute consulted the Consul-General for Japan in London, who has kindly furnished the following information: The official estimates for rice production in Japan refer to "gemmai," that is, rice husked but not cleaned. The yield of gemmai from paddy is 78·8 per cent., and the yield of cleaned rice from gemmai varies from 90 to 95 per cent. according to the quality of the rice and the extent of cleaning. In the light of this statement, the figures for the production of rice in Japan given on pp. 231, 232 of the BULLETIN article are too high, and should be reduced by from 5 to 10 per cent., for, as already stated, it was assumed that the estimates referred to cleaned rice. The figures for the trade in rice in Japan will not be affected, as these are given in terms of weight in the Japanese statistics.

On the basis of the figures supplied by the Consul-General, the yield of cleaned rice from paddy in Japan is fully 70 per cent. This is rather higher than the Indian Government's estimate, *viz.*, 62½ per cent., and would seem to indicate either that Japanese paddy yields a higher percentage of cleaned rice than the Indian paddy, or that the Burma mills carry the cleaning process further than the Japanese.

The following figures relating to Japanese rice were also furnished by the Consul-General: 1 picul paddy = 0·588 koku; 1 picul gemmai = 0·421 koku; 1 picul cleaned rice = 0·411 koku. According to the *Financial and Economic Annual of Japan* 1 picul = 100 kin. = 132·277 lb., and 1 koku = 4·96005 bushels.

Economic Products of Colombia.—An account of a journey down the river Magdalena from Bogota northwards to the coast, and along the peninsula of Goajira, forms the subject of an illustrated brochure recently issued by authority of the Colombian Ministry of Agriculture and Commerce.

The journey referred to was undertaken during the latter part of the year 1916 by Mr. M. T. Dawe, F.L.S., Director of the Tropical Agricultural Station at San Lorenzo, Colombia, with a view to ascertaining the forest resources and agricultural possibilities of the country as a preliminary step to development. Owing to unfavourable climatic conditions, the expedition was not entirely successful, but sufficient information was obtained to indicate that there are many important products awaiting exploitation and certain districts available for agricultural development as soon as the country is provided with better means of communication and modern methods of transport.

Amongst forest products the palms are of considerable importance. In the neighbourhood of Puerto Berrio, the river terminus of the Medellin railway, the noli palm (*Elæis* sp.) occurs in abundance. Allied to the West African oil palm, this species produces an oil-yielding nut which is utilised locally as a source of oil, but which, at present, is not exported.

Lower down the river in the vicinity of Gamarra, the tagua or ivory-nut palm (*Phytelephas macrocarpa*, R. et P.) grows in wet and rather heavy clay lands over considerable areas. This palm is a stemless species with male and female flowers on different plants, the two sexes occurring in about equal numbers. The heads of fruit, each containing about 50 nuts, are produced near the ground level. To obtain the nuts, the fruit heads are beaten with a wooden mallet, and in good seasons a single collector may secure from 100 to 125 lb. of nuts in one day.

A species apparently identical with the cuesco palm of Tolima, but possessing larger fruits, occurs in great abundance in the neighbourhood of Gamarra, and also further north on the river Cesar in the Province of Valle Dupar. The nuts of this palm are available in large quantities, and with a view to ascertaining whether they yield an oil of commercial value, a sample was forwarded to the Imperial Institute for examination. The results of this work have already been published (this BULLETIN, 1917, **15**, 479).

On the Sierra Nevada in the vicinity of Circayuca at an altitude of 1,380 metres above sea level a species of Ceroxylon palm finds its lowest range. This species is allied to the wax palm (*Ceroxylon andicola*, H. et B.), and like that species has its trunk covered with a waxy coating, but it is of more slender habit and is considered distinct.

Amongst timber trees the more important are mahogany (*Swietenia Mahagoni*, Linn.), cedar (*Cedrela Glaziovii*, DC.), and guayacón, which occur in the forests clothing the banks of the river Carare, a tributary of the Magdalena. The mahogany and cedar have been extracted from the more accessible parts and exported via Barranquilla, and no attention appears to have been paid to maintaining a supply of these timbers by replanting. A valuable timber known locally as comino is employed for constructional work and as sleepers on the Medellin railway. The tree producing this timber (*Aneba perulitis*, Hemsl.) is said to occur in quantity in the higher and drier lands of the interior, and it is considered possible that a surplus supply of hard timber may be available for export.

The sandy lands near the coast on the peninsula of Goajira are the habitat of the divi-divi tree (*Cæsalpinia Coriaria*, Wild.), the pods of which are an important tanning material and constitute one of the principal exports of the country.

Forming extensive forests on the foot-hills of the Sierra Nevada occurs the tree known locally as brazilete (*Hæmatoxylon brasileto*, Krst.), which yields one of the dye woods known commercially as brazil-wood. These rich forests cannot at present be exploited owing to their inaccessibility, but others occur in the peninsula of Goajira, although they are not so extensive.

Several indigenous forest trees yield gums and resins of commercial value, the more important being the copaiba tree (*Copaifera officinalis*, L.) from which is obtained balsam of copaiba. This tree was noticed in the neighbourhood of Puerto Berrio and Puerto Wilches. To obtain the balsam V-shaped incisions, which penetrate to the heart-wood, are made in the trunk of the tree, and the balsam which accumulates in the plate-like cavity formed at the base of the incisions is removed by collectors. From three to four kerosene tins are frequently filled from a single tree, but it is stated that the tapping operation can only be performed once during the life of each tree, owing to the depth of the incision. A sample of this Colombian balsam has been examined at the Imperial Institute (this BULLETIN, 1918, **16,** 147).

A new resin, known locally as quika resin, was discovered in the peninsula of Goajira, occurring as a thin layer on the branches and exposed roots of *Cercidium spinosum*, Tulasne, a small tree. The commercial value of this resin is at present unknown, but samples have been received at the Imperial Institute for examination.

Another resin produced by a small tree (? *Bursera* sp.) was discovered at the extreme end of the peninsula. It is known to the Indians as aría. So far its commercial value has not been ascertained.

A kind of copal locally known as algarobilla, and probably derived from *Hymenæa splendida*, Tr., a large tree which also furnishes a timber of great durability, is obtained on the Carare. At present it is not collected to any extent as the local price is not sufficiently remunerative (see this BULLETIN, 1917, **15**, 494). It should perhaps be mentioned that the name algarobilla applied to this copal is also used for other South American products, including the pods of *Cæsalpinia brevifolia*, a tanning material sometimes imported into the United Kingdom.

Several fibres that promise to be of commercial value are derived from plants indigenous in this region. The most important is that obtained from the leaves of *Furcræa macrophylla*, Baker, a species that covers large areas in the neighbourhood of Rio Hacha, a township on the coast west of the Goajira peninsula. Samples of this fibre prepared in the United States have been reported on favourably, and it is considered probable that the exploitation of the large areas of Furcræa plants available in this locality may in the near future become an important industry. The fibre is known locally as "maguey," a name which is also applied to a kind of sisal hemp obtained in the Philippines from *Agave Cantala*.

A fibre known locally as pita or pita del Opón is obtained from the leaves of a plant at present not botanically identified, but belonging to the N.O. Bromeliaceæ. The plant grows in the shade of forests and forms extensive natural plantations. These have been exploited to a small extent for local markets, and the fibre has a reputation for great strength and durability. As the pita plant occurs in several localities on the rivers Opón, Carare and Cesar, and elsewhere in accessible places, the name pita de Colombia is proposed for it, and it is suggested that decorticating machines should be introduced to extract the fibre for export. An account of the results of examination of this fibre at the Imperial Institute is given on p. 289.

On the foot-hills of Sierra Nevada, in the neighbourhood of Santo Tomás, ginger grows wild in great abundance. The collection and preparation of the rhizomes of these wild plants is recommended, and planters are advised to devote attention to ginger as a plantation crop, as the fact that the plant occurs naturally in the locality, proves that the soil and climatic conditions are favourable to this somewhat fastidious crop.

Along the Carare in the Department of Santandas, cocoa, sugar and maize are cultivated; bananas are grown in the neighbourhood of Santa Marta, the plantations being served by the Santa Marta Railway; coffee is produced in the neighbourhood of Puebloviejo on the Sierra Nevada. The total production of coffee in this locality is said not to exceed 300 to 400 tons per annum, owing to the industry being in the hands of small owners, whose methods of cultivation and preparation leave much to be desired. Cotton is grown in the Goajira peninsula and a ready market for this fibre exists in Barranquilla, and also in Venezuela. The perennial type common to South America is the kind cultivated, but it is considered that the annual varieties would give better results, and the introduction of cotton seed from Egypt is recommended.

In order to develop the country, and to exploit the natural products already available, the provision of roads and communications is of the first importance, but owing to the paucity of the population the encouragement of colonisation by immigrants is considered to be equally important. In view of the results already achieved by the Japanese in South America, especially in Brazil, Mr. Dawe recommends securing Japanese settlers, particularly for the large and important Department of Magdalena in the region of the Sierra Nevada.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Foodstuffs and Fodders

Castor Bean Meal.—In the *Journ. Board Agric.* (1918, **24**, 1444) an account is given of trials carried out by the Veterinary Department of the Board in order to determine whether the residue of castor beans, after the removal of the oil, can be used satisfactorily for feeding pigs, and in particular to ascertain whether the toxic properties of the residue, which are due to ricin, can be removed by submitting the material to a high temperature. The heating process was carried out by the manufacturers, and the temperature employed is not recorded. The pigs refused to eat the meal when merely mixed with water or when mixed with treacle. When, however, the meal was given with house-wash of good quality, which had been boiled and mixed with other meals, a considerable amount was consumed with good results. In no case was any symptom of poisoning observed.

Chicory.—Attention has recently been given in South Africa to the cultivation of chicory, and an account of the progress made with this crop is given in the *South African Journal of Industries* (1918, **1**, 622). The industry is developing particularly in the neighbourhood of Port Elizabeth, where a number of farmers have become interested in it. The crop seems to offer good prospects of success, but development has been hampered by the difficulty of securing seed of the best varieties and by the lack of knowledge as to the best means of producing seed locally for future use. Good results have been obtained, however, and the soil in the neighbourhood of Port Elizabeth appears well suited to chicory. A fine quality of root is now being grown, and modern machinery has been installed which enables chicory of uniform and superior quality to be prepared. Experiments in chicory cultivation are also being undertaken in the Transvaal.

Oils and Oil Seeds

Castor Seed.—The question of the advisability of growing castor seed on a commercial scale in the West Indies is discussed in *Agric. News* (1918, **17**, 100). It is pointed out that the yield from this crop may be largely affected by environmental conditions and the incidence of insect pests. Thus, experiments in Antigua, carried out with four varieties over a period of years, showed wide fluctuations in the yields of seed in different years; in 1910–1911, for example, only 240 lb. of seed per acre were obtained, the young plants being badly attacked by aphis, whereas in 1911–1912 1,970 lb. per acre were obtained. Many morphologically different types of castor-oil plants exist in the West Indies, some of which possess undesirable characters; in some the seeds are not easily freed from the husks, and in others they are too easily freed, so that the seeds are shed on the ground, and so on. It would be necessary, therefore, to make careful selection experiments with the plants, whilst the effect of different spacings on the yield also needs investigation. Preliminary experiments in crossing a native type with *Ricinus Gibsoni* at the St. Vincent Experiment Station showed that it might be possible to produce improved races. It is considered that until exhaustive experiments on a large scale have been carried out, it must remain an open question whether castor seed can be cultivated successfully on a commercial scale in the West Indies.

Bulletin No. 5, 1918, *Section des Matières grasses, Institut Colonial de Marseille*, is devoted almost entirely to a consideration of castor seed. An article which appeared originally in the *Bulletin Econ. de l'Indo Chine* (1917, **20**, 206), dealing with the cultivation, harvesting and uses of the seed, is reprinted, and this is followed by sections on the methods of cultivation, varieties grown, etc., in the following French possessions: Algeria, Tunis, Morocco, Cochin-China, Cambodia, and Upper Senegal and Niger.

Coconuts.—After heavy and unseasonable rains in January and February 1917, some estates between Galagedara and Kurunegala in Ceylon suffered from the falling of large numbers of nearly mature coconuts from the trees. On one estate of 600 acres, over 100,000 immature fallen nuts were collected during March (*Trop. Agriculturist*, 1918, **49**, 336). The fallen nuts showed signs of attack by a fungus (*Phytophthora* sp.) at the stalk end; in some cases only the stalk was affected, in others a dark brown patch extended from the stalk over the fruit towards the point. This fungus also attacks the leaf bases, causing the leaves to hang down close to the trunk of the tree and die. The only successful method of combating nut-fall is to spray with Bordeaux mixture, which should also prevent leaf-fall. Experiments are being made to ascertain if the placing of pieces of copper sulphate in the crown of the tree will prevent leaf-fall. All fallen nuts and dead and fallen leaves should be burned, and dead trees should also be cut down and burned.

The caterpillars of *Brachartona catoxantha* have been found to attack coconut trees in Malaya, and have recently caused serious damage in the neighbourhood of Batu Gajah (*Malayan Tin and Rubber Journ.*, 1918, **7**, 364). The caterpillars feed on the epidermal tissues of the leaves, and the surfaces affected offer points of infection for fungoid diseases. Two natural enemies of the pest are known, one a fly which deposits its eggs in the body of the caterpillar just after the commencement of pupation; the other a fungoid disease of the pupa, but these natural enemies are not plentiful and the pest is making headway on the coconut trees in consequence. Trees may be killed in some cases, while the productivity of affected trees is fairly certain to be decreased. The matter is receiving the attention of the Department of Agriculture, but no definite method of treatment can yet be recommended.

Ground Nuts.—The cultivation of ground nuts is an important industry in the Valencia region of Spain, the production amounting to 19,588 tons in 1914 and 11,250 tons in 1915 (*Bulletin agricole du Congo Belge*, 1917, **8**, 291). Two varieties are grown, one known as "Cacahuete" or "Mani" bearing nuts containing two kernels, the other known as "Cacahua," "Mauro" or "Moruno," with nuts containing either three or four kernels. The former variety is seldom exported, but is used locally for the manufacture of oil; the latter, which is superior in quality, is exported largely to northern European countries and used for edible purposes. The plant is grown chiefly on sandy or sandy-ferruginous soils, as calcareous-sandy soils afford only poor crops. The soil, after lying fallow during the winter, is manured and deeply worked in March, after which it is cultivated with disc cultivators; a few days before sowing, the ground is superficially worked either with a plough or "polysoc" cultivator, and then rolled.

Artificial manures, composed chiefly of mixtures of superphosphate and sodium nitrate, are employed to a large extent; ammonium sulphate is occasionally applied, but potash manures are rarely used; the use of nitrogenous manures appears to be carried to excess at times.

In sowing, either kernels or whole nuts are used. In the latter case germination is assisted by lightly breaking the shells and then moistening the nuts by placing them in a sack and dipping them in water, after which the sack full of nuts is hung up in the open, but shaded from the sun. Sowing is carried on between the middle of April and the middle of May. The plants are spaced about 8 to 10 in. apart in rows about 16 in. apart. Rain is of rare occurrence during the growing season, and the fields are irrigated by means of canals which were constructed by the Moors during their occupation of Spain, and also from wells worked by pumps.

During the growth of the plants, the surface soil is kept stirred, weeds are removed and the plants are earthed-up. Harvesting takes place in October, the plants being pulled by hand and dried in the field. The nuts are removed by beating against a board, and then sifted to remove earth, stones, etc. They are finally dried by spreading them out in a layer about 6 or 8 in. deep in the sun, or in barns, and turning them occasionally. The dried nuts are stored in sacks. The yields of (whole) nuts obtained vary from about 1,300 lb. to 3,000 lb. with an average of about 2,200 lb. per acre.

After removal of the nuts, the plants (ground-nut hay) are fed to working oxen, cows and other farm animals. Ground nuts take a place in the regular rotation of crops, being grown after the land has lain fallow or after wheat or beans; they are also grown as an intercrop in plantations of young orange trees.

Oil-palm.—The results of examination of fruits of the different varieties of oil-palm found in the Belgian Congo, and of the oils derived from them, are given in detail in a recent number of the *Bulletin agricole du Congo Belge* (1917, **8**, 218). The varieties are evidently similar to those found in other parts of West Africa (cf. this BULLETIN, 1909, **7**, 357). It appears that some attempts have been made in the past by natives to cultivate the oil-palm in certain parts of the Belgian Congo, the trees being planted along the roads and near villages. The establishment of regular plantations is considered desirable, and it is recommended that an experimental plantation should be formed for the purpose of investigating the different varieties of oil-palm and other related problems.

A company with headquarters at Los Angeles is making preparations to work palm kernels (the species of palm is not stated) in Central America (*West Africa*, 1918, **2**, 75). It is stated that large nut-cracking machines of the centrifugal type, capable of dealing with 10 tons of nuts per hour, are to be utilised.

Miscellaneous. — Attention is called to the possibility of utilising avocado fruit as a source of oil which should be suitable for edible purposes (*Agric. News*, 1918, **17**, 102). According to analyses made in California, the edible portion of the fruit of different varieties contains from 9·8 to 29·1 per cent. of oil, the average for twenty-four varieties being 20·1 per cent. Although no commercial undertaking has so far attempted the production of oil from avocado fruit, it is estimated that 48 gallons of oil per acre of avocado trees could be obtained from a variety bearing fruit containing about 10 per cent. of oil. This yield is about equal to the average yield obtained from olives in California.

An edible oil is obtained from the fruit of the "Shinia" tree (*Pistacia lentiscus*), which grows wild throughout a large part of Cyprus (*Cyprus Agric. Journ.*, 1918, **13**, 28). Owing to the high cost of olive oil, the production of "Shinia" oil is said to have increased largely in 1917. The oil is prepared by primitive processes, and a yield of 18 per cent. is obtained.

The seeds of a variety of *Citrullus vulgaris*, known in the Belgian Congo as "Cocorico," contain 37·5 per cent. of non-drying oil (*Bulletin agricole du Congo Belge*, 1917, **8**, 320). The yield of seed per acre is small, and the removal of seed from the fruit is tedious, so that the seeds are not considered likely to become important commercially. It might be possible to stimulate cultivation of the seed in the neighbourhood of towns as the oil is considered suitable by Europeans for edible purposes.

According to Bolton and Revis (*Analyst*, 1918, **43**, 251), "Oiticica" or "Oilizika" kernels from Brazil, probably derived from *Couepia grandiflora*, yield 62 per cent. of semi-solid oil with strong drying properties.

Rubber

Hevea.—Para rubber trees grown in Fiji from seedlings planted 17 ft. by 17 ft. in 1906, had reached a girth of 21·5 in. three ft. from the ground in 1916, in which year 50 trees tapped on 251 days yielded 111 lb. of sheet and about 3 lb. of scrap rubber (*Fiji Dept. Agric. Rept.*, 1916, p. 3). Seedlings planted in 1908 and 1909 had reached a girth of 17 and 13 in. respectively in 1916, while imported stumps planted in 1908 were 14·5 in. in girth in 1916. Seedlings planted 28 by 28 ft. between cocoa in 1909 had attained a girth of 15 in. in 1916; this rapid growth is thought to be due partly to the application of manure to the cocoa plants. The good development of rubber trees on the whole is attributed to the abnormal rainfall and freedom from wind. Tapping experiments on eight different systems have been commenced and *Dolichos Hosei* is being tried as a cover-crop.

Much interest has been taken recently in the disease known as "Brown bast," the cause of which has not yet been definitely ascertained. In the course of a lecture and demonstration at the Chemor Rubber Estate near Ipoh, Mr. Pinching, mycologist to the Rubber Growers' Association, described the nature of this disease and the remedial measures employed (*Malayan Tin and Rubber Journal*, 1918, **7**, 367). The disease appears to commence generally at the bottom of the tapping cut, near the ground level, or at some small wound beneath the soil; on rare occasions it commences at tapping cuts higher up the tree. In an advanced stage of disease the trees fail to yield latex. It seems unlikely that the disease is due to physiological causes; it is more probably due to a definite organism attacking the cortical layer, as diseased trees can be saved by careful removal of the affected tissues. Many methods of treating diseased trees have been tried, but the only remedial measure which seems to have met with promise of success up to the present appears to be the removal of the diseased tissues by careful scraping or by actual stripping of the diseased bark, care being taken not to expose the wood or to injure the cambium; after this treatment the exposed area may advantageously be treated with a weak disinfectant. It is important that the disease should be recognised and dealt with as soon as possible, as badly diseased trees cannot be treated successfully and must be cut out. Every effort should be made to prevent the disease obtaining a hold on young trees. Evidence of the attack of the disease on young trees is afforded either by the failure of the tree to yield latex, or by a diminution in yield of latex, and tapping coolies should be trained to report such cases immediately.

In Cochin China the rubber plantations suffered to some extent during 1916, owing to drought in the early part of the year, and the yield of rubber obtained in that year, amounting to 545 tons, as compared with 363 tons in 1915, was not so large as had been expected (*India Rubber World*, 1918, **58**, 437). In some parts of the country the area under rubber was extended.

Fibres

Paper-making Materials.—In the *Indian Forester* (1918, **44**, 125) an account is given of a native paper-making industry in Gahrwal, United Provinces. The raw material of the industry consists of the inner bark of *Daphne cannabina*, Wall., a shrub which is known locally as "satpura." This plant grows in the Gahrwal District, at an elevation of over 4,000 feet, as an undergrowth in "banj" (*Quercus incana*) and "tilonj" (*Q. dilatata*) forests. For the manufacture of paper-pulp, the bark is peeled from the stem, dried in the sun, and placed in water, afterwards being well rubbed with the hand to separate the epidermis from the inner fibrous portion. The latter is boiled with a mixture of water and ashes until it becomes soft, and is then removed and washed with water. The product is pounded with wooden mallets and then made into balls. A ball of pulp is put into a cloth sieve with a wooden frame, generally $2\frac{1}{2}$ ft. by $1\frac{1}{2}$ ft.; this is placed on water and the ball is stirred by hand to make the pulp spread evenly over the sieve. The frame is then raised, and, after the water has drained away, it is placed in the sun. After one or two days, the paper is dry and is then removed. The paper thus obtained is of a pale grey colour. It is of rather loose texture, but is regarded as more durable than mill-made paper, and is therefore used for the official vernacular records. If the primitive method of manufacture could be improved by the use of simple mechanical labour-saving appliances, it might prove a useful and profitable cottage industry in Gahrwal. By the present method, a man can make, on the average, only two sheets of paper a day, which are sold at six pies ($\frac{1}{2}d.$) each.

It is stated in the *Indian Trade Journal* (1918, **48**, 311) that application has been made to the Government of India for certain concessions with a view to the organisation of a bamboo paper-pulp industry in the forests of the Kanara district of Bombay. It is proposed that a syndicate should conduct experiments on the possibilities of the manufacture of bamboo pulp on a commercial basis. There are good prospects of establishing a profitable industry in the Kanara forests, but a good deal of preliminary experimental investigation is needed for the production of a satisfactory scheme of working. As such enquiries will cost a considerable amount, and the results will be of value in connection with the manufacture of bamboo pulp in other parts of India, the Government have decided to grant certain facilities and encouragement to the enterprise. The Kanara district will accordingly be reserved for the syndicate's experimental operations for a period of two years, and during a period of seven years from the date of the formation of a public company no supplies of bamboos will be available from the Government forests in Kanara for the purpose of making bamboo pulp to any one except the proposed concessionaires.

Sisal Hemp.—It is stated in *Colonial Reports—Annual No.* 959, *Cayman Islands* (*Jamaica*), *Report for* 1916–17 [Cd. 8973–8] that strenuous efforts are being made to encourage the establishment of a Sisal hemp industry in these islands. The soil is of limestone formation and well adapted to the crop. The Government obtained a pre-emption on all bulbils and suckers of the henequen variety growing in Grand Cayman, and distributed them to the growers at cost price. About 100,000 bulbils and 10,000 suckers were distributed. Other means which have been adopted to stimulate the industry include the circulation of pamphlets, giving an account of the methods of cultivating the plants, harvesting the leaves, and extracting the fibre, and the establishment of a Government nursery of 50,000 bulbils. The industry is regarded as of great importance, as being the only one capable of re-establishing the prosperity of the islands, which has been seriously affected by repeated hurricanes, which have destroyed most of the bread-fruit and other fruit trees. As bread-fruit was the mainstay of the poorer classes owing to the high prices of other food-stuffs, a serious position has been created. It is hoped that the occurrence of hurricanes will not discourage the Sisal hemp industry, as the plants which have been growing for some years in Grand Cayman have not sustained any appreciable damage from the storms.

Cotton

French Colonies. — An interesting account of the present position and prospects of cotton-growing in the French Colonies has been given in a paper by M. Paul Bourdarie, of the Association Cotonnière Coloniale, which is published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (1918, **129**, 97). In 1913 the quantity of cotton produced in the French Colonies under the auspices of the Association was 715,501 kilos., but in 1914 colonial enterprise was either suspended or hindered owing to the outbreak of war, and the production fell to about 130,000 kilos. In 1915, the position still remained difficult, and 150,319 kilos. of cotton were produced, but in 1916 a decided improvement took place, resulting in an output of 654,005 kilos., and the production for 1917 is estimated at over 900,000 kilos.

French North Africa.—Cotton was at one time produced in Algeria in considerable quantities, and in 1866 the crop amounted to 850,000 kilos., this large output being due to the exceptional circumstances created by the American War of Secession. When conditions became normal again, the industry was abandoned owing chiefly to lack of an abundant labour supply and of a sufficiency of water for irrigation. Since the establishment of the Association Cotonnière Coloniale, renewed attention has been devoted to Algeria and excellent results have been obtained. The cotton produced in this country approximates in quality to that of Egypt, but the extension of the industry depends on the creation of facilities for irrigation, and it is anticipated that after the war the Government will give special attention to this matter. The quantities of cotton produced in Algeria during recent years were as follows: 1913, 120,000 kilos; 1914, 45,000 kilos.; 1915, 15,000 kilos.; 1916, 60,000 kilos.

Cotton-growing trials have been carried out in Tunis, but although many regions appear to be suited to the industry, the crop has not yet been produced on a commercial scale.

The prospects of cotton cultivation in Morocco are regarded as very hopeful as the country possesses fertile and well-watered plains, and is inhabited by a people favourably inclined to agricultural pursuits.

French West Africa.—It has been proved that no important progress can be made in Senegal without irrigation. In the French Sudan successful trials have been carried out at Segu, Sansanding, and other places (compare this BULLETIN, 1904, **2**, 127). Other cotton fields exist on the Upper Niger and in the region of the Niger lakes, but their development will have to await the advent of railway facilities. In Dahomey, an important cotton area has been developed by an agent of the Association Cotonnière Coloniale and cotton of a special quality is being produced. The Ivory Coast has now taken the first place among the cotton countries of French West Africa, and the crop of 1917 reached 500,000 kilos.

The production of cotton in French West Africa during 1913–1916 was as follows:

	1913. kilos.	1914. kilos.	1915. kilos.	1916. kilos.
Senegal and the French Sudan	106,474	12,584	35,319	36,608
Dahomey	175,450	—	—	200,000
Ivory Coast	39,737	73,000	100,000	357,397
Total	321,661	85,584	135,319	594,005

French Equatorial Africa.—Although there are large areas suitable for cotton cultivation in the French possessions in Equatorial Africa, the crop has been produced hitherto only in small quantities, and during the years 1913–1916 the output ceased. The countries of the interior cannot be developed until railways have been constructed.

Oceania.—The French possessions in Oceania—New Caledonia, New Hebrides, Tahiti—promise to become important cotton-producing countries, but little news has been received from them during the war. The output increased steadily from 1908, when it amounted to 5,000 kilos., until 1913, when 273,850 kilos. were produced.

Indo-China.—This country is outside the sphere of operations of the Association Cotonnière Coloniale, but is of considerable importance as a cotton-growing region, the production in Cambodia in 1913 amounting to no less than 5,586,000 kilos. The quality of the cotton is said to be superior to that of the Indian staple, and the whole crop is purchased by the Japanese at good prices.

NOTICES OF RECENT LITERATURE

A Historical Geography of the British Dominions. Vol. V. Canada—Part II. Historical. 2nd Edition. By Hugh E. Egerton, M.A. Pp. viii + 365, Crown 8vo. (Oxford: Clarendon Press, 1917.) Price 5*s.*; post free, United Kingdom and abroad, 5*s.* 4*d.*

The new edition of this work is practically a reprint of the first edition, which has already been noticed in this BULLETIN (1908, **6**, 455). A few corrections have been made, and the bibliography has been enlarged to include the names of books which have appeared since the original issue of the volume.

THE SEASONING OF WOOD: A treatise on the natural and artificial processes employed in the preparation of lumber for manufacture, with detailed explanations of its uses, characteristics and properties. By Joseph B. Wagner. Pp. xiii + 274, Med. 8vo. (New York: D. van Nostrand Company, 1917.) Price 16*s.* net; post free, United Kingdom 16*s.* 9*d.*, abroad 16*s.* 10*d.*

In a previous notice in this BULLETIN (1917, **15**, 592), reference was made to the increased attention paid during the last few years to the artificial seasoning of timber, and to the important position which this process is likely to occupy in relation to the timber-consuming industries in the future, especially in the reconstruction period after the war. Considerable experience of artificial seasoning has already been gained both in America and in Europe, but up to the present comparatively few books dealing with the subject have been published.

In the present work no attempt has been made to produce a complete technical guide to the various processes employed in seasoning timber, but to furnish an account of the principles upon which these processes (natural and artificial) are based. With this object the book has been divided into some fourteen "sections" or chapters, which fall naturally into three parts. The first five chapters comprise an account of the properties and characteristics of the timbers of coniferous and broad-leaved trees, and include descriptive lists of the more important timbers of the United States. In addition there is a section dealing with the "enemies of wood," in which, however, insect pests alone are considered, no account being given of the damage caused to timber by fungi.

Succeeding chapters are concerned with an account of the theory underlying the seasoning of wood, in which the benefits resulting from seasoning and the difficulties encountered in drying green timber are also discussed. In the third part the methods employed in seasoning are dealt with and the principal systems of kiln-drying, as practised in America, are described. This section is well illustrated, as is also the succeeding chapter dealing with "dry kiln specialities," in which an account is given of leading types of kiln cars and the methods of loading them, automatic lumber stackers, trucks and other appliances employed in the process. The concluding chapter describes the principal instruments used in regulating the drying process in the kilns, and includes a large folder in which is given a "humidity diagram" devised by the United States Forestry Service to enable the operator to determine quickly and directly the humidity conditions and vapour pressure, as well as the changes which occur with variations of temperature. The book concludes with a short bibliography, glossary and a reference list of botanical names of the timber trees referred to in the text. The general index is full, but contains several entries which should have been omitted.

Flax: its Cultivation and Preparation for Market. By H. R. Carter. Pp. viii + 84, Demy 8vo. (London: John Bale, Sons & Danielsson, Ltd., 1918.) Price 3*s*. 6*d*. net; post free, United Kingdom and abroad, 3*s*. 8*d*.

The critical position in which the British flax manufacturing industry has been placed by the restriction of supplies from the Continent owing to the war has emphasised the importance of extending the cultivation and preparation of the fibre in the United Kingdom. It is pointed out in the introduction to Mr. Carter's book that only about 10 per cent. of the flax used in the spinning mills of this country is home-grown, that the cultivation might easily be extended, and that the growing, retting and scutching of the fibre are very profitable when properly conducted. The work has been written in the hope that it may afford assistance and encouragement to farmers in the cultivation and preparation of this valuable product.

An account is given of the methods of cultivation, harvesting, retting and scutching practised in Ireland and in Continental countries. The chapter devoted to scutching provides a good description of the machinery employed and is well illustrated.

In an appendix, various matters relating to flax production are discussed, including schemes for ensuring a larger supply of Irish flax, the different methods of retting in tanks, improvements in scutching, and the efforts which are being made to develop flax-growing in England.

The Dispensatory of the United States of America. 20th Edition. Thoroughly revised, largely rewritten, and based upon the Ninth Revision of the United States Pharmacopœia and the British Pharmacopœia 1914. By Joseph P. Remington, Ph.M., F.C.S., Horatio C. Wood, Jr., M.D., Samuel P. Sadtler, Ph.D., LL.D., Charles H. LaWall, Ph.M., Henry Kraemer, Ph.G., Ph.D., and John F. Anderson, M.D. Pp. cxxii + 2010, Super Roy. 8vo. (Philadelphia and London: J. B. Lippincott Company.) Price 50*s.* net; post free, United Kingdom, 50*s.* 10*d.*

Recent advances in pharmaceutical and medical science have necessitated an extensive revision of this well-known work on materia medica. The general features of the 19th edition have been retained, but the greater part of the subject-matter has been entirely rewritten. The article on the various serums has been considerably extended and a valuable article has been added on the subject of vaccines. On the whole, the work has been well brought up-to-date and its continued usefulness is assured.

Colour in Relation to Chemical Constitution. By E. R. Watson, M.A. (Cantab.), D.Sc. (Lond.). Pp. xii + 197, with 4 coloured plates and 65 figures of absorption curves, spectra, etc., Demy 8vo. (London: Longmans, Green & Co., 1918.) Price 12*s.* 6*d.* net; post free, United Kingdom and abroad, 13*s.*

The subject of the relation between the colour and chemical constitution of substances is not only of great scientific interest, but also has an important practical bearing on the production of dyes. The various theories which have been proposed with regard to these relationships have already been of service as a guide to chemists in the preparation of dyes of desired shades. In this work, the author has given an account of the gradual development of our present knowledge of the subject and of the principal researches on which this knowledge is based. The value of the book is enhanced by the inclusion of numerous diagrams and illustrations and a useful bibliography.

The Zinc Industry. By Ernest A. Smith. Pp. viii + 223, Demy 8vo. (London: Longmans, Green & Co., 1918.) Price 10*s.* 6*d.* net; post free, United Kingdom and abroad, 11*s.*

In the small compass of some 200 pages, the author has succeeded in giving a concise but comprehensive view of the present condition of the zinc industry, and has also found space to touch upon the history of zinc production with particular reference to the part played therein by

British metallurgists. The monograph describes the chief minerals forming ores of zinc, and indicates the British and foreign occurrences of such ores. The author points out that while British enterprise has been prominent in the discovery, mining and concentration of zinc ores, the control of the smelting facilities has been allowed to pass largely into hands other than British, with the result that the British consumer depends upon foreign producers for the larger portion of his requirements of the metal.

The metallurgy of zinc production, including the latest developments in roasting the ores, smelting in horizontal retorts, and in vertical retorts as in the Roitzheim-Remy furnace, the electric furnace method of smelting and the electrolytic deposition of zinc from solutions obtained by the acid leaching of roasted ores are briefly but clearly described. Other sections of the monograph deal with the industrial applications of zinc, including the modern methods of "galvanising" iron, the production and uses of the more important alloys of zinc and the manufacture of the pigments, zinc oxide and lithopone, and also the production and chief applications of zinc chloride and zinc sulphate.

In discussing the future of the zinc industry the author refers to the critical situation that arose in this country at the commencement of the war, owing to enemy control of spelter production, and emphasises the importance of avoiding a recurrence of this situation. He recognises the steps taken by the Home and Colonial Governments to that end, but considers them inadequate, and recommends the establishment by the Government of zinc-smelting on a scale commensurate with our needs. Not every one will be found to agree with the author as to the necessity of this. Nevertheless it must be admitted that if the Empire is to be self-supporting as regards spelter production, special steps must be taken to meet the competition, not only of the experienced and well-equipped Belgian and German spelter-producing companies, but also that of the American spelter industry, which during the war has passed far beyond the stage of merely meeting home requirements.

Detailed information regarding the zinc ore deposits of the world, and especially those of the British Empire, was already available in the monograph on Zinc Ores published by the Imperial Institute in 1917. With the addition of Mr. Smith's book, dealing, as it does, more especially with the smelting and metallurgy of zinc, English readers are now provided with complete information as to the various aspects of the zinc industry.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

INVESTIGATIONS OF THE QUALITY OF PLANTATION RUBBER CONDUCTED UNDER THE CEYLON RUBBER RESEARCH SCHEME.—II

In a previous number of this Bulletin (1916, **14**, 495), an account was given of the results of mechanical and vulcanisation tests and of the chemical examination of a large number of samples of rubber prepared in connection with the scheme of rubber research arranged by the Government of Ceylon in conjunction with some of the principal planting companies in the island and with the Imperial Institute. The principal object of the work is to ascertain the methods of preparing plantation rubber which lead to the production of rubber of the quality required by the rubber manufacturer. The work in Ceylon is carried out under the auspices of two Committees: a General Committee, composed of representatives of the Government and of the planting and mercantile companies concerned, and a Technical Committee, of which the Director of Agriculture is Chairman. A Committee has also been appointed in London to consider the results of the investigations and tests conducted at the Imperial Institute. This Committee includes representatives of the planting companies and of manufacturers of rubber in this country.

The previous article dealt with the results of investigations designed to ascertain the effect on the mechanical properties of the vulcanised rubber of (1) different methods of coagulation; (2) the addition of various substances to the latex in order to retard coagulation; (3) the form of the rubber; (4) the method of drying; (5) "over-working" freshly coagulated rubber in the washing machine; (6) various methods of smoking; (7) drying sheet-rubber under tension; (8) rolling up wet and dry sheet rubber, with and without tension; (9) the conversion of wet and dry crêpe rubber into block; and (10) separating the rubber from the latex in successive portions. Since that account was published, further reports on the investigations made at the Imperial Institute have been furnished to Ceylon, dealing with the effect on the mechanical properties of the vulcanised rubber of (1) different methods of coagulation; (2) diluting the latex before coagulation; (3) conversion of worm rubber into wet block, and rolling up wet and dry sheet rubber, with and without tension; (4) adding sodium bisulphite to the latex for the production of pale rubber; (5) machining the freshly coagulated rubber; (6) machining the dry rubber; (7) preparing the rubber in a moist condition; and (8) adding papain to the latex before coagulation with a view to the removal of part of the protein. The results of these investigations are now published. The notes given below on the methods employed for the preparation of the samples, dealt with in the various sections, are compiled from information supplied by Mr. L. E. Campbell, B.Sc., F.I.C., Rubber Research Chemist in Ceylon, under whose superintendence the samples were prepared. The vulcanisation and mechanical tests at the Imperial Institute were carried out by Mr. R. G. Pelly, F.I.C., Mr. W. S. Davey and Mr. F. L. Elliott, and the chemical examination of the samples has also been conducted at the Imperial Institute chiefly by Mr. F. H. Lane, B.Sc., and Mr. S. J. Rogers, B.Sc., A.I.C. For details as to the methods used in preparing the control samples, and in testing the various rubbers, reference should be made to the previous article (*loc. cit.* p. 498).

(1) Experiments to determine the Effect of Different Methods of Coagulation on the Mechanical Properties of the Rubber

The previous report included the results of examination of samples of rubber which had been prepared in Ceylon with the object of determining the effect of different methods of coagulation on the mechanical properties of the vulcanised rubber. In the case of the rubbers coagulated with acids, the specimens in Series II (prepared from latex from trees 16 to 20 years old) had a much lower tensile strength than the corresponding specimens of Series I (prepared from latex from trees 7 years old), and, as the results in this Section of Series II appeared to be abnormal, it was decided that the experiments should be repeated for further comparison. The present section of this report deals with the specimens thus prepared (Nos. 224 to 248 inclusive).

Two sets of samples were prepared in exactly the same way as the previous set from latex derived from the 16 to 20 year old trees used for Series II. Each set included specimens coagulated spontaneously and with varying amounts of acetic, formic, sulphuric and hydrofluoric acids. Samples coagulated with lactic acid were also included in one of the present sets.

Excluding two specimens of scrap rubber (Nos. 225 and 236), all the samples consisted of plain sheet rubber. The sheets were of good appearance, with the exception of the samples obtained by spontaneous coagulation (Nos. 226 and 237), which were somewhat spotted by mould growths and pitted by bubbles. The specimens coagulated with sulphuric acid were of paler colour than those prepared by means of other coagulants.

The following details were supplied as to the methods of preparation adopted :

Series II

Date of experiment : October 23, 1914.
Rainfall : 0·44 in.
Percentage of dry rubber in latex : 34.

Section I, Sub-section 1. Spontaneous Coagulation

No. 224.—Rubber coagulated in pails and buckets. "Not enough for tests; less than 1 lb. dry rubber."

No. 225.—Scrap from trees.

No. 226.—Spontaneously coagulated rubber. Latex brought into factory at 1 p.m. and rolled out at 7 a.m. on the following morning.

Sub-section 2. Acid Coagulation

Experiments were made with acetic, formic, sulphuric and hydrofluoric acids; the quantity of acid used and the time the rubber took to dry are shown in the following table:

No. of sample.	Acid.	Quantity of acid used.	Time of drying of rubber.
		Grams per 100 cc. of latex.	*Weeks.*
227	Acetic	0·13	4
228	,,	0·26	4
229	Formic	0·07	4
230	,,	0·14	4
231	Sulphuric	0·10	5
232	,,	0·20	5
233	Hydrofluoric (Purub)	0·04	4
234	,, ,,	0·08	not stated
235	Control sample (Acetic acid)	0·20	4

A duplicate set of samples prepared in exactly the same way as the above from latex from the same trees was sent for comparison, and the following details were supplied regarding these specimens:

Date of experiment: October 26, 1914.

Rainfall: 0·12 in.

Percentage of rubber in latex: 36.

Section I, Sub-section 1. Spontaneous Coagulation (Duplicate)

No number. Rubber coagulated in cups and buckets. "Not enough for tests."

No. 236.—Scrap from trees.

No. 237.—Spontaneously coagulated rubber: prepared as No. 226.

Sub-section 2. Acid Coagulation (Duplicate)

In addition to the acids used in the first set, specimens were prepared with lactic acid.

No. of sample.	Acid.	Quantity of acid used.	Time of drying of rubber.
		Grams per 100 *cc. of latex.*	*Weeks.*
238	Acetic	0·13	4
239	,,	0·26	4
240	Formic	0·07	4
241	,,	0·14	4
242	Sulphuric	0·10	4
243	,,	0·20	4
244	Hydrofluoric (Purub)	0·04	4
245	,, ,,	0·08	5
246	Lactic	not stated	4
247	,,	,,	4
248	Control sample (Acetic acid)	0·20	4

The quantities of the various acids (excepting the lactic acid) used in the experiments were the same as those employed in the original experiments (*loc. cit.*, p. 502). In all cases the minimum quantities of acid took all night to coagulate the latex, whilst twice the minimum amounts produced an appreciable effect within half an hour and from that time coagulation proceeded rapidly.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table I. The results of the chemical examination of the samples are given in Table II.

Remarks on Series II, Section 1

Time of Vulcanisation.—The results of the vulcanising tests of these two sets of specimens are in general agreement with those already recorded (this BULLETIN, 1916, **14,** 505) for the original samples of Series I and II.

The time of vulcanisation of the specimens coagulated with acids varied from 65 to 115 minutes, and, as in the previous cases, the samples prepared with twice the minimum amounts of sulphuric and hydrofluoric acids required the longest times. The quickest-curing rubbers

TABLE I

Results of Vulcanisation and Mechanical Tests

Series II. Section I

	Form of rubber.	First Set of Experiments. Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.	Second Set of Experiments. Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
			Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*		*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Sub-section 1. Spontaneous Coagulation											
Rubber coagulated in pails and buckets. Not enough for tests	—	224	No sample sent				—	No sample sent			
Scrap from trees	Scrap	225	85	1,350	830	5·00	236	85	1,520	813	4·44
Spontaneously coagulated rubber	Sheet	226	60	2,460	894	2·40	237	55 [1]	2,490	863	2·18
Sub-section 2. Acid Coagulation											
Acetic acid, minimum amount	Sheet	227	70	2,480	889	2·33	238	70	2,520	872	2·22
,, ,, twice the minimum amount	,,	228	70	2,450	894	2·10	239	70 [1]	2,420	853	2·40
Formic acid, minimum amount	,,	229	65	2,470	896	2·11	240	70	2,510	877	2·14
,, ,, twice the minimum amount	,,	230	90	2,490	872	2·28	241	82	2,450	887	2·40
Sulphuric acid, minimum amount	,,	231	80	2,250	894	2·60	242	82	2,350	888	2·30
,, ,, twice the minimum amount	,,	232	115	2,590	876	2·32	243	115	2,400	884	2·30
Hydrofluoric acid (Purub) minimum amount	,,	233	90	2,430	885	2·44	244	85 [2]	2,180	853	2·52
,, ,, ,, twice the minimum amount	,,	234	110 [1]	2,300	866	2·80	245	105	2,510	882	2·40
Lactic acid, minimum amount	,,	—	—	—	—	—	246	65 [3]	2,420	912	2·04
,, ,, twice the minimum amount	,,	—	—	—	—	—	247	80	2,440	871	2·12
Control sample	,,	235	73	2,310	896	2·35	248	70	2,300	879	2·26

[1] *Slightly overcured.* [2] *Slightly overcured; gave rather low tensile results in all the preliminary vulcanisation trials.* [3] *Slightly undercured.*

TABLE II

Results of Chemical Analyses

Series I. Section I

	Form of rubber.	First Set of Experiments. Serial No.	Loss on washing.	Composition of dry, washed rubber. Caoutchouc.	Resin.	Protein.	Ash.	Second Set of Experiments. Serial No.	Loss on washing.	Composition of dry, washed rubber. Caoutchouc.	Resin.	Protein.	Ash.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sub-section 1. Spontaneous Coagulation													
Rubber coagulated in pails and buckets. Not enough for tests .	—	224		No sample sent				—		No sample sent			
Scrap from trees. . . .	Scrap	225	7·27	91·56	3·86	3·03	1·55	236	11·32	92·73	2·95	2·77	1·55
Spontaneously coagulated rubber .	Sheet	226	0·66	96·20	2·28	1·20	0·32	237	1·17	94·39	2·59	2·55	0·47
Sub-section 2. Acid Coagulation													
Acetic acid, minimum amount .	Sheet	227	0·93	95·03	2·60	2·16	0·21	238	0·65	95·09	2·68	1·99	0·24
,, ,, twice the minimum amount . .	,,	228	0·90	94·96	2·67	2·16	0·21	239	0·54	95·11	2·64	2·02	0·23
Formic acid, minimum amount .	,,	229	0·97	95·24	2·65	1·85	0·26	240	0·66	94·99	2·67	2·04	0·30
,, ,, twice the minimum amount . .	,,	230	0·77	94·99	2·69	2·13	0·19	241	0·42	94·98	2·70	2·11	0·21
Sulphuric acid, minimum amount.	,,	231	0·89	95·10	2·55	2·03	0·32	242	0·44	95·07	2·42	2·18	0·33
,, ,, twice the minimum amount . .	,,	232	0·93	95·14	2·55	2·02	0·29	243	0·35	94·97	2·61	2·13	0·29
Hydrofluoric acid (Purub), minimum amount	,,	233	0·69	94·80	2·90	2·05	0·25	244	0·49	95·05	2·55	2·10	0·30
,, ,, ,, twice the minimum amount	,,	234	0·63	94·53	3·13	2·04	0·30	245	0·44	94·63	3·03	2·08	0·26
Lactic acid, minimum amount .	,,	—	—	—	—	—	—	246	0·61	95·08	2·52	2·08	0·32
,, twice the minimum amount . .	,,	—	—	—	—	—	—	247	0·51	94·94	2·69	2·16	0·21
Control sample	,,	235	0·66	94·80	2·83	2·09	0·28	248	0·46	95·38	2·29	2·07	0·26

were those prepared with acetic acid and the minimum amounts of formic and lactic acids. Doubling the amount of acid used for coagulation had no effect on the time of vulcanisation when acetic acid was employed, but with all the other acids—formic, sulphuric, hydrofluoric and lactic—the time of cure was distinctly lengthened. The original samples of Series I and II gave similar results, with the exception that the formic acid specimens behaved irregularly in the two series.

The two samples of spontaneously coagulated rubber, Nos. 226 and 237, agree with the previous samples in that they cure more rapidly than the rubber coagulated with acids.

Mechanical Tests.—The tensile strength of the rubbers coagulated with acids was quite satisfactory in both the present sets of specimens. The figures were uniformly high, there being only two out of twenty samples which gave a value below 2,300 lb. It is clear that the low results obtained in the case of the original samples of Series II were abnormal and due to some cause which cannot be explained.

The use of different acids for coagulating the latex had no very marked influence on the tensile strength of the rubber. The specimens prepared with acetic, formic and lactic acids all gave high figures, and the doubling of the amount of acid had little effect on the tensile strength. The rubbers coagulated with sulphuric acid showed more variation in tensile strength (from 2,250 lb. to 2,590 lb., the latter being the highest result obtained), and in the first set of specimens the rubber coagulated with the larger amount of sulphuric acid gave a distinctly higher figure than the sample prepared with the minimum amount. The specimens prepared with hydrofluoric acid gave much better results than the original samples of Series I and II, though there was a considerable variation in tensile strength (from 2,180 lb. to 2,510 lb.). In this case the effect of doubling the amount of acid was irregular.

The two samples of spontaneously coagulated rubber gave good results in the tensile tests, but the figures for the two scrap rubbers were as usual very low.

Chemical Composition.—It will be seen from the figures in Table II that the samples of rubber prepared with different acids show little variation in composition, the extreme difference being as follows :

Caoutchouc	94·53 to 95·38 per cent.
Resin	2·29 to 3·13 ,, ,,
Protein	1·85 to 2·18 ,, ,,
Ash	0·19 to 0·33 ,, ,,

Conclusions.—The results now recorded indicate that the original specimens of Series II, Section 1, which gave much lower results in the tensile tests than the corresponding samples of Series I, were for some reason abnormal. This conclusion is supported by the fact that no marked difference in tensile strength has been found to occur in the later groups of Series I and II prepared respectively from 7-year-old and 16- to 20-year-old trees.

Acetic acid is again shown to be the most suitable acid for coagulation, as the use of twice the minimum amount has no adverse effect on the rubber, whereas a similar excess of formic, lactic, sulphuric or hydrofluoric acid distinctly lengthens the time of cure. On the other hand, the mechanical properties of the rubber are not greatly affected by the particular acid used for coagulation. In this connection it should be mentioned that the specimens prepared with hydrofluoric acid are not inferior in tensile strength to the other samples, as in the case of the original specimens of Series I and II.

It is of interest that the two samples of spontaneously coagulated rubber agree with those previously examined in having a quicker rate of cure than the specimens prepared with acids, and in being quite equal to the latter in tensile strength. Further specimens obtained by spontaneous coagulation are now under investigation, and a more detailed report on rubber prepared by this method will be made at a later date.

(2) Experiments to determine the Effect of diluting the Latex before Coagulation

The object of these experiments was to determine the effect of diluting the latex to varying degrees before coagulation. The specimens of rubber examined, which numbered twenty-six, belong to the Intermediate Series I (P. 1 to P. 8), and to Sections I, II and III of Series III.

INTERMEDIATE SERIES I

Dilution of Latex.—Rubber prepared in sheet. The experiments were made with latex from the 7-year-old trees used for Series I.

Separate portions of the latex, which contained 33 per cent. of dry rubber, were diluted with gradually increasing quantities of water. The same amount of acetic acid was used for coagulation in each case, *viz.* 0·206 gram of pure acetic acid per 100 cc. of undiluted latex. The acid after dilution was stirred into the latex, except in Nos. P. 7 and P. 8, where the diluted acid was simply poured into the latex. The following table gives particulars of the specimens :

Serial No.	Volume of latex taken.	Volume of water added.	Volume of diluted acid added.	Final dilution. Volume to which 1 volume of latex was diluted.	Time required for coagulation.	Time of drying of rubber.
	Litres.	*Litres.*	*Litres.*			*Weeks.*
P. 1 .	. 2	nil	0·25	1·125	Immediate	3
P. 2 .	. 2	nil	1·0	1·5	1 to 2 minutes	3
P. 3 .	. 2	0·5	0·5	1·5	,, ,,	3
P. 4 .	. 2	1·0	1·0	2·0	Thickened in 2 minutes; hardened gradually	3
P. 5 .	. 2	3·0	1·0	3·0	Appreciably slower than P.4	3
P. 6 .	. 2	9·0	1·0	6·0	About 30 mins.	Not stated
P. 7[1].	. 1	4·5	0·5	6·0	,, ,,	,,
P. 8 .	. 2	11·0	1·0	7·0	45 minutes	,,

[1] *Two samples prepared.*

All these specimens consisted of sheet rubber prepared in the usual manner (see this BULLETIN, 1916, **14,** 498).

The results of the vulcanisation and mechanical tests with the samples of rubber included in this series are shown in Table III, and the results of their chemical examination in Table IV.

TABLE III

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Dilution of Latex (Intermediate Series)

	Form of Rubber.	Serial No.	Time of cure.	Tensile strength.	Elongation at breaking point.	Permanent set.
Volume.			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
1 volume of latex was diluted to: 1·125	Sheet	P. 1	60	2,670	855	2·06
1·5	,,	P. 2	62	2,370	876	2·28
1·5	,,	P. 3	62	2,440	854	2·28
2·0	,,	P. 4	62	2,650	894	2·33
3·0	,,	P. 5	65	2,400	902	2·76
6·0	,,	P. 6	62	2,470	882	2·06
6·0	,,	P. 7	62	2,520	869	2·06
7·0	,,	P. 8	65[1]	2,230	883	2·80

[1] *Slightly undercured.*

TABLE IV

RESULTS OF CHEMICAL ANALYSES

Dilution of Latex (Intermediate Series)

	Form of rubber.	Serial No.	Loss on washing.	Composition of dry washed rubber.			
				Caoutchouc.	Resin.	Protein.	Ash.
Volume.			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1 volume of latex was diluted to: 1·125	Sheet	P. 1	0·50	94·29	2·92	2·50	0·29
1·5	,,	P. 2	0·35	94·51	2·84	2·41	0·24
1·5	,,	P. 3	0·50	94·61	2·80	2·35	0·24
2·0	,,	P. 4	0·35	94·72	2·70	2·35	0·23
3·0	,,	P. 5	0·40	94·92	2·51	2·32	0·25
6·0	,,	P. 6	0·20	94·76	2·78	2·28	0·18
6·0	,,	P. 7	0·40	94·85	2·76	2·19	0·20
7·0	,,	P. 8	0·30	94·85	2·67	2·33	0·15

Remarks on Intermediate Series

In this set of samples (P. 1 to P. 8) there does not appear to be any definite connection between the degree of dilution of the latex and the time of cure or the quality of the rubber as judged by the results of the vulcanisation tests. The variations in the time of cure, tensile strength, elongation and permanent set are comparatively small and show no regular relation to the increasing dilution of the latex.

The time of cure varied from 60 to 65 minutes, which is a little below the average of the control sheet specimens previously examined, *viz.* 66·6 minutes for trees 7 years old and 71·0 minutes for trees from 16 to 20 years old (*loc. cit.*, p. 561); P. 1, which was made from the least diluted latex, had the shortest time of cure, but the differences in the series are only slight. All the vulcanised samples, with the exception of P. 8, which was slightly under-cured, gave good tensile strengths ranging from 2,370 to 2,670 lb. per sq. in.; P. 1 and P. 4 (dilution 1·125 and 2·0 respectively) gave the highest figures and were practically equal in respect of tensile strength.

With regard to the chemical composition of these samples, the increased dilution of the latex appears to have caused a fairly steady decrease in the amounts of ash, protein and resin present in the rubber, with a corresponding increase in the percentage of caoutchouc. This result is probably due to the larger bulk of liquid retaining more of the non-caoutchouc constituents in solution.

Series III

Experiments conducted with latex from the trees 16 to 20 years old used for Series II.

Section I. Dilution of Latex.—Rubber prepared in sheet.

Date of experiment: June 4, 1914.

Rainfall: 0·79 in.

Percentage of dry rubber in latex: 26.

This Section includes a range of dilutions up to 1 volume of latex with 8 volumes of water. The standard method of coagulation employed in the course of these investigations was to dilute 2 litres of normal latex (containing from 30 to 34 per cent. of dry rubber), with 1 litre of water, and the proper amount of acetic acid, diluted to 1 litre, was then added, the final mixture of latex, water and acid containing 15 to 17 per cent. of dry rubber; the amount of acetic acid used was 0·2 gram per 100 cc. of normal latex, or 1 part of pure acetic acid to 1,000 parts of the diluted latex. In the present case coagulation was not carried out by the standard method, but was brought about by adding 40 cc. of 10 per cent. acetic acid to 3 litres of latex containing 26 per cent. of dry rubber. Particulars of the specimens are given in the following table :

Serial No.	Volume of latex taken.	Volume of water added.	Volume of acetic acid (10 per cent.) added.	Final dilution. Volume to which 1 volume of latex was diluted.	Time of drying of rubber.
	Litres.	*Litres.*	*Litres.*		*Weeks.*
186 . .	3	nil	0·04	1·013	5
187 . .	3	0·04	0·04	1·027	5
188 . .	(no sample)	—	—	—	—
189 . .	3	0·375	0·04	1·138	3
190 . .	3	1·5	0·04	1·513	3
191 . .	3	3·0	0·04	2·013	3
192 . .	3	6·0	0·04	3·013	3
193 . .	3	15·0	0·04	6·013	5
194 . .	3	24·0	0·04	9·013	8

All the samples were made into sheet in the usual manner.

With reference to the time required for coagulation in these specimens, Mr. Campbell supplied the following note :

" The apparent difference in the rates of coagulation would appear to depend not so much on an actual difference in the rates at which the emulsoid phase of the latex is destroyed as on the rates at which the minute particles of rubber become coherent one with the other. To take an example, in the cases of Nos. 186, 187 and 188 the latex commenced to 'thicken' in about 15 minutes, and a solid coherent coagulum was formed in 40 minutes. In the cases of Nos. 193 and 194, on the other hand, two or three hours elapsed before a solid coherent coagulum was formed similar to that produced in 40 minutes in the cases of Nos. 186, 187 and 188. This proved to be not due principally to a slower rate of destruction of the emulsoid state, for after 15 minutes the latex had changed entirely in character, the solid particles of rubber had formed, but in the form of very small flakes which took a very considerable time to cohere. Microscopic examination showed that Brownian movement of the globules had ceased. The apparent difference in rates of coagulation must depend on the rates at which the particles of rubber cohere together to form a coagulum."

Section II. Dilution of Latex.—Rubber prepared in sheet.

Date of experiment : June 7, 1914.

Rainfall : 0·06 in.

Percentage of dry rubber in latex : 34.

The samples were prepared as follows :

	Volume of latex taken.	Volume of diluted acid added.	Final dilution. Volume to which 1 volume of latex was diluted.	Time of drying of rubber.
	Litres.	*Litres.*		*Weeks.*
No. 195 . .	2·0	0·1	1·05	4
No. 196 [1] . .	2·0	2·0	2·0	3
No. 197 . .	2·0	4·0	3·0	4
No. 198 . .	2·0	12·0	7·0	8

[1] *Control sample.*

All the samples were made into sheet in the usual manner.

Section III. Dilution of Latex.—Rubber made into crêpe.

Date of experiment : June 16, 1914.

Rainfall : 0·47 in.

Percentage of dry rubber in latex : 32.

The samples were prepared as follows :

	Volume of latex taken.	Volume of diluted acid added.	Final dilution. Volume to which 1 volume of latex was diluted.	Time of drying of rubber.
	Litres.	*Litres.*		*Days.*
No. 199 . .	4·0	0·2	1·05	10
No. 200 . .	4·0	4·0	2·0	10
No. 201 . .	4·0	8·0	3·0	10
No. 202 . .	4·0	24·0	7·0	10

All the samples in this Section were crêped in exactly the same way : seven times through rough rollers and once through smooth rollers.

The specimens were vulcanised and submitted to mechanical tests with the results shown in Table V. The chemical composition of the samples is given in Table VI.

TABLE V

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series III. Sections I–III

		Form of rubber.	Serial No.	Time of cure.	Tensile strength.	Elongation at breaking point.	Permanent set.
Section I. Dilution of Latex.	*Volumes.*			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
1 volume of latex was diluted to	1·013	Sheet.	186	70	2,660	865	2·00
	1·027	,,	187	70	2,510	869	1·98
	—	,,	188		No sample.		
	1·138	,,	189	80	2,530	847	1·92
	1·513	,,	190	70	2,560	872	2·13
	2·013	,,	191	80	2,370	881	2·11
	3·013	,,	192	78	2,300	862	2·55
	6·013	,,	193	80	2,490	856	2·30
	9·013	,,	194	80	2,380	862	2·24
Section II. Dilution of Latex.							
1 volume of latex was diluted to	1·05	Sheet.	195	70	2,470	866	2·26
	2·0	,,	196 [1]	80	2,560	871	2·12
	3·0	,,	197	80	2,360	889	2·27
	7·0	,,	198	70	2,560	863	1·98
Section III. Dilution of Latex.							
1 volume of latex was diluted to	1·05	Crêpe.	199	100	2,550	872	1·71
	2·0	,,	200	110 [2]	2,450	837	2·06
	3·0	,,	201	110	2,220	881	2·89
	7·0	,,	202	110	2,290	875	2·06
Control . .		Sheet.	224	80	2,320	867	2·54

[1] *Control sample.* [2] *Slightly overcured.*

Remarks on Series III, Sections I–III

In Section I the time of cure varied from 70 to 80 minutes; three of the samples prepared from the least diluted latex, Nos. 186, 187 and 190, all cured in 70 minutes, but No. 189 took 80 minutes, like the samples Nos. 191 to 194 prepared from more diluted latex. The tensile strength was good throughout the Section, the figures ranging from 2,300 to 2,660 lb. per sq. in. Three of the samples prepared from the more diluted latex, Nos. 191, 192 and 194, were a little inferior in mechanical properties to Nos. 186 to 190. No definite conclusion can be drawn, however, on this point, as No. 193 (final dilution 6·0) gave very good results and

TABLE VI

RESULTS OF CHEMICAL ANALYSES

Series III. Sections I–III

		Form of rubber.	Serial No.	Loss on washing.	Composition of dry, washed rubber.			
					Caoutchouc.	Resin.	Protein.	Ash.
Section I. Dilution of Latex.	*Volumes.*			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1 volume of latex was diluted to	1·013	Sheet.	186	0·60	95·60	2·06	2·08	0·26
	1·027	,,	187	0·55	95·73	2·13	1·85	0·29
	—	,,	188	—	No sample			
	1·138	,,	189	0·60	95·62	2·05	2·10	0·23
	1·513	,,	190	0·60	95·87	1·99	1·96	0·18
	2·013	,,	191	0·30	95·45	2·24	2·07	0·24
	3·013	,,	192	0·40	95·64	2·33	1·85	0·18
	6·013	,,	193	0·50	95·61	2·12	2·06	0·21
	9·013	,,	194	0·30	95·52	2·28	2·01	0·19
Section II. Dilution of Latex.								
1 volume of latex was diluted to	1·05	Sheet.	195	0·60	95·66	2·01	2·07	0·26
	2·0	,,	196	0·40	96·18	1·71	1·92	0·19
	3·0	,,	197	0·40	96·41	1·57	1·86	0·16
	7·0	,,	198	0·40	95·81	2·30	1·77	0·12
Section III. Dilution of Latex.								
1 volume of latex was diluted to	1·05	Crêpe.	199	0·60	94·48	2·79	2·42	0·31
	2·0	,,	200	0·35	94·88	2·57	2·34	0·21
	3·0	,,	201	0·35	94·91	2·56	2·31	0·22
	7·0	,,	202	Sample too small for analysis.				
Control . .		Sheet.	224	0·50	94·83	2·23	2·70	0·24

was approximately equal to No. 187, which was made from practically undiluted latex.

There does not appear to be any connection in the samples of Section I between the composition of the rubber and the degree of dilution such as was evident in the Intermediate Series, P. 1 to P. 8 (p. 420).

The four samples of Section II cured in 70 to 80 minutes, the specimens from both the lowest and the highest dilution curing in the same time (*viz.* 70 minutes), whilst the intermediate specimens required 80 minutes. All four samples had good tensile strengths, the values ranging from 2,360 to 2,560 lb. per sq. in. No. 197 (dilution 3·0) had a somewhat lower tensile strength than the three other samples. Sample No. 196 (dilution

2·0) which served as the control sample for the Section, and No. 198 (dilution 7·0) gave almost identical figures in the mechanical tests.

In Section II there is a steady decrease in the amounts of ash, resin and protein present in the rubber, with increase of dilution of the latex, except that in No. 198 the percentage of resin shows an unaccountable increase.

The samples in Section III were in the form of crêpe and therefore required a longer time of cure than the control sheet. The time of cure of the crêpe samples varied from 100 to 110 minutes, compared with 80 minutes for the control sheet; the sample of lowest dilution cured in the shortest time (100 minutes), and the other three samples (dilutions 2·0, 3·0 and 7·0 respectively) all required 110 minutes. The two samples of lowest dilution gave much better tensile results than the two of higher dilutions, and were in fact better in this respect than the control sample No. 224.

In composition, the samples Nos. 199–201 show a slight decrease in ash, resin and protein with increasing dilution of the latex; but unfortunately the amount of No. 202, the highest dilution, was not sufficient for both analysis and mechanical tests.

General Conclusions

The results of these experiments to determine the effect of dilution of the latex on the vulcanising and mechanical properties of the rubber are somewhat inconclusive.

The effect of dilution on the rate of cure is not very marked. The samples prepared from undiluted or slightly diluted latex have in each case given good results in the mechanical tests, whereas those prepared from much diluted latex are in some cases distinctly lower.

The results are too irregular to allow of the conclusion that excessive dilution of the latex has a deleterious influence on the qualities of the rubber, although this appeared to be so in some cases. In other instances, however, this was not the case, whilst the diminution effected by dilution in the quantities of mineral constituents, protein and resin, may be of importance. It is desirable that further experiments should be made with a view to clearing up these discrepancies.

(3) Experiments to determine the Effect of converting Worm Rubber into Wet Block and of rolling up Wet and Dry Sheet Rubber, with and without Tension

This report deals with twenty-one specimens of rubber, included in Sections IV, V and VI of Series III. In these Sections, wood creosote or formalin was added to the latex as a preservative and specimens of rubber, (1) dried in the usual way, *i.e.* without artificial aid in a special drying chamber at a temperature of 85° to 90° F., and (2) in the form of wet block or roll, were then prepared for comparison. Specimens of rubber prepared in this way were included in Sections XIV and XVI of Series I and II, and were dealt with in this Bulletin (1916, **14**, 543, 552).

Series III

Experiments conducted with latex from the trees 16 to 20 years old used for Series II.

Section IV. Wet Block Rubber

Date of experiment: May 23, 1914.

Rainfall: nil at 6 a.m.; rain occurred during tapping.

Percentage of dry rubber in latex: 28.

No. 203.—Control sample. Time of drying: 4 weeks.

No. 204-5.—Alkaline solution of wood creosote was added to the latex until the latter contained 0·125 per cent. by volume of creosote. The latex was then coagulated with acetic acid in the standard way (see p. 420); the rubber was pressed into sheet in a Golledge hand-roller and cut into "worm." A portion of the worm rubber was dried and the remainder was converted into wet block.

No. 204.—Creosoted "worm" rubber dried on bamboo mesh in the rubber room of the factory. Time of drying, 24 hours ; mean temperature, 83° F.

No. 205.—Creosoted "worm" rubber pressed into block while still wet.

Section Va. Wet Rolled Sheet

Date of experiment : June 10, 1914.

Rainfall : 0·98 in.

Percentage of dry rubber in latex : 35.

No. 206.—Control sample. Time of drying : 4 weeks.

No. 207-8.—Alkaline solution of wood creosote was added to the latex so that the latter contained 0·125 per cent. of creosote. The rubber was made into sheet by the standard method : *i.e.* by putting the coagulum through smooth equal speed rollers five times, the distances between the rollers being 0·22 in., 0·16 in., 0·11 in., 0·05 in., and 0·04 in. respectively. Part of the sheet was dried in the usual way, and the remainder was rolled up under tension while still wet.

No. 207.—Sheet dried in the usual way. Time of drying : 3 weeks.

No. 208.—Sheet rolled up while wet under tension sufficient to stretch it to 1¼ times its original length.

Sections Vb and Vc. Effect of Different Amounts of Moisture in Wet Rolled Sheet ; Wood Creosote as Preservative

Section Vb

Date of experiment : June 28, 1914.

Rainfall : 0·15 in.

Percentage of dry rubber in latex : 34.

No. 209.—Control sample. Time of drying : 4 weeks.

No. 210.—Alkaline solution of wood creosote was added to the latex, so that the latter contained 0·125 per cent. of creosote. The rubber was prepared in sheet by the standard method and rolled up wet on the day after preparation.

No. 211.—Prepared as No. 210, but the sheet rubber was rolled up three days after preparation.

No. 212.—Prepared as No. 210, but the sheet rubber was rolled up when dry. Time of drying: 3 weeks.

No. 213.—Prepared as No. 210, but the sheet rubber was dried and not rolled up.

Section Vc

Date of experiment: June 25, 1914.

Rainfall: 3·04 in.

Percentage of dry rubber in latex: 35.

No. 214.—Control sample. Time of drying: 4 weeks.

No. 215.—Creosoted sheet rubber rolled up wet one day after preparation.

No. 216.—Creosoted sheet rubber rolled up wet three days after preparation.

No. 217.—Creosoted sheet rubber rolled up wet seven days after preparation.

No. 218.—Creosoted sheet rubber rolled up when dry. Time of drying: 4 weeks.

In the preparation of these creosoted rubbers (Sections IV and V), the following points were noted by Mr. Campbell:

> (1) That the presence of the creosote emulsion in the latex tends to hasten the formation of a coherent coagulum.
>
> (2) That the rubber which contains creosote dries more rapidly than rubber which does not contain it. In the case of sheet this difference is not readily observable, for the reason that sheets do not dry evenly; a comparison is thus difficult. With crêpe the difference is much more easily noticeable.
>
> (3) That the wet sheet should not be rolled up immediately after passing through the rolling machine, but should be hung up for some hours so that the superficial water can drain off. By this procedure it is possible to avoid the offensive smell and sliminess of rolls made from rubber which has just been passed through the rolling machine and not allowed to dry on the surface. It is sufficient to allow the sheets to drain for 12 hours.

Section VI. Effect of Different Amounts of Moisture in Wet Rolled Sheet: Formalin as Preservative

Date of experiment: July 1, 1914.
Rainfall: 0·44 in.
Percentage of dry rubber in latex: 28.

Formalin was added to the latex corresponding to 0·5 per cent. of pure formaldehyde.

No. 219.—Control sample. Time of drying: 4 weeks.
No. 220.—Sheet rolled up wet 1 day after preparation.
No. 221.—Sheet rolled up wet 3 days after preparation.
No. 222.—Sheet rolled up when dry. Time of drying: 3 weeks.
No. 223.—Sheet not rolled up.

The results of vulcanisation and mechanical tests of the samples included in Series III, Sections IV-VI, are given in Table VII, and their chemical composition is shown in Table VIII.

TABLE VII

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series III. Sections IV–VI

	Form of rubber.	Serial No.	Time of cure.	Tensile strength.	Elongation.	Permanent set.
Section IV. Wet block rubber.			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Control (without creosote).	Sheet.	203	95	2,480	859	2·32
Creosote added to latex, rubber made into worm and dried at 83° F.	Creosoted worm, dry.	204	85	1,800	868	4·40
Ditto, but worm rubber blocked while wet.	Creosoted wet worm block.	205	60	2,490	886	2·26
Section Va. Wet rolled sheet.						
Control (without creosote).	Sheet.	206	70	2,500	858	2·41
Creosote added to latex, rubber made into sheet and dried in the usual way.	Creosoted sheet, dry.	207	95	2,300	876	2·52
Ditto, but sheet rolled up wet under tension sufficient to stretch it to 1¼ times its original length.	Creosoted roll, wet.	208	55	2,550	887	2·20

TABLE VII—*continued*

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series III. Sections IV–VI

	Form of rubber.	Serial No.	Time of cure.	Tensile strength.	Elongation.	Permanent set.
Section Vb. Wet rolled sheet.			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Control (without creosote).	Sheet.	209	85	2,490	894	2·67
Creosote added to latex, rubber made into sheet and rolled up wet after 1 day.	Creosoted roll, wet.	210	55	2,430	881	2·76
Ditto, but sheet rolled up wet after 3 days.	Do.	211	60	2,470	880	2·28
Ditto, but sheet rolled up when dry.	Creosoted roll, dry.	212	90	2,440	869	2·70
Ditto, but sheet dried and not rolled up.	Creosoted sheet, dry.	213	95	2,430	860	2·61
Section Vc. Wet rolled sheet.						
Control (without creosote).	Sheet.	214	75	2,540	879	2·62
Creosote added to latex, rubber made into sheet and rolled up wet after 1 day.	Creosoted roll, wet.	215	52	2,570	896	2·76
Ditto, but sheet rolled up wet after 3 days.	Do.	216	55	2,370	883	2·50
Ditto, but sheet rolled up wet after 7 days.	Do.	217	62	2,400	870	2·08
Ditto, but sheet rolled up when dry.	Creosoted roll, dry.	218	85	2,440	880	2·50
Section VI. Wet rolled sheet.						
Control (without formalin)	Sheet.	219	80	2,380	874	1·90
Formalin added to latex, rubber made into sheet and rolled up wet after 1 day.	Roll, wet.	220	72	2,470	892	1·96
Ditto, but sheet rolled up wet after 3 days.	Do.	221	75	2,450	878	1·68
Ditto, but sheet rolled up when dry.	Roll, dry	222	95	2,310	889	2·36
Ditto, but sheet dried and not rolled up.	Sheet. dry.	223	105	2,390	895	2·50

TABLE VIII

Results of Chemical Analyses

Series III. Sections IV–VI

	Form of rubber.	Serial No.	Loss on washing.	Composition of dry washed rubber.			
				Caoutchouc.	Resin.	Protein.	Ash.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Section IV. Wet block rubber.							
Control (without creosote).	Sheet.	203	0·36	95·66	2·10	2·03	0·21
Creosote added to latex, rubber made into worm and dried at 83° F.	Creosoted worm, dry.	204	0·54	94·70	2·58	2·41	0·31
Ditto, but worm rubber blocked while wet.	Creosoted wet worm block.	205	6·83	95·05	2·61	2·14	0·20
Section Va. Wet rolled sheet.							
Control (without creosote).	Sheet.	206	—	95·33	2·33	2·11	0·23
Creosote added to latex, rubber made into sheet and dried in the usual way.	Creosoted sheet, dry.	207	0·36	95·52	2·23	2·05	0·20
Ditto, but sheet rolled up wet under tension sufficient to stretch it to 1¼ times its original length.	Creosoted roll, wet.	208	4·26	94·54	3·30	1·96	0·20
Section Vb. Wet rolled sheet.							
Control (without creosote).	Sheet.	209	0·45	95·26	2·17	2·37	0·20
Creosote added to latex, rubber made into sheet and rolled up wet after 1 day.	Creosoted roll, wet.	210	4·45	94·46	3·20	2·08	0·26
Ditto, but sheet rolled up wet after 3 days.	Do.	211	2·05	94·67	3·00	2·07	0·26
Ditto, but sheet rolled up when dry.	Creosoted roll, dry.	212	0·61	94·53	3·02	2·21	0·24
Ditto, but sheet dried and not rolled up.	Creosoted sheet, dry.	213	0·38	95·69	1·80	2·21	0·30

TABLE VIII—*continued*

RESULTS OF CHEMICAL ANALYSES

Series III. Sections IV–VI

	Form of rubber.	Serial No.	Loss on washing.	Composition of dry washed rubber.			
				Caoutchouc.	Resin.	Protein.	Ash.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Section Vc. Wet rolled sheet.							
Control (without creosote).	Sheet.	214	0·34	95·39	2·15	2·21	0·25
Creosote added to latex, rubber made into sheet and rolled up wet after 1 day.	Creosoted roll, wet.	215	11·10	94·27	3·55	1·97	0·21
Ditto, but sheet rolled up wet after 3 days.	Do.	216	3·25	94·61	3·29	1·88	0·22
Ditto, but sheet rolled up wet after 7 days.	Do.	217	1·40	94·75	3·03	1·98	0·24
Ditto, but sheet rolled up when dry.	Creosoted roll, dry.	218	0·53	94·88	2·86	2·00	0·26
Section VI. Wet rolled sheet.							
Control (without formalin).	Sheet.	219	0·39	95·89	1·91	1·96	0·24
Formalin added to latex, rubber made into sheet and rolled up wet after 1 day.	Roll, wet.	220	5·06	94·73	3·08	1·96	0·23
Ditto, but sheet rolled up wet after 3 days.	Do.	221	2·79	94·81	2·97	2·00	0·22
Ditto, but sheet rolled up when dry.	Roll, dry.	222	0·50	94·66	2·85	2·24	0·25
Ditto, but sheet dried and not rolled up.	Sheet, dry.	223	0·19	95·71	1·95	2·12	0·22

Remarks on Series III, Sections IV-VI

Time of Vulcanisation.—As in the case of previous specimens of a similar nature (*cf.* Series I and II, Sections XIV and XVI, *loc. cit.* pp. 547, 554), the wet rubbers included in this report all cured more rapidly than the dry specimens from the same latex; but the differences in the times of vulcanisation were smaller in Series III than in Series I and II. The results obtained in the three Series are compared in the following table :

Time of Cure in Minutes

	Series III.					Series I. Average results.		Series II. Average results.	
	Section IV.	Va.	Vb.	Vc.	VI.[1]	XIV.	XVI.	XIV.	XVI.
Creosoted wet rubber .	60	55	55 60	52 62	72 75	38	67[2]	45	65[2]
Creosoted dry rubber .	85	95	90 95	85	95 105	—	—	—	—
Plain (control) sheet, dry	95	70	85	75	80	65	95[3]	70	105[3]

[1] *Formalin used instead of creosote.* [2] *Wet block made from crêpe.*
[3] *Dry crêpe rubber.*

It will be seen from these figures that none of the wet specimens in Sections IV to VI of Series III had a time of cure less than 52 minutes, whereas similar specimens of wet roll (creosoted) rubber examined previously (*loc. cit.*, p. 547) required only 38 minutes' cure in certain cases (Nos. 83, 84, 85). It is, however, quite clear that the wet rubbers have a much shorter time of cure than the dry specimens. The results also indicate that the rubber containing the largest amount of moisture cures in the shortest time, *e.g.* in Section V*c* the sheet rolled up wet after one and three days cured much quicker than that rolled up when partially dry after seven days.

With reference to the longer time of cure required by the wet specimens in Series III as compared with those in Series I and II, it may be noted that the control specimens in the three Series also show a similar difference. The times of cure of the five control specimens included in this report (Series III) ranged from 70 to 95 minutes, with an average of 81 minutes; in the case of 18 control samples of Series I, the average time of cure was 66·6 minutes, and only one of the 18 required over 75 minutes; whilst in Series II the average time of cure of 8 control samples was 71 minutes, with a maximum of 75 minutes. It may be mentioned that the samples of Series III were made from the same trees as were used for Series II, and it is of interest that the time of cure of the control samples, prepared from the latex in exactly the same way, shows considerable variation in the two cases. It is evident that, as was pointed out in the previous article (*loc. cit.*, p. 561), marked differences in the time of vulcanisation may occur in rubbers prepared at different times from the same trees by identical methods.

The specimens of dry creosoted sheet rubber in Sections V*a*, V*b* and V*c* have a distinctly longer time of cure than the plain (not creosoted) sheet from the same latex. Previous specimens of dry creosoted sheet rubber (*e.g.* Nos. 69 and 150) did not differ appreciably in time of cure from plain sheet (Controls C. 9 and C. 20) made from the same bulk latex (*loc. cit.*, p. 540). It would appear, however, from the results now recorded that the addition of alkaline creosote solution to the latex before coagulation may lengthen the time of cure.

In Section VI the samples prepared from latex containing formalin and rolled up while wet, cure much more quickly than the corresponding samples of dry sheet or roll containing formalin. The latter samples have a distinctly longer time of cure than the plain control sheet prepared without the addition of formalin. Formalin has been shown already to lengthen the time of cure when added to the latex before coagulation (*cf.* Series I and II, Section IV, Subsection 3, *loc. cit.*, pp. 512, 513).

Mechanical Tests.—With one exception (No. 204—dry worm rubber) all the specimens included in the present report gave very good results in the mechanical tests. Excluding No. 204, the figures for tensile strength ranged from 2,300 to 2,570 lb. per sq. in., with an average value of 2,445 lb. for the twenty specimens. This is a higher average value for tensile strength than that given by the samples included in any of the previous reports.

Specimen No. 204, which was in the form of "worm" and had been dried at a temperature of 83° F., gave a very poor result in the tensile tests, *viz.* only 1,800 lb. per sq. in.; but it is noteworthy that the block rubber (No. 205) made from a portion of the same worm rubber when wet had a very much higher value, *viz.* 2,490 lb. per sq. in., which is equal to the tensile strength of the control sample.

In all cases the wet rubbers, prepared by the addition of creosote or formalin to the latex, were of very good quality, as is evident from the following table giving the average results obtained in the present Series and in Series I and II, Section XIV:

		Tensile strength. lb. per sq. in.	Elongation. Per cent.	Permanent set. Elongation per cent.
Series III, Sections IV, *Va*, *Vb*, *Vc*.	Wet roll or block, creosoted (Nos. 205, 208, 210, 211, 215, 216, 217).	2,470	883	2·40
	Controls (Nos. 203, 206, 209, 214).	2,500	873	2·50
Series III, Section VI.	Wet roll, formalin (Nos. 220, 221).	2,460	885	1·82
	Control (No. 219)	2,380	874	1·90
Series I, Section XIV.	Wet roll, creosoted (Nos. 83, 84, 85)	2,430	867	2·93
	Control (No. C.12)	2,470	881	2·11
Series II, Section XIV.	Wet roll, creosoted (Nos. 162, 163, 164)	2,600	882	2·58
	Control (No. C.21)	2,450	879	2·71
Plain sheet .	(Average of twenty-six controls, Series I and II)	2,385	870	2·52 [1]

[1] *Average of* 19 *samples only.*

It will be seen, from these results, that the wet rubbers gave very good results in the tensile tests, the values obtained being on the whole quite equal to those furnished by plain dry sheet from the same latex.

In Section V*a* the creosoted rubber which was rolled up wet under tension had a much higher tensile strength than the creosoted sheet rubber dried in the usual way, the figures being 2,550 lb. and 2,300 lb. respectively; but the former value is practically the same as that of the control sheet which gave 2,500 lb.

Chemical Composition.—In dealing with the specimens of Section XIV in Series I and II (*loc. cit.*, p. 543), attempts were made to ascertain if there were any marked differences in chemical composition between the dry and the wet roll rubbers. From the results obtained it appeared that:

(1) The amount of resin was higher in the wet rubbers than in the dry rubber from the same bulk latex, and that the resin was highest in those rubbers which cured quickest.

(2) The amount of protein was consistently lower in the wet roll rubbers than in the dry rubbers, after each had been washed and dried in the usual way.

A further investigation of these points has been made in connection with the present samples.

The average composition of the wet and dry specimens included in Sections V*a*, V*b*, V*c* and VI of Series III is given in the following table :

	Caoutchouc.	Resin.	Protein.	Time of Vulcanisation.
	Per cent.	*Per cent.*	*Per cent.*	*Minutes at 50 lb. pressure.*
(1) Creosoted roll (Sections V*a*, V*b* and V*c*).				
Dry	95·15	2·48	2·12	91
Wet	94·55	3·23	1·99	56
(2) Rubber preserved with formalin (Section VI).				
Dry	95·18	2·40	2·18	100
Wet	94·77	2·94	1·98	73

It will be seen that in both these groups the wet quick-curing rubber contains a higher percentage of resin and a lower percentage of protein than the dry rubber, prepared from the same bulk latex. No definite relationship between the amounts of protein and the time of vulcanisation is apparent in these samples, as the two groups of wet rubbers containing on the average 1·99 and 1·98 per cent. of protein differed considerably in time of vulcanisation, the average figures being 56 and 73 minutes respectively.

Table IX gives the percentages of resin and the times of cure of the samples in Sections V*a*, V*b*, V*c* and VI in Series III, compared with the average figures for the similar samples in Series I and II. From the figures given in this table it is evident that the wet rubbers contain more resin than the dry rubbers prepared from the same latex, and that, of the wet rubbers, the samples which were rolled up shortly after coagulation contain more resin than those kept for a few days before rolling (and therefore allowed to dry partially). It appears, further, that a high proportion of resin is again generally associated with rapid cure. That the high percentage of resin is not due to the inclusion of creosote in the " resin " as extracted by acetone is apparent from the facts :

(1) That the resin in dry sheet prepared with creosote

TABLE IX

Relation between the Percentage of Resin and Time of Cure

	Series I. Section XIV. (Average). Creosoted.		Series II. Section XIV. (Average). Creosoted.		Section Va. Creosoted.		Series III. Section Vb. Creosoted.		Section Vc. Creosoted.		Series III. Section VI. Formalin.	
	Resin.	Time of cure.	Resin.	Time of cure.	Resin.	Time of cure.	Resin.	Time of cure.	Resin.	Time of cure.	Resin.	Time of cure.
	Per cent.	*Minutes.*	*Per cent.*	*Minutes.*	*Per cent.*	*Minutes.*	*Per cent.*	*Minutes.*	*Per cent.*	*Minutes.*	*Per cent.*	*Minutes.*
Control sheet (no creosote)	2·48	65	2·97	70	2·33	70	2·17	85	2·15	75	1·91	80
Creosoted sheet, rolled wet .	3·92	38	3·36	45	3·30	55	—	—	—	—	—	—
Creosoted sheet, rolled wet, after 1 day . . .	—	—	—	—	—	—	2·30	55	3·55	52	3·08	72
Creosoted sheet, rolled wet, after 3 days . . .	—	—	—	—	—	—	3·00	60	3·29	55	2·97	75
Creosoted sheet, rolled wet, after 7 days . . .	—	—	—	—	—	—	—	—	3·03	62	—	—
Creosoted sheet, rolled when dry	—	—	—	—	—	—	3·02	90	2·86	85	2·85	95
Creosoted sheet, dry, not rolled	—	—	—	—	2·23	95	1·80	95	—	—	1·95	105

is not higher than in sheet from the same latex prepared without creosote.

(2) That the wet rolled samples prepared with formalin show the same higher percentage of resin compared with samples from the same latex without formalin.

The fact that the samples which are rolled up soonest generally contain the highest amounts of resin suggests that some of the "resin" may be lost in the liquid which exudes from the sheets during drying, or that a portion of the "resin" becomes insoluble in acetone when the sheet is dried in the usual way.

A curious point which will require further investigation is that the sheet rubber prepared with creosote or formalin and rolled up when dry contains a larger amount of resin than the similar dry sheets which were not rolled up.

The results obtained with the previous specimens of wet and dry roll rubbers in Series I and II (Section XIV) showed that after the rubbers were washed and dried in the usual way the percentage of protein was invariably higher in the dry rubber than in the corresponding samples of wet rubber. In Section XIV of Series I the average amount of protein in the samples of dry and wet rubbers were 2·36 and 1·89 per cent. respectively, and in Series II the figures were 2·41 and 2·16 per cent. (*loc. cit.*, p. 549). A comparison of the analyses of the dry and wet rubbers dealt with in the present report shows that this is also true of the present samples, but that the differences in the percentages of protein are much less than in the previous Series. The figures for Series III are summarised in the following table :

	IV.	V*a*.	V*b*.	V*c*.	VI.
Protein in	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry rubber . . .	2·41	2·05	2·21	2·00	2·18
Wet rubber . . .	2·14	1·96	2·08	1·94	1·98
Difference . . .	0·27	0·09	0·13	0·06	0·20

The average difference in the amounts of protein in the dry and wet rubbers of Series III is therefore 0·15 per cent., compared with 0·47 per cent. in Series I and 0·25 per cent. in Series II.

It was also found in the cases of two previous specimens that protein was removed during the washing of wet roll rubbers (*loc. cit.*, p. 550), and experiments were therefore made to ascertain whether the wet roll rubbers of Series III gave similar results. For this purpose seven samples of wet rubber (Nos. 205, 208, 210, 211, 215, 220 and 221) were examined chemically (1) without washing (the rubber as received being merely cut up for analysis) and (2) after washing and drying in the usual way. The results are given in the following table :

	No. 205.	No. 208.	No. 210.	No. 211.	No. 215.	No. 220.	No. 221.
Protein in rubber :	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Not washed	2·20	2·09	2·26	2·12	2·28	2·28	2·25
Washed	2·14	1·96	2·08	2·07	1·97	1·96	2·00
Loss on washing . .	0·06	0·13	0·18	0·05	0·31	0·32	0·25

The average loss of protein on washing was therefore 0·18 per cent., compared with losses of 0·15 per cent. in a previous sample of wet roll rubber and 0·62 per cent. in a specimen of wet rubber prepared by evaporating the latex to dryness in a vacuum drier (*loc. cit.*). It has been found, however, that some loss of protein also takes place in washing rubber which has been dried in the usual way soon after coagulation, the loss in the case of specimens Nos. 213 and 218 being 0·034 and 0·09 per cent. respectively.

This question of the loss of protein on washing wet and dry rubbers, and the effect of this loss on the vulcanising properties of the washed rubber as compared with the unwashed, requires further investigation. The present specimens were not sufficiently large for the purpose, and the work will have to be deferred until further specimens of wet rubber already asked for are received.

Conclusions

The results obtained in the case of the specimens included in Series III, Sections IV–VI, confirm the previous conclusion that rubber prepared in such a way as to remain moist for a considerable period invariably cures more rapidly than rubber prepared from the same latex and dried thoroughly soon after coagulation. The rubbers retaining most moisture appear to cure more quickly than those containing less water. It is of interest to notice that this effect is produced even when preservatives such as creosote and formalin are added to the latex before coagulation.

Rubber allowed to remain in a moist condition almost invariably gives excellent results in the mechanical tests. Such rubber appears to be quite equal in physical properties to rubber from the same latex which is dried thoroughly soon after coagulation, and has a much quicker rate of cure.

As in the case of previous samples, the wet, quick-curing rubbers contain larger amounts of resin and smaller amounts of protein than the dry rubbers prepared from the same latex, but the investigation of the possible relationship between the percentages of resin and protein and the time of vulcanisation cannot be carried further until the additional samples of wet rubber which have been prepared for the purpose have been examined.

It is of interest to note that the control samples of Series III have a distinctly longer time of cure than those of Series II (see p. 435), although both Series were prepared from latex obtained from the same group of trees. This fact confirms the previous results recorded in this BULLETIN (1916, **14**, 561) and indicates that considerable variation in time of cure may occur in plantation rubber prepared at different times from the same trees by identical methods.

(4) Experiments to determine the Effect of adding Sodium Bisulphite to the Latex for the Production of Pale Rubber

The ten samples dealt with in this report, forming Sections I and II of Series IV, were prepared from latex obtained from the sixteen- to twenty-year-old trees used for Series II.

Series IV

Section I. Crêpe Rubber

Date of experiment: September 29, 1914.

Rainfall: 0·15 in.

Percentage of dry rubber in latex: 31.

The required quantity of commercial sodium bisulphite was first added to the latex, which was then coagulated with acetic acid, 1 part of acid being used for 1,000 parts of diluted latex containing 15 to 17 per cent. of dry rubber. The samples were made into thin crêpe in exactly the same way (seven times through rough rollers and once through smooth rollers), and were dried in the air at the normal temperature.

No. 249.—1 part sodium bisulphite to 500 parts latex. Time of drying: 15 days.

No. 250.—1 part sodium bisulphite to 1,000 parts latex. Time of drying: 15 days.

No. 251.—1 part sodium bisulphite to 5,000 parts latex. Time of drying: 10 days.

No. 252.—No bisulphite added. Time of drying: 10 days.

No. 253.—Control sample (sheet). Time of drying: 3 weeks.

Section II. Sheet Rubber

Date of experiment: November 1, 1914.

Rainfall: nil.

Percentage of dry rubber in latex: 36.

No. 254.—1 part sodium bisulphite to 500 parts latex. Time of drying: not stated.

No. 255.—1 part sodium bisulphite to 1,000 parts latex. Time of drying: not stated.

No. 256.—1 part sodium bisulphite to 5,000 parts latex. Time of drying: 5 weeks.

No. 257.—1 part sodium bisulphite to 10,000 parts latex. Time of drying: 4 weeks.

No. 258.—Control sample. Time of drying: 4 weeks.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table X.

TABLE X

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series IV. Sections I and II

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
			Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Section I. *Effect of Sodium Bisulphite. Rubber made into Crêpe*						
1 part sodium bisulphite to 500 parts latex	Thin crêpe.	249	100[1]	2,230	857	2·26
1 ,, ,, ,, 1,000 ,, ,,	,, ,,	250	105	2,490	873	2·13
1 ,, ,, ,, 5,000 ,, ,,	,, ,,	251	105	2,400	862	2·71
No bisulphite added	,, ,,	252	100	2,450	874	2·20
Control sample	Sheet.	253	70	2,470	870	2·26
Section 2. *Effect of Sodium Bisulphite. Rubber made into Sheet*						
1 part sodium bisulphite to 500 parts latex	Sheet.	254	73	2,380	852	1·55
1 ,, ,, ,, 1,000 ,, ,,	,,	255	80	2,380	878	1·98
1 ,, ,, ,, 5,000 ,, ,,	,,	256	80	2,480	859	1·76
1 ,, ,, ,, 10,000 ,, ,,	,,	257	75	2,440	866	2·05
Control sample	,,	258	75	2,340	853	2·13

[1] *Slightly overcured.*

Remarks on Series IV, Sections I, II

Time of Vulcanisation.—The addition of sodium bisulphite to the latex in the proportions used in these experiments had no appreciable effect on the time of vulcanisation of the rubber. The samples in sheet form which contained bisulphite vulcanised in from 73 to 80 minutes, compared with 75 minutes for the plain control sheet without bisulphite. The crêpe specimens containing bisulphite required from 100 to 105 minutes, and the corresponding sample without bisulphite 100 minutes; these figures are quite normal for plain crêpe.

Tensile Strength.—The tensile strength of the specimens was uniformly good, the only result below 2,300 lb. being that obtained for No. 249, which was slightly overcured. It would appear, therefore, that the use of sodium bisulphite has no adverse effect on the mechanical properties of the rubber.

Conclusions.—The results of the examination of these specimens indicate that the addition of sodium bisulphite to the latex before coagulation, in the proportions used in these experiments, has no marked influence on the time of cure or the tensile strength of the rubber.

It was not possible to form a definite opinion from these samples as to the most suitable amount of sodium bisulphite for use in the preparation of a pale rubber. When received at the Imperial Institute the specimens exhibited very little variation in colour, and those containing no bisulphite were not appreciably darker than the samples to which bisulphite had been added. No particulars were supplied as to the appearance of the freshly prepared samples, but it is clear that any advantage in colour which the rubber prepared with bisulphite may have possessed at first was entirely lost on keeping.

(5) Experiments to determine the Effect of Machining the Freshly Coagulated Rubber

The four samples dealt with below were prepared from latex obtained from the sixteen- to twenty-year-old trees used for Series II and III.

SERIES IV

Section III.—A repetition of previous experiments on the effects of machining wet rubber (*loc. cit.*, p. 515).

Date of experiment: November 4, 1914.

Rainfall: nil.

Percentage of dry rubber in latex: 35·0.

No. 259.—Sheet (Control). Time of drying: 4 weeks.

No. 260.—Worm. Time of drying: 4 days.

No. 261.—Thin crêpe. Time of drying: 1 week.

No. 262.—Thick crêpe. Time of drying: 3 weeks.

Nos. 261 and 262 were each put through the rough rollers seven times.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table XI.

TABLE XI

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series IV. Section III

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
Section III. Effect of machining wet rubber			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Control sample .	Sheet	259	80	2,430	875	2·58
Worm . .	Worm	260	85	2,050	875	3·53
Thin crêpe . .	Crêpe	261	105	2,470	889	2·66
Thick crêpe .	Crêpe	262	95[1]	2,460	858	2·41

[1] *Slightly overcured.*

Remarks on Series IV, Section III

A comparison of the figures obtained for the control sheet and the crêpe rubbers shows that the machining has not affected the mechanical properties of the rubber, but has lengthened the time of vulcanisation.

The results previously obtained have invariably shown that the crêpeing of rubber lengthens the time of cure in comparison with that of the corresponding sheet. The effect on the tensile strength has not been very marked or constant. In a number of cases, including the present samples, the crêpe has given tensile figures as good as those of the sheet, whilst in others the crêpe has been either slightly superior or slightly inferior in tensile strength to the sheet.

It may, therefore, be considered to be definitely established that the machining of wet rubber lengthens the time of cure, but has no marked effect on the tensile strength.

The specimens of thin and thick crêpe agreed in time of vulcanisation with the corresponding samples in Series I and II (*loc. cit.*, pp. 519, 520), but gave rather better results in the tensile tests, as will be seen from the following figures:

	Time of vulcanisation.	Tensile strength.	Elongation.
Thin crêpe	*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*
Mean of six samples in Series I and II	105	2,230	889
No. 261	105	2,470	889
Thick crêpe			
Mean of six samples in Series I and II	95	2,350	877
No. 262	95	2,460	858

As in the previous cases, the thick crêpe cured a little more quickly than the thin crêpe. The longer period required for the drying of thick crêpe, which in the present case took three weeks as compared with one week for the thin crêpe, may have some influence in reducing the time of cure of thick crêpe.

The sample of worm rubber included in this Section had a much lower tensile strength than any of the other specimens. No sample of plain untreated worm rubber was included among the earlier samples from Ceylon, but a number of Byrne-cured and creosoted worm rubbers previously received were also found to give low results in the tensile tests. The following statement shows the results obtained with the previous samples of worm rubber (*see* this Bulletin, 1916, **14**, 540):

	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.
		Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*
Worm, Byrne-cured partly dried, then blocked	72	97	2,340	857
Worm, Byrne-cured fully dried, then blocked	73	102	2,170	881
Worm, Byrne-cured partly dried, then blocked	75	78	2,270	874
Worm, Byrne-cured for 1 hour, then blocked	102	110	2,200	846
Worm, Byrne-cured for 2 hours, then blocked	103	120	2,100	863
Worm, Byrne-cured for 3 hours, then blocked	104	140	2,110	847
Worm, Byrne-cured, then blocked .	153	135	1,970	878
Creosote added to latex, rubber wormed and dried at 83° F. .	204	85	1,800	868
Creosote added to latex, rubber wormed and blocked while wet .	205	60	2,490	886
Untreated worm	260	85	2,050	875

It will be seen that several of these worm rubbers gave distinctly low figures in the tensile tests. All the Byrne-cured rubbers examined behaved irregularly, so that the poor results from the worm specimens treated by this process cannot be definitely attributed to the "worming." It seems possible, however, that the rapid drying of worm rubber is the cause of the inferiority, as it will be seen that the sample of dry worm No. 204 gave very low figures in comparison with worm from the same latex blocked while wet (No. 205). This point is of general interest, but, in view of the small amount of worm rubber made in Ceylon, this method of preparation is not of great importance.

(6) Experiments to determine the Effect of Machining the Dry Rubber

The two samples dealt with below were prepared from bulked latex obtained from trees sixteen to twenty years old.

Series IV

Section VI. Effect of Working Dry Rubber

No. 272.—Thin crêpe. Put seven times through the rough rollers, and once through the smooth rollers.

No. 273.—The same crêpe put through the rough rollers three additional times when dry. The temperature of the rubber rose from 82° to 120° F. during this process.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table XII.

TABLE XII

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series IV. Section VI

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
			Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Section VI. Effect of working dry rubber						
Thin crêpe . .	Crêpe.	272	115	2,280	879	2·50
Thin crêpe put through the rough rollers three times when dry . .	Crêpe.	273	115	2,360	874	2·20

Remarks on Series IV, Section VI

Somewhat irregular results were obtained with these two samples, but the average figures indicate that both samples are of good quality, and that the extra rolling received by No. 273 when dry has had no appreciable effect on the time of vulcanisation or the mechanical properties of the rubber. In view of the much more drastic treatment which the rubber always receives during mixing prior to vulcanisation, it seems improbable that passing the dry rubber three times through crêpeing rollers would have any adverse effect.

It has already been shown (*cf.* Series I and II, Sections VII, VII*R*, VIII, VIII*R*) that thick crêpe made by rolling together pieces of dry thin crêpe had the same time of vulcanisation as the latter, and did not differ appreciably in tensile strength (*loc. cit.*, p. 528).

The result now recorded confirms those previously obtained, and it may be concluded that the machining of dry rubber to any ordinary extent is without effect on the vulcanising and mechanical properties.

(7) Experiments to determine the Effect of Preparing the Rubber in a Moist Condition

The two samples used for this purpose were also prepared from bulked latex obtained from sixteen to twenty year old trees.

Series IV

Section VII. Wet and Dry Sheet

No. 274.—Plain sheet.

No. 275.—Sheet made from latex containing 0·125 per cent. of creosote and rolled up the day after the sheet had been put through the rolling machine.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table XIII.

TABLE XIII

Results of Vulcanisation and Mechanical Tests

Section IV. Series VII

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
			Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Section VII						
Plain sheet . .	Sheet.	274	65	2,430	887	2·43
Wet rolled sheet, creosoted . .	Wet roll.	275	50	2,490	895	2·26

Remarks on Series IV, Section VII

The plain dry sheet (No. 274) and the wet-rolled creosoted sheet (No. 275) both gave excellent results in the mechanical tests. The wet-rolled sheet cured in 50 minutes compared with 65 minutes for the dry sheet, this difference in time of cure being not so great as in some previous samples as will be seen from the following table :

	Time of cure. *Minutes at 50 lb. pressure.*	
Series I.		
Plain sheet, C. 12	65	
Wet roll, creosoted—Nos. 83, 84, 85	38	
Series II.		
Plain sheet, C. 21	70	
Wet roll, creosoted—Nos. 162, 163, 164	45	
Series III.	V*b*.	V*c*.
Plain sheet	85	75
Sheet rolled up wet after 1 day	55	52
,, ,, ,, 3 days	60	55
,, ,, ,, 7 days	—	62
Present samples.		
Plain sheet	65	
Sheet rolled up wet after 1 day	50	

In the present specimens the sheet rolled up wet after one day cured in 77 per cent. of the time required for the control sheet, whilst the time of cure of the corresponding samples in Series III was 65 and 70 per cent. of that of the control sheet. The samples of wet rubber in Series I and II required 58 and 64 per cent. of the time taken by the control sheet.

It is clearly established that rubber which is allowed to remain in a wet condition after coagulation vulcanises quicker than the plain dry sheet prepared from the same latex. The extent of this increase in the rate of vulcanisation of wet rubber has shown some variation in the samples so far examined at the Imperial Institute. The results given by the specimens in Series III (see p. 430) suggested that the rubber which contained the most water when rolled up (*i.e.* those rolled up after one day) cured slightly quicker than those which had been allowed to dry for three to seven days before rolling up. It is also noteworthy that the wet rubbers of Series I and II which cured in the shortest time of any of the specimens examined were rolled up directly after being made into sheet. This point will be further considered in connection with a series of wet rubbers which have been received at the Imperial Institute from Ceylon.

The composition of the dry washed rubbers was as follows :

	Serial No.	Loss on washing.	Composition of dry washed rubber.			
			Caoutchouc.	Resin.	Protein.	Ash.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Plain sheet . . .	274	0·80	95·11	2·43	2·15	0·31
Wet rolled, creosoted .	275	3·52	94·11	3·46	2·17	0·26

The amount of resin in the creosoted wet-rolled rubber is, as usual, higher than in the plain sheet (*cf.* p. 437), but there is no appreciable difference in the amount of protein present.

The results given by the present samples, Nos. 274 and 275, confirm those previously recorded, viz. that wet rubber cures quicker than the corresponding dry rubber, and gives equally good mechanical results. As indicated in a previous Report (*loc. cit.*, p. 566) this method of preparation will be useful if manufacturers desire to have a quicker curing rubber than the dry rubber usually prepared on plantations.

A sample of rubber prepared by leaving latex in a carboy for a year, the slab being then simply taken out and allowed to dry, was received along with the two preceding samples. The sample consisted of a circular cake of rubber, of very poor appearance. It was of dark colour externally, moist internally, and full of bubbles, and varied in colour from yellowish-white to almost black. On washing and drying it lost 48·3 per cent. by weight. Owing to the final vulcanised sheet being accidentally spoiled it was only possible to carry out tests with two rings, but the preliminary results indicated that the rubber cured fairly rapidly, and gave a vulcanised product of fair quality.

The results obtained with this sample were as follows :

Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
		Minutes at 50 lb. pressure.	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Lump .	276	65	2,290	881	—

(8) Experiments to determine the Effect of adding Papain to the Latex before Coagulation

The following sections were made at various times, each section being prepared from bulked latex obtained from trees sixteen to twenty years old.

Series IV

Sections IV and V

In these experiments an attempt was made to remove part of the protein by means of papain in order to determine the effect on the resulting rubber. The papain was added in the proportion of ¼ oz. mixed with water, to ½ gallon of latex. Part of the latex started clotting almost immediately.

Samples were also prepared for comparison from the same latex by spontaneous coagulation, and by coagulation with acetic acid and with alcohol.

Section IV

No. 263.—Papain added to latex, 1st clot after 3 hours.

No. 264.—Papain added to latex, 2nd clot after 16 hours.

No. 265.—Latex coagulated with acetic acid.

No. 266.—Spontaneous coagulation, 16 hours.

The samples were submitted to vulcanisation and mechanical tests, with the results shown in Table XIV.

TABLE XIV

Results of Vulcanisation and Mechanical Tests

Series IV. Section IV

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
Section IV. Effect of adding papain to latex			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Papain added to latex, 1st clot .	Crêpe	263	60[1]	2,280	913	2·39
Ditto, 2nd clot .	,,	264	65	2,390	877	1·92
Coagulated with acetic acid .	,,	265	95[2]	2,400	808	2·39
Spontaneous coagulation . .	,,	266	80	2,280	884	2·43

[1] *Slightly undercured (small sample only: not sufficient for further tests).*
[2] *Overcured (small sample only: not sufficient for further tests).*

Section V

No. 267.—Papain added to latex, 1st clot after 2 hours.

No. 268.—Papain added to latex, 2nd clot after 16 hours.

No. 269.—Latex coagulated with acetic acid.

No. 270.—Coagulated with alcohol; 300 cc. of methylated spirit added to 3 litres of latex. Part of the latex coagulated in a clot on addition of the alcohol and the whole was coagulated in 16 hours.

No. 271.—Spontaneous coagulation, 16 hours.

The samples were submitted to vulcanisation and mechanical tests with the results shown in Table XV.

TABLE XV

RESULTS OF VULCANISATION AND MECHANICAL TESTS

Series IV. Section V

	Form of rubber.	Serial No.	Time of vulcanisation.	Tensile strength.	Elongation.	Permanent set.
Section V. Effect of adding papain to latex			*Minutes at 50 lb. pressure.*	*lb. per sq. in.*	*Per cent.*	*Elongation per cent.*
Papain added to latex, 1st clot .	Crêpe	267	65	2,490	875	2·65
Ditto, 2nd clot .	,,	268	68	2,360	890	2·80
Coagulated with acetic acid .	,,	269	80[1]	2,500	865	1·54
Coagulated with alcohol . .	,,	270	80	2,460	893	2·19
Spontaneously coagulated . .	,,	271	70	2,230	875	2·33

[1] *Slightly overcured.*

Remarks on Series IV, Sections IV and V

These sections included, in addition to rubber prepared from latex to which papain had been added, samples prepared from the same latex by coagulation with acetic acid, or alcohol or by spontaneous coagulation.

The four samples of crêpe rubber prepared by the addition of papain to the latex were of good quality, and cured more quickly than crêpe rubber prepared from the same latex by coagulation with acetic acid or with alcohol.

The samples in Section V were submitted to chemical examination in order to determine whether the use of papain had effected any alteration in the composition of the rubber. The following results were obtained :

	Serial No.	Loss on washing.	Composition of dry washed rubber.			
			Caoutchouc.	Resin.	Protein.	Ash.
Section V.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Papain added to latex, 1st clot . . .	267	0·86	92·00	4·90	2·50	0·60
Ditto, 2nd clot . .	268	0·51	93·92	3·67	2·01	0·40
Coagulated with acetic acid . . .	269	0·40	94·11	3·32	2·24	0·33
Ditto, alcohol . .	270	0·47	94·55	3·08	2·00	0·37
Spontaneously coagulated . . .	271	0·38	94·74	2·93	1·96	0·37

It will be seen, from these figures, that the first clot obtained by the addition of papain to the latex contains more protein than any of the other samples ; and that, while the second clot contains less protein than the first clot, the amount is only slightly less than that present in the rubber coagulated with acetic acid, and about the same as in the rubber coagulated with alcohol or prepared by spontaneous coagulation. It does not appear from these results that protein is removed in any appreciable amount by the action of the papain, but some alteration in the nature, if not in the quantity, of the nitrogenous constituents may have taken place which would possibly account for the change in the rate of cure.

The rubbers prepared with papain, especially the first clot, contain more resin than the other samples. It seems possible that some of this "resin" may have been derived from the papain, and may have some influence in reducing the time of cure.

The coagulation of latex by the addition of papain is, however, only of scientific interest, and it does not appear necessary to prepare any further samples by this method for examination.

The two samples of spontaneously coagulated rubber (Nos. 266 and 271) included in Sections IV and V vulcanised more quickly than the corresponding samples prepared with acetic acid, but not quite so rapidly as most of the samples of spontaneously coagulated rubber previously examined. In view, however, of the fact that the conditions under which spontaneous coagulation occurs will vary widely at different times, some irregularity in the results is to be anticipated.

The sample No. 270, coagulated by means of alcohol, cured at the same rate as crêpe prepared from the same latex by means of acetic acid, and gave good results in the mechanical tests. There does not appear to be any advantage in using alcohol as a coagulant.

INDIAN TEA SEED AS A SOURCE OF OIL

A sample of Indian tea seed (*Camellia Thea*) was forwarded by the Chief Scientific Officer of the Indian Tea Association in September 1917, at the suggestion of the Imperial Institute, in order that the yield and character of the oil it contains might be ascertained in comparison with that obtained from *Camellia Sasanqua* seed, the usual source of commercial tea-seed oil from China.

The sample was described as Assam Kharikatia tea seed from the Jorehaut Tea Company. It consisted of dark greyish-brown seeds, which were mostly spherical and measured from $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter. The shell was rather less than $\frac{1}{16}$ in. in thickness.

The kernels, which were wholly or partly covered with a thin, wrinkled, brown skin, were spherical in shape, hard and yellow, and could be easily split into halves.

The seed consisted of kernel 58 per cent. and shell 42 per cent.

The air-dry kernels contained 10·4 per cent. of moisture and yielded 17·3 per cent. of clear golden-yellow liquid oil, with a slight, not unpleasant taste and smell. This yield is equivalent to 19·2 per cent. of oil from the dry kernels.

The oil extracted from the kernels with light petroleum was submitted to chemical examination with the following results, compared with those recorded for the oil from *C. Sasanqua* seed from China examined at the Imperial Institute (*see* this Bulletin, 1912, **10**, 234).

		Present sample of *C. Thea* oil.	*C. Sasanqua* oil.
Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$		0·921	0·918
Solidifying point of fatty acids		32·8° C.	—
Acid value[1]		3·6	9·4
Saponification value[1]		194·2	193·4
Iodine value	*per cent.*	93·2	87·5
Hehner value		95·2	—
Insoluble fatty acids	*per cent.*	93·7	—
Unsaponifiable matter	,, ,,	1·5	—
Volatile acids, soluble		0·14	—
,, ,, insoluble		0·16	—

[1] *Milligrams of potash for 1 gram of oil.*

The oil furnished by this Indian tea seed is of the "non-drying" class and resembles the tea-seed oil of commerce derived from *C. Sasanqua*. There is no doubt that the Indian oil would be readily saleable if it could be produced in commercial quantities.

The amount of oil contained in the kernels is low, *viz.* 17·3 per cent. as compared with 58 to 59 per cent. in Sasanqua kernels. Seeds or kernels containing such a low percentage of oil as the Indian tea-seed kernels are usually not of commercial importance as sources of oil unless the residual cake has a high value as a feeding stuff or for some other purpose. Tea-seed cake contains saponin, and is therefore not suitable for use as a cattle food. The Chinese tea-seed cake has been principally employed for the manufacture of worm-killing preparations for use in horticulture, and for this purpose was offered at about £8 10*s*. per ton c.i.f. London before the war. The cake from the Indian tea seed could be utilised for the same purpose.

The small yield of oil from the Indian tea seed and the comparatively low value of the residual cake render it unlikely that the seed could be remuneratively employed as a source of oil. Only in the event of large supplies of the seed being available at a low price does it seem probable that the extraction of the oil on a commercial scale could be recommended. It would not be remunerative to export the seed or kernels and the oil would therefore have to be extracted in India.

MINERALS FROM RHODESIA

A CONSIDERABLE number of minerals from Rhodesia have been examined at the Imperial Institute in recent years. The reports on some of these samples are of general interest, and a selection from them is now published together with a short account of the mineral resources of the country.

I. MINERAL RESOURCES OF RHODESIA

The chief minerals produced in Southern Rhodesia are gold and silver, copper ore, chromite, coal, asbestos, and galena. The output and value of these and other minerals and metals in recent years are shown in the following table, taken from the *Annual Reports* of the Secretary for Mines, Southern Rhodesia.

Mineral Production of Southern Rhodesia

Quantity.	1912.	1913.	1914.	1915.	1916.	1917.
Gold . . *oz.*	642,807	689,954	854,480	915,029	930,356	834,231
Silver . . ,,	176,532	142,390	150,793	185,233	200,676	211,989
Lead *short tons*[1]	588	326	150	28	—	—
Chrome ore ,,	69,261	63,383	48,207	60,581	88,871	72,963
Coal raised ,,	216,140	243,328	349,459	409,763	491,582	548,954
,, sold ,,	162,707	173,658	265,574	288,057	308,730	323,026
Wolframite ,,	1	4	—	—	2½	12
Asbestos ,,	—	290	487	2,010	6,157	9,562
Diamonds, *carats* .	—	706	1,004	272	1,021	619
Copper, *short tons*	—	—	1,011	3,517	3,521	3,912
Arsenic ,,	—	—	76	—	—	—
Ironstone ,,	—	—	—	9,622	5,387	5,290
Antimony ,,	—	—	—	—	38	15
Tin ,,	—	—	—	—	3½	—

Value. (£)	1912.	1913.	1914.	1915.	1916.	1917.
Gold . . .	2,707,369	2,903,268	3,580,209	3,823,168	3,895,311	3,495,391
Silver . . .	20,010	15,106	14,277	17,144	21,917	26,619
Lead . . .	9,253	5,233	2,488	557	—	—
Chrome ore .	154,600	141,481	107,612	175,792	333,170	327,347
Coal, sold . .	73,268	78,422	115,099	123,194	131,468	179,588[2]
Wolframite . .	100	427	—	—	466	2,070
Asbestos . .	—	5,224	8,612	32,190	99,059	189,890
Diamonds . .	—	3,645	3,985	1,016	5,331	2,991
Copper . .	—	—	50,559	224,314	341,041	414,448
Arsenic . .	—	—	160	—	—	—
Ironstone . .	—	—	—	1,699	730	661
Antimony . .	—	—	—	—	662	330
Tin . . .	—	—	—	—	549	—
	2,964,600	3,152,806	3,883,001	4,399,074	4,829,704	4,639,335

[1] *Short ton* = 2,000 *lb.* [2] *Includes value of coal used for coke and bricks.*

In Northern Rhodesia there has been a production of gold, copper and lead in recent years, but figures for output are not available.

Antimony.—Auriferous and argentiferous stibnite (antimony sulphide), usually granular in texture and associated with vein quartz, is known in several localities, as at Hope Fountain, near Bulawayo, Umniati and Belingwe. It forms part of the ore worked at some of the gold-mines in the Gwelo district. The auriferous deposits of the Sebakwe and Hartley districts commonly contain cervantite (oxide of antimony) near the surface and jamesonite (sulphide of lead and antimony) at greater depths. There are also coarsely crystalline stibnite veins containing no gold, as at Gatooma. Little antimony has been produced in the past. In 1907 there was an output of some fourteen tons, valued at £275, from the Hartley district, and no more was produced until 1916, when the output was 38 tons, valued at £662, from the Gwelo district.

A sample of massive stibnite from Rhodesia, analysed at the Imperial Institute, contained 65·67 per cent. of antimony and no gold or silver (*see* this BULLETIN, 1907, **5**, 138).

Arsenic.—Arsenical ores are treated for their gold and silver in the Umtali, Gwanda, Gatooma, Mazoe and other districts, but the only arsenic recorded as recovered was an amount of 76 tons from the Bulawayo district in 1914. Now, however, white arsenic is being produced at the Bessie Mine, near Umtali. Many of the mines could at little expense save and refine the arsenic now lost in roasting the ore. There is a large demand in South Africa for arsenic in the form of cattle and sheep dips, and for use in preserving hides.

Asbestos.—Chrysotile asbestos occurs in the serpentine of the Victoria, Belingwe, Filabusi, Gwanda, Hartley, Umtali, and other districts, and fibrous amphibole asbestos is found in the Victoria, Tuli, Gwanda and Lomagundi districts. The output consists chiefly of chrysotile from two mines in the Mashaba Mountains, about twenty-six miles west of Victoria, but asbestos of good quality is also produced in the Belingwe district. The Mashaba mines are situated in the north-western corner of a range of precipitous serpentine hills. The serpentine is dark grey to black, weathering to red, and appears to be derived in part from olivine rocks, in part from pyroxenites. It shows an incipient cleavage. At the mines it is divided into zones of greyish-brown and pale green rock; the former is barren, and the best asbestos is found in the middle of the green bands. The asbestos veins vary from a small fraction of an inch up to 1¼ in. in width. Occasionally they unite to form bands two or three inches wide, but the fibres in these cases are not continuous across the width. Thus the asbestos produced is somewhat short, but there is a considerable proportion of good marketable fibre. As the table on p. 456 shows, the output is steadily increasing.

Barytes.—Barytes, of granular texture, is known to form extensive deposits in granite near Que Que. One mass is over 300 feet long and about 20 feet wide on the average. The deposits lie to the west of the railway and within two miles of Gado Siding.

Bismuth.—Bismuth minerals occur in the Mazoe, Lomagundi and other districts, often associated with gold-bearing veins. A specimen of bismuth ore recently received at the Imperial Institute contained 79 per cent. of bismuth.

Chromite.—Rhodesia is now the world's largest producer of chrome ore. The mineral is mined at Selukwe, where it occurs in talc-schist and silicified serpentine. These rocks form the northern and eastern boundaries of the Mont d'Or granite mass, which is about ten miles long and four miles wide. On the southern margin of the granite they do not carry chromite. The mineral occurs as disseminated crystals in these and the associated rocks, and also forms isolated lenticles of massive and crystalline chromite, weighing from a few pounds to many thousands of tons. These ore-bodies occur mainly close to the margin of the talc-schist formation, and some of the chromite has found its way into the adjacent conglomerate. The lenticles are irregular in form and mode of occurrence, sometimes lying parallel with one another, and sometimes without any definite orientation. Most commonly, perhaps, they show a vein-like outcrop, 300 to 400 feet long and 10 or 20 feet in average width, tapering out at the extremities. The ore is mined by open cuts and adits, and is carried by rail to Beira for export.

The chrome ore as mined averages 50·75 per cent. of chromic oxide, and contains considerable amounts of alumina and magnesia. The mineral appears to be intermediate between chromite and picotite, and has a specific gravity of 4·2 when coarsely crystalline and 3·9 when compact. There are large bodies of low-grade ore which are not mined. Analyses of seven samples of the crude ore as sold from the Chrome Mine, Selukwe, published by A. E. V. Zealley in *Trans. Geol. Soc., S. Africa* (1914, **17**, 72) show the following percentage composition: chromic oxide, Cr_2O_3, 41·70 to 51·20; ferrous oxide, FeO, 11·40 to 16·00; ferric oxide, Fe_2O_3, 1·05 to 2·70; alumina, Al_2O_3, 14·50 to 16·30; magnesia, MgO, 8·30 to 15·15; manganous oxide, MnO, 0·40 to 0·70; lime, CaO, 0·50 to 1·05; silica, SiO_2, 4·48 to 11·40; phosphoric acid, P_2O_5, 0·03 to 0·08; sulphur, S, trace; water, H_2O, etc., 1·66 to 2·95; moisture, 0·07 to 0·14.

Large masses of low-grade chromite are said to occur in serpentine and talc-schist in the Umtebekwe Valley, north of Selukwe. Other occurrences are known at Victoria, Makwiro, Lomagundi and elsewhere, some, if not all of them, being connected with a great intrusion of ultrabasic rocks, which runs southward from the Zambesi for 300 miles.

The results of analysis of Rhodesian chromite at the Imperial Institute are given in this BULLETIN (1907, **5**, 136).

Coal.—Coal-bearing strata of Karroo (Permo-Carboniferous) age occupy considerable areas in Southern and Northern Rhodesia. The coal-fields occur in the low-lying country of the Zambesi basin, and in the Limpopo and Sabi river valleys in the south. In the northern area are the coal-fields of Wankie, Lubu, Sengwe, Mafungabusi, Angwa, and the Luano Valley (in Northern Rhodesia), while the southern area includes the Tuli, Massabi and Sabi coal-fields.

The Wankie colliery, sixty-eight miles from the Victoria Falls on the line to Bulawayo, is at present the sole producer of coal in Rhodesia. The output in 1916 was nearly half a million tons, of which 308,730 tons were sold at an average price of 8*s.* 6*d.* per ton. In addition to the coal sold, 99,158 tons were converted into metallurgical coke, and 1,347 tons were used in the manufacture of firebricks. The coal-bearing rocks consist of sandstones, grits, shales and fireclay, and contain leaves of *Glossopteris* and other fossils. They rest on ancient gneisses, and are succeeded by the Batoka basalts. The main coal seam, which is the only one worked, varies between 7½ and 13½ feet in thickness, and there are two higher seams as yet unworked. The main seam dips to the north at an angle of about 2½°. It has a strong roof of shale, and is reached by an incline of 1 in 7. East and west slants are driven at an angle of 45° from the main dip heading, and the seam is worked on the pillar and stall system, 5½ feet being taken out at the first operation, while the remainder of the seam is shot down subsequently. There are no shale partings in the seam. Analyses of five samples taken at random over the thickness of the seam showed fixed carbon 62·72 to 65·13 per cent.; volatile matter, 19·41 to 23·36; ash, 9·70 to 12·96; moisture, 0·61 to 0·83; sulphur, 1·42 to 4·18; evaporative power, 12·67 to 13·46 by Thompson's calorimeter.

The reserves of coal in this and the other coal-fields of Rhodesia were estimated as follows by the Director of the Geological Survey in 1914:

District.	Actual reserve (based on actual thickness and extent).	Probable reserve (approximate estimate).	Possible Reserve.
	Metric tons.	*Metric tons.*	
Tuli:			
Umsingwani	5,100,000	—	Relatively large.
Singmesi	1,785,000	—	
Massabi	36,720,000	30,464,000	
Sabi	7,807,000	—	Relatively large.
Wankie	201,200,000	400,000,000	—
Sebungu Mafungabusi:			
Lubu	—	81,550,000	—
Sengwe	69,700,000	—	—
Mafungabusi	74,590,000	—	—
Lufua and Losito	—	38,080,000	Large.
Luano	22,415,000	—	Large.
	419,317,000	550,094,000	—

Actual reserve	419,317,000	*metric tons.*
Probable reserve	550,094,000	,, ,,
Total	969,411,000	,, ,,

Copper.—The chief producer of copper ore in Southern Rhodesia is the Falcon Mine in the Umvuma district. The matte produced at this mine contains gold as well as copper. The metallurgical plant is large and up-to-date, and treats copper and gold ores from other mines. The rest of the output comes mainly from mines in the Lomagundi district, while North-Western Rhodesia has copper mines at Bwana M'Kubwa, Kansanshi and elsewhere. The two localities last mentioned are near the Katanga copper district of the Belgian Congo, and the ores consist largely of impregnations in sedimentary rocks, as is the case at Katanga and the Otavi district in South-West Africa. Elsewhere the copper occurs in sulphide lodes, which are in many cases auriferous. Several mines are on the sites of ancient workings.

Corundum.—This mineral occurs in crystals of fair size in granite and pyroxene-garnet-granulite at Rusapi. Loose blocks of rock composed largely of corundum occur at Bembesi, and corundum pebbles are abundant in the gravels of the Limpopo near Rhodes' Drift. Corundum of gem quality, in the form of ruby, amethyst and sapphire, occurs in the Somabula gravels (see next section—Diamonds, etc.).

Diamonds and other Precious Stones.—The output of precious stones comes almost exclusively from the gem-bearing gravel of the Somabula Forest, some eighty miles north-east of Bulawayo and twelve miles south-west of Gwelo. The gravel occurs, between beds of sand, on the top of ridges of granite, and is 40 or 50 feet thick, while the whole series of sand and gravel reaches a thickness of 150 feet. The gravel yields diamond, ruby, sapphire, oriental amethyst, chrysoberyl, catseye, alexandrite, aquamarine, blue and white topaz, and other stones. Diamonds also occur in pipes of kimberlite near Bembesi and elsewhere, and in some of the river gravels.

Gold.—Gold furnishes about 80 per cent. by value of Rhodesia's mineral output, and the country ranks fifth among the gold-producers of the world. In Southern Rhodesia the annual production amounts to about 900,000 oz., which is fairly evenly divided between Matabeleland and Mashonaland, while a few hundred ounces come from

Northern Rhodesia. The gold production of each district of Southern Rhodesia in recent years is given in the following table:

	1914.	1915.	1916.	1917.
Matabeleland:	Oz.	Oz.	Oz.	Oz.
Bulawayo	202,719	171,762	192,734	197,722
Gwelo	239,427	254,648	266,349	236,535
Mashonaland:				
Hartley	184,226	206,018	190,721	157,665
Lomagundi . . .	41,330	62,587	59,559	34,823
Mazoe	41,232	39,150	34,311	31,213
Salisbury . . .	86,421	135,983	141,718	129,219
Umtali	48,984	38,002	35,579	37,937
Victoria	10,141	6,879	9,385	9,117
Total, Southern Rhodesia .	854,480	915,029	930,356	834,231

The gold occurs as impregnations and in quartz veins and sulphide lodes in a series of ancient schists, and occasionally in the granite which is intrusive in them. Very little alluvial gold has been obtained. Most of the mines are on the sites of ancient workings for gold, few of which reached a greater depth than about 70 feet. The dominant minerals of the lodes vary in different localities, and include pyrite, pyrrhotite, arsenopyrite, chalcopyrite, galena, zinc-blende, antimonite, jamesonite, bismuthinite and scheelite.

Gold-bearing rocks from Sasare, in North-Eastern Rhodesia, and other localities are described in this Bulletin (1904, **2**, 77; 1907, **5**, 139).

Graphite.—This mineral occurs at Belingwe, Victoria, Gwanda, Malindi and elsewhere, but is usually impure. Samples of Rhodesian graphite examined at the Imperial Institute have been described in this Bulletin (1909, **7**, 168).

Iron Ores.—Iron ores are widely distributed, and extensive old workings and slag-heaps exist. At present, however, there is little likelihood of their being worked for iron, though a small amount of ironstone is raised for use as a flux at the Falcon copper mine (see p. 461). The most important potential supplies of iron ore are in the Banded Ironstone Series of ancient rocks, where large bodies of fairly pure hæmatite occur. Superficial deposits of laterite cover wide areas and vary much in composition. There are also deposits connected with igneous rocks and lodes.

Analyses of iron ores from North-Eastern Rhodesia are given in this BULLETIN (1904, **2**, 74) and reports on samples from Southern Rhodesia are given later (p. 467).

Lead.—Galena is a common mineral in the gold-bearing lodes of Rhodesia, and small amounts of lead have been recovered as a by-product in the extraction of gold and silver. Lead, zinc and vanadium minerals occur in the limestone of Broken Hill, in North-Western Rhodesia, and the lead is being extracted. Some of the lead from Broken Hill is used in the manufacture of lead nitrate, which now takes the place of imported lead acetate in the extraction of gold in cyanide plants. Northern Rhodesia exported 1,282 tons of lead in 1916.

Limestone.—Limestones occur in many districts and are burned for lime. In some instances the magnesium content is too high for the lime to be used in the extraction of gold by the cyanide process, and for certain other purposes. The rock from the Sinoia Caves, Lomagundi, for example, is a dolomite containing 54 per cent. of calcium carbonate and 43 per cent. of magnesium carbonate, but it would make a useful flux for metallurgical purposes. Many magnesian limestones are burned and yield good lime for plaster, whitewash and other uses, as at Lusaakas in North-Western Rhodesia. Good limestones are also burned at Chishawasha, near Salisbury, between Umtali and Melsetter, and at Claremont near Bulawayo. In the last locality only about 0·5 per cent. of magnesia is present in the rock. Concretionary limestone occurs at and near the surface in many localities, and there are deposits of travertine in the Mazoe, Gwelo, and other districts, which usually contain from 2 to 5 per cent. of magnesium carbonate. A limestone from near Que Que of good quality for cement-making has been examined recently at the Imperial Institute (see p. 468). A cement factory has been started near Bulawayo, and the material produced is said to be equal in all respects to the best Portland cement imported. Calcium carbide is being made at the Falcon Mine.

Magnesite.—This mineral occurs in some quantity in veins in serpentine at Lomagundi, and is also reported from Gwanda, Belingwe and Enkeldoorn. A specimen of magnesite from the last-named locality is described, with an analysis, in this BULLETIN (1912, **10**, 484).

Manganese.—Lateritic manganese ore occurs in the neighbourhood of the Somabula diamond workings, but apparently not in quantity.

Mica.—Good-sized masses of muscovite occur in the Tuli district and near Selukwe, Wankie, Umtali, Impantene (Geelong) and elsewhere. Lepidolite, a lithia-mica, is abundant in greisenised pegmatites in the Enterprise district, near Salisbury, and between Umtali and Melsetter, and zinnwaldite occurs in the lithia-greisens of Odzi, near Umtali.

Molybdenite.—Molybdenite occurs in the Salisbury, Bulawayo, Gadzema, Victoria and Mazoe districts, near the Umfuli River, and west of Gatooma. In some cases it is found in fairly rich patches, but none appears to have been mined.

Nickel.—Occurrences of nickel ore are known in many localities in Rhodesia, but the amount is small.

Phosphates.—Triplite, a fluor-phosphate of manganese and iron, containing 30 to 35 per cent. of phosphoric acid (P_2O_5), has recently been found in considerable quantity, associated with bismuth minerals, on the Angwa River, Lomagundi district. In view of the shortage of phosphatic fertilisers in South Africa, it has been suggested that if the bismuth ore can be profitably mined the triplite might be obtained as a by-product, and finely ground or otherwise treated for use in agriculture. Pot-culture trials are being made at Salisbury to test the efficacy of the ground mineral as a manure.

Platinum.—The probability of the occurrence of platinum in the basic and ultra-basic rocks of Rhodesia has long been recognised, and it has been detected in the Selukwe chromite. In 1917 a deposit on Glencraig (Guburie) Farm, about six miles east by north of Indiva Siding, in the Gwelo district, was visited by the Southern Rhodesia Geological Survey. A sample of 40 lb. of the material was crushed and concentrated by panning to about 2 lb., and this was assayed at the Imperial Institute, and found to contain 1 dwt. 20 grains of platinum per ton. The deposit is in the Great Dyke of Norite, which is here about four miles wide and consists of serpentinised dunite with bands of enstatite rock. Magnetite and chromite are abundant, forming nests in serpentine, and there is a gossan consisting largely of hæmatite and chalcedony, with small amounts of copper and nickel minerals. The gossan is 4 or 5 feet in greatest width and has been traced for about 100 feet.

Potash.—Bat-guano from caves, containing potassium nitrate, forms a valuable manure for local use at Figtree, Lomagundi, Bwana M'Kubwa and elsewhere. Potassium nitrate is also recorded from Belingwe. Samples of potash-bearing materials examined at the Imperial Institute are dealt with on page 469.

Silver.—Silver is obtained as a by-product at the gold-mines, where it occurs as an impurity in the gold. The natural alloy electrum, containing about 40 per cent. of silver, occurs in the Hanover Mine, Filabusi, and native silver has recently been found with copper ore in the Lomagundi district. Argentiferous galena, zinc-blende and arsenopyrite form considerable proportions of the lodes worked in the Umtali district. Silver is also present in the chalcopyrite of some mines.

Talc and Steatite.—These minerals are of frequent occurrence in the serpentines of the great intrusion of ultra-basic rocks already mentioned.

Tantalum.—Tantalite occurs in coarse radiating masses in the Victoria tin-field, with another tantalum mineral which may be microlite. The lithia-greisens of the Odzi Reserve, west of Umtali, also yield small amounts of tantalite and microlite. A specimen of the latter mineral has been examined at the Imperial Institute, and is dealt with on p. 475. The Victoria tantalite contains a considerable amount of tin oxide; it occurs in a quartz-reef associated with dykes of pegmatite and greisen in epi-diorite.

Tin.—In the Enterprise district, east of Salisbury, and the Ndanga district, east of Victoria, there are promising deposits of tinstone in pegmatite dykes which are more or less greisenised. Greisens west of Umtali have recently been found to contain tin, tantalum and tungsten minerals. Tin-bearing pegmatites are also known in the Mazoe and Shamva districts, and tin and copper ores occur together in chlorite-schist near the Umniati River. Many of the lodes have been prospected, and trial samples of ore have been produced, but the high working costs render it doubtful whether the ore can be extracted at a profit.

Tungsten.—Wolframite is obtained from the rubble overlying dykes of greisen near Essexvale station, east of Bulawayo. The mineral is found on the surface over a wide area here, sometimes in masses weighing one or two hundredweights, and it also occurs on the Sabi River in association with scheelite and copper ores. Scheelite is of common occurrence in the auriferous quartz veins, and in some cases might probably be saved as a by-product. It is known in the Mazoe and Bubi districts, at Hartley, Gadzema, Umsingwane, Penhalonga and other localities. A promising deposit is being developed near Que Que. Scheelite was formerly mined in a quartz vein in granite near Gatooma, and a total output of 46½ tons of hand-cobbed ore was obtained.

Vanadium.—The minerals descloizite and vanadinite are associated with the zinc and lead ores of Broken Hill in North-Western Rhodesia. They are found in the gossan of the kopjes and have not been detected in the unoxidised ore. Coarsely crystalline descloizite sometimes forms pockets nearly a foot across, and there are also compact seams and incrustations of this mineral. It seems likely that a considerable amount of vanadium ore might be obtained at Broken Hill, either by hand-picking or in the treatment of the zinc and lead ores. Several tons of vanadium ore are said to be lying in the dumps.

Zinc.—Zinc-blende is known in a number of localities, and is usually associated with auriferous and argentiferous galena, *e.g.* in many of the gold-mines of the Umtali, Gatooma, Lower Gwelo, Filabusi, Selukwe and Gwanda districts. At Broken Hill, in North-Western Rhodesia, zinc-blende and galena are found in limestone, and in the oxidised gossan there are a number of interesting zinc, lead and vanadium minerals. A considerable amount of zinc ore is known to exist, but metallurgical difficulties have hitherto prevented its utilisation, though the lead ore is being mined and smelted.

II. Results of Examination of Rhodesian Minerals at the Imperial Institute

Iron Ore

Four samples of iron ore from Southern Rhodesia have been received in recent years. The locality from which the first two samples were derived was not stated. The others came from the Sabi district and from near Que Que, respectively.

No. 1.—This sample, which was received in March, 1914, consisted of highly siliceous iron ore, having a specific gravity of about 3·6. It gave the following results on chemical examination :

		Per cent.
Total iron	Fe	44·80
Silica	SiO_2	32·92
Loss on ignition		3·62

This material contained too much silica to be of value as an iron ore for export. It might, however, be utilised for smelting in Rhodesia, if the deposits are extensive and supplies of suitable cheap fuel and limestone are available locally.

No. 2.—This sample, which was received with sample No. 1, consisted of magnetite (magnetic iron ore), having a specific gravity of about 5. It contained 68·77 per cent. of iron (Fe) and 0·98 per cent. of titanium dioxide (TiO_2).

This material consisted of almost pure magnetic oxide of iron, and would be an excellent ore if it could be obtained in large quantities. It was pointed out to the Rhodesian authorities that if there is reason to suppose that much ore of this quality is available, the deposits should be thoroughly examined and a large representative sample of the ore obtained for complete analysis and valuation.

No. 3. *Iron Ore from Sabi District.*—This sample, which was received in July 1917, consisted of black magnetic iron ore. It was submitted to chemical examination with the following results :

		Per cent.
Ferric oxide	Fe_2O_3	79·20 } [1]
Ferrous oxide	FeO	16·41 }
Silica	SiO_2	0·88
Titanium dioxide	TiO_2	0·80
Phosphorus	P	0·05
Sulphur	S	0·06

[1] *Equivalent to* 68·21 *per cent. of metallic iron* (*Fe*).

This sample represents an iron ore of good quality, which would be suitable for the production of pig-iron or steel.

No. 4. *Iron Ore from near Que Que.*—This sample, received in November 1917, consisted of crushed hæmatite. It was submitted to chemical examination with the following results :

		Per cent.
Ferric oxide	Fe_2O_3	82·26[1]
Ferrous oxide	FeO	nil
Silica	SiO_2	9·16
Sulphur	S	0·05
Titanium dioxide	TiO_2	0·13
Phosphorus	P	0·09
Manganese tetroxide	Mn_3O_4	1·04
Loss on ignition		3·81

[1] *Equivalent to* 57·54 *per cent. of metallic iron* (*Fe*).

This was a fairly good iron ore, containing only small amounts of phosphorus and sulphur. It could be used for the production of pig-iron or steel by the acid process.

Limestone

A sample of crushed limestone, obtained from near Que Que, was received in November 1917. It gave the following results on chemical examination :

		Per cent.
Lime	CaO	52·83
Magnesia	MgO	1·62
Alumina	Al_2O_3	0·72
Ferric oxide	Fe_2O_3	0·20
Silica	SiO	0·40
Loss on ignition		44·06

This was a limestone of good quality, which would be suitable, along with a good clay, for the manufacture of Portland cement, and would give a high-grade building lime. It could also be used in iron smelting.

Potash

"Saltpetre Rock"

A specimen of so-called "saltpetre rock" from Northern Rhodesia was received in July 1916. The material consisted of calcareous tufa impregnated with potassium nitrate. The deposit, which occurs in a precipitous gorge on the Kelewa River, a tributary of the Kafue River in the Chilanga Sub-district, is not extensive, and the presence of the saltpetre appears to be derived originally from the excrement of colonies of baboons, which inhabit caves in the rocks. The deposit is worked to some extent by natives, who prepare from it crude potassium nitrate, which is used for making gunpowder.

The sample received at the Imperial Institute was submitted to chemical examination, and was found to contain 3·50 per cent. of potassium nitrate (KNO_3).

The result obtained indicates that, with the present high price ruling for potassium salts, the material represented by this sample would probably repay treatment, if it is available in sufficient quantity. As mentioned already, however, the deposit is not extensive, and the Resident Mining Engineer, Rhodesia, who made a special visit to the locality to examine the occurrence, considers that it would not pay to exploit it on a large scale. It was suggested to the Rhodesian authorities that the natives might be encouraged to work the deposits to a greater extent than hitherto.

Crude Potash Salt

A small supply of saline material, which was stated to have been obtained from a sample of banded ironstone by leaching the crushed ore with water and evaporating the solution to dryness, was received from Rhodesia in April 1917. It was a white crystalline powder consisting chiefly of a mixture of sulphates. On chemical analysis the following results were obtained :

		Per cent.
Potash	K_2O	18·80[1]
Soda	Na_2O	5·77
Ferric oxide	Fe_2O_3	nil
Alumina	Al_2O_3	
Lime	CaO	2·00
Magnesia	MgO	9·84[2]
Sulphuric acid	SO_3	42·70
Chlorine	Cl	1·55
Nitrates, expressed as nitric anhydride	N_2O_5	1·56
Moisture and combined water	H_2O	17·55
Matter insoluble in water		0·44

[1] *Equivalent to* 31·0 *per cent. of potassium sulphate* (*K_2SO_4*) *and* 3·3 *per cent. of potassium chloride* (*KCl*).

[2] *Equivalent to* 29·5 *per cent. of magnesium sulphate* (*$MgSO_4$*).

This material contained enough potassium sulphate to be a useful source of this salt, which could probably be separated from certain of the other constituents by fractional crystallisation; sulphates of magnesium and sodium, and sodium nitrate, being obtained as by-products.

From the results of small preliminary experiments it appears probable that the potassium will crystallise as a double sulphate with magnesium, $MgSO_4$, K_2SO_4, $6H_2O$, similar to that produced in the Stassfurt recrystallisation works.

The crude material would be suitable for use as a potash manure, except possibly for plants which are naturally sensitive to sodium sulphate. For purposes of comparison the following figures for German potash manures may be quoted:

		I. Crude kainit from Stassfurt. Per cent.	II. Sulphate of potash-magnesia from Stassfurt. Per cent.	III. Present sample from Rhodesia. Per cent.
Potassium sulphate	K_2SO_4	21·3	50·4	31·0
Potassium chloride	KCl	2·0	—	3·3
Magnesium sulphate	$MgSO_4$	14·5	34·0	29·5
Magnesium chloride	$MgCl'$	12·4	—	—
Sodium chloride	$NaCl$	34·6	2·5	—
Sodium sulphate	Na_2SO_4	—	—	10·5[1]
Sodium nitrate	$NaNO_3$	—	—	2·4[1]
Calcium sulphate	$CaSO_4$	1·7	0·9	4·9[1]
Water	H_2O	12·7	11·6	17·55
Matter insoluble in water		0·8	0·6	0·44

[1] *Calculated for hypothetical combinations.*

The Rhodesian sample approximates in general composition to Stassfurt potash-magnesia salts represented by Analysis II in the above table, but it contains less potash, and includes a fair quantity of sodium sulphate. Stassfurt salt, as represented by Analysis II, found a ready sale before the war; thus, in 1913, 59,207 tons, valued at £275,191, were exported from Germany.

Hæmatite Shale

Two samples, stated to represent the crude ore from which the foregoing saline material was prepared, were subsequently received.

No. 1, which weighed 17 lb., was a crushed hæmatite shale containing some siliceous and saline impurity.

It was examined chemically with the following results :

		Per cent.
Total potash	K_2O	2·78
,, soda	Na_2O	0·64
,, matter soluble in water		10·01[1]
,, iron expressed as ferric oxide	Fe_2O_3	68·0

[1] *This yield represents the dry salts and does not include water of crystallisation.*

The matter soluble in water had the following composition, the percentages being expressed on the original material :

		Per cent.
Potash	K_2O	2·75
Soda	Na_2O	0·37
Lime	CaO	1·03
Magnesia	MgO	0·46
Chlorine	Cl	0·16
Sulphuric acid	SO_3	4·79
Nitric acid	N_2O_5	0·37

A small quantity of organic matter was also present. It will be seen that the whole of the potash contained in the crude material is soluble in water.

The calculated hypothetical composition of the soluble salts is as follows, the percentages being expressed as before on the original material :

		Per cent.
Potassium sulphate	K_2SO_4	4·70
Sodium sulphate	Na_2SO_4	0·35
Magnesium sulphate	$MgSO_4$	1·36
Calcium sulphate	$CaSO_4$	2·63
Sodium nitrate	$NaNO_3$	0·59
Potassium chloride	KCl	0·33

This sample of hæmatite shale therefore contains 4·7 per cent. of potassium sulphate and a little potassium chloride.

The yield of 10 per cent. of dry salts from the crude material, as shown in the table on p. 471, represents the maximum amount obtainable when the material is very finely ground and completely extracted by hot water. This treatment, however, removes a large amount of calcium sulphate from the crude material and experiments were therefore made using a much smaller quantity of water in order to determine whether the whole of the potash could be extracted in this way without so much calcium sulphate. In these experiments the crude material was ground to pass a sieve having thirty meshes to the linear inch, and extracted with successive quantities of boiling water, together amounting to six times the weight of material treated. It was found that under these conditions the whole of the potassium, sodium and magnesium salts were removed, but only about 25 per cent. of the calcium sulphate, the total yield of dry salts being 7·5 per cent. as compared with 10 per cent. obtained in the total extraction. This method of treatment would therefore be more satisfactory for use on a large scale as the bulk of the calcium sulphate would be left behind in the insoluble residue.

It is of interest to note that the ratios of magnesia to potash, and soda to potash in the soluble salts, are both considerably lower than in the case of sample No. 2 (p. 473), or of the sample of soluble salts previously examined (p. 470).

The residue remaining after the total extraction of the soluble salts contains about 75 per cent. of ferric oxide and about 15 per cent. of silica, and might be used for smelting locally, but would need briquetting.

Further experiments were made with a view to obtaining some indication of the possible behaviour of the soluble salts on fractional crystallisation. It was found that if the soluble salts obtained by treating the crude material with six times its weight of water are separated into five approximately equal fractions by recrystallisation, the composition of the fractions will be roughly as follows :

Fraction 1. Potassium sulphate and calcium sulphate, which could be largely separated by further crystallisation.

Fraction 2. Largely potassium sulphate.

Fraction 3. Largely potassium sulphate with some magnesium sulphate.

Fraction 4. Approximately equal amounts of potassium and magnesium sulphates.

Fraction 5. Largely magnesium sulphate with some sodium nitrate, potassium chloride and sodium sulphate.

No. 2.—This weighed ¾ lb. and consisted of powdered hæmatite shale closely similar in appearance to No. 1, but more finely powdered and containing a larger proportion of soluble matter. On complete extraction with hot water it yielded 49·92 per cent. of soluble salts, this yield representing the dry salts free from water of crystallisation. The total amount of calcium sulphate present in this sample was very much less than in No. 1.

The soluble salts had the following composition, the percentages being expressed on the original material :

		Per cent.
Potash	K_2O	12·62
Soda	Na_2O	2·43
Lime	CaO	0·82
Magnesia	MgO	6·30
Chlorine	Cl	trace
Sulphuric acid	SO_3	25·90
Nitric acid	N_2O_5	1·90

The calculated hypothetical composition of the soluble salts is shown in the following table :

		Per cent.
Potassium sulphate	K_2SO_4	23·36
Sodium sulphate	Na_2SO_4	2·59
Magnesium sulphate	$MgSO_4$	18·90
Calcium sulphate	$CaSO_4$	1·99
Sodium nitrate	$NaNO_3$	3·00

The ratio of magnesia to potash in the soluble salts from this sample is approximately the same as in the sample of crude potash salt previously examined (p. 470) but the ratio of soda to potash is lower.

The composition of the soluble salts extracted from these two samples of hæmatite shale is given in the following table, in comparison with the composition of the sample of soluble salts previously examined. The percentages are expressed on the dry material in each case.

	Present samples.			
	No. 1. Total extraction.	No. 1. Extraction with six times its weight of water.	No. 2. Total extraction.	Previous sample.
Potassium sulphate .	47·0	59·0	46·7	37·5
Potassium chloride .	3·3	4·1	—	4·0
Sodium sulphate . .	3·5	4·4	5·2	12·7
Sodium nitrate . .	5·9	7·4	6·0	2·9
Magnesium sulphate .	13·6	17·2	37·8	35·8
Calcium sulphate . .	26·3	7·9	4·0	5·9
Insoluble matter . .	—	—	—	0·5

It is clear from these figures that the composition of the soluble salts extracted from this hæmatite shale is liable to considerable variation, especially with respect to the proportions of sodium and magnesium sulphates present. The amounts of soluble matter in the two samples of shale also differ widely, being 10 per cent. in No. 1 and 49·9 per cent. in No. 2.

Sample No. 1 contained 4·7 per cent. of potassium sulphate, and, when extracted with six times its weight of water, gave about 7·5 per cent. of dry soluble salts, nearly three-fifths of which was potassium sulphate. The mixed soluble salts extracted from this shale could be used as a potash manure, or potassium sulphate might be prepared from the mixture by fractional crystallisation. For the latter purpose it would be necessary to devise a suitable process for separating the potassium sulphate from the magnesium sulphate which is also present.

Sample No. 2 contained nearly 50 per cent. of soluble salts, of which potassium sulphate formed nearly one-half. In this case also the extracted salts could be employed as as manure or they might serve as a source of potash salts. The soluble salts from this sample would, however, not be so desirable as those from No. 1 for the preparation of potash salts, owing to the larger quantity of magnesium salts contained in the crude mixture.

The insoluble residue in each case might be utilised as an iron ore.

If the soluble salts can be produced from this hæmatite shale in large quantities there is very little doubt that with potash salts at the present exceedingly high prices the manufacture of potassium sulphate from the material would be a profitable undertaking. If, however, Stassfurt salts again become freely available after the war, it is doubtful whether potassium sulphate could be made and exported from Rhodesia at a profit, though it might still be possible to manufacture it for local use as a manure and perhaps for export to neighbouring African territories.

As an indication of the competition which might have to be met from the Stassfurt salts, it may be mentioned that it was estimated that in 1913 the cost of production of "manure salt" containing 38 per cent. of potassium oxide was 42*s.* per ton, and that of potassium sulphate £4 9*s.* 1*d.* per ton, in the Stassfurt district. The export values of these two salts as shown in the official German Trade Returns were £3 10*s.* per ton, and £8 15*s.* per ton respectively.

It is improbable that prices as low as this will be reached for potash salts after the war, but in calculating the prospects of a Rhodesian export industry in potassium sulphate these values should be taken into account. As regards the home market in Rhodesia, the export values of the German salts quoted above would be considerably increased by other charges including the cost of freight to Rhodesia.

The commercial possibilities of this deposit of hæmatite shale will depend on the quantity of shale available, its average richness in soluble salts and the proportion of potash present in the latter, and the cost of extraction in Rhodesia. Until precise information on these points has been obtained it will not be possible to express a definite opinion as to the importance of the deposit as a possible source of potash salts.

Tantalum Ore

A sample of microlite concentrate was received in March 1917. It consisted of material in the condition of a sand, and was composed chiefly of heavy yellowish grains of microlite, mixed with a little impurity which was largely micaceous and appeared to be possibly lithium mica.

An analysis of the microlite gave the following results :

		Per cent.
Tantalic acid	Ta_2O_5	63·41
Niobic oxide	Nb_2O_5	16·80
Ferric oxide	Fe_2O_3 [1]	0·27
Uranium oxide	U_3O_8	0·10
Maganese oxide	MnO	trace
Titanium dioxide	TiO_2	nil
Stannic oxide	SnO_2	trace
Ceria and allied oxides	Ce_2O_3, etc.	0·50
Lime	CaO	12·75
Magnesia	MgO	0·70
Potash	K_2O	0·50
Soda	Na_2O	3·52
Sulphuric acid	SO_3	0·06
Arsenic	As	nil
Silica	SiO_2	0·50
Fluorine	F	not estimated
Loss on ignition		0·50

[1] *Including ferrous oxide.*

A firm of mineral merchants in Liverpool offered to purchase one ton of this material containing not less than 55 per cent. of tantalic acid (Ta_2O_5), at the rate of 55*s.* c.i.f. Liverpool per unit per cent. of tantalic acid, per ton of ore. The Imperial Institute has been informed, however, that the results of development work at the mine proved disappointing, and that for the present work there has been stopped.

GENERAL ARTICLES

THE EMPIRE'S TRADE IN WOOL IN ITS RELATION TO THE WOOL TRADE OF THE WORLD

In connection with an enquiry in progress at the Imperial Institute with respect to the trade in wool, more especially as it affects India and the Empire, the following article has been prepared by Mr. A. S. Judge, lately Chief Collector of Customs in Burma, who has kindly placed his services at the disposal of the Imperial Institute in connection with the Indian Trade Enquiry now in progress.

The world's production of wool has been estimated by various authorities at about 3,000 million pounds. These estimates are based on the production of wool in Europe and North America, and on the imports into those countries from other parts of the world. No account is taken of the wool produced and used outside Europe and North America. Mohair, Alpaca, Vicuna, and Camels'-hair are included in the estimates, but not ordinary goats'-hair. None of the estimates differentiate between "greasy" and "scoured and washed" wool. The estimates of production for certain countries relate obviously to clean wool, and for other countries to wool in the grease, or to both greasy and clean wool. Raw wool loses a considerable amount of weight after being washed and scoured; an estimate of 3,000 million pounds as the world's production of wool would be too high, therefore, if it referred to wool on a clean scoured basis, and too low for wool in the grease. The quantity of "wool yolk," or grease naturally present in wool, varies largely with season, locality, breed, and condition. It has been estimated that the loss in weight sustained by the removal of impurities from wool by washing and scouring ranges from 15 to 25 per cent. in the coarse and long lustrous wools; from 25 to 40 per cent. in medium and fine cross-bred wools; and from 40 to 55 per cent. in fine merino wools. In Australia, where merino wools are largely grown, it is estimated that 2 lb. of greasy wool are on an average required to produce 1 lb. of scoured and washed wool.

Among impurities contained in wool as it comes from the sheep, which must be removed before the wool can be used by the spinner, is a material called "suint," the dried sweat of the sheep. It is soluble in water, and consists principally of potash salts, which will average about 4½ per cent. of the weight of the crude wool. In addition to suint, crude wool also contains grease, and any process for recovering potash from wool must include the recovery of the grease also to be commercially profitable. Wool grease is used for dressing leather and for lubricating purposes, and it is also the source of the very valuable material known as lanolin used in pharmaceutical preparations.

Production of Wool

The following estimate of the world's wool production was published by the National Association of Wool

Manufacturers, U.S.A., and relates to pre-war conditions. Although not specifically stated, the figures are evidently meant to refer to wool in the grease; they also include hairs, which are usually classed as wools. The estimates for countries in South America, Africa, Asia, and Australasia relate only to quantities exported, and do not include wool used locally. Apparently no account has been taken of the quantity of wool imported into Europe on the skin.

Europe	*lb.*
Austria-Hungary	41,600,000
France	75,000,000
Germany	25,600,000
Italy	21,500,000
Portugal	10,000,000
Russia-in-Europe	320,000,000
Spain	52,000,000
Turkey and Balkan States	90,000,000
Greece	16,000,000
United Kingdom	121,000,000
All other countries	30,000,000
Total	802,700,000

North America	
United States	288,777,000
Canada	11,210,000
Mexico	7,000,000
Total	306,987,000

Central America	
	750,000

South America	
Argentina	264,500,000
Brazil	35,000,000
Chile	17,000,000
Peru	9,420,000
Uruguay	143,293,000
Falkland Islands	3,200,000
All other countries	5,000,000
Total	477,413,000

Asia	*lb.*
British India	60,000,000
China	50,000,000
Persia	12,146,000
Russia-in-Asia	60,000,000
Turkey-in-Asia	90,000,000
All others	1,000,000
Total	273,146,000

Africa	
Algeria	33,184,000
British S. Africa	157,761,000
Tunis	3,735,000
All others	13,000,000
Total	207,680,000

Australasia	
Australia	569,775,000
New Zealand	197,266,000
All others	100,000
Total	767,141,000

Grand Total	
Europe	803,400,000
North America	306,987,000
Central America	750,000
South America	477,413,000
Asia	273,146,000
Africa	207,680,000
Australasia	767,141,000
Total	2,836,517,000

The great changes brought about by the war, and the difficulties experienced by belligerent countries in supplying their usual customers have resulted in a great extension of the woollen industry in countries outside Europe. In the future it will be necessary, therefore, to take into consideration the consumption of wool in those countries.

Europe

According to the latest pre-war statistics the number of sheep in Europe were distributed as follows :

	No.
Russia, including Finland	44,418,000
United Kingdom	27,911,000
Balkan Peninsula	22,267,000
France	16,211,000
Spain	15,000,000
Austria-Hungary	12,300,000
Italy	9,150,000
Germany	5,521,000
Portugal	3,078,000
Other countries	5,000,000
Total	160,856,000

On the basis of the number of sheep in the country, the yield of 320 million pounds of wool for Russia given in the table opposite is too high. Russia does not produce enough wool for her own requirements, and is a big importer. The estimated yield for the Balkan States also appears to be too high; although, in the past, Austria has been supplied with large numbers of live sheep and sheepskins, very little wool is exported from any of these States. On the other hand, some of the estimates appear to be too low. The average yield of raw wool per sheep in the United Kingdom is about 6 lb., whereas the estimate given in the table works out at less than 4½ lb. per head, and probably relates to clean wool. The following estimate of raw wool is based on the number of sheep :

	lb.	
Russia	180,000,000	average yield of 4 lb. per sheep
United Kingdom	150,000,000	,, ,, ,, 6 lb. ,, ,,
France	80,000,000	,, ,, ,, 5 lb. ,, ,,
Spain	60,000,000	,, ,, ,, 4 lb. ,, ,,
Austria-Hungary	48,000,000	,, ,, ,, 4 lb. ,, ,,
Italy	36,000,000	,, ,, ,, 4 lb. ,, ,,
Germany	30,000,000	,, ,, ,, 5 lb. ,, ,,
Portugal	12,000,000	,, ,, ,, 4 lb. ,, ,,
Balkan States	90,000,000	,, ,, ,, 4 lb. ,, ,,
Other countries	25,000,000	,, ,, ,, 5 lb. ,, ,,
Total	711,000,000	

Since the outbreak of the war there has been a large reduction in the head of sheep on the Continent, and the condition of the remaining sheep is worse owing to the scarcity of proper fodder. In France there was in 1916 a decline of over 25 per cent. in the number of sheep as compared with thefigures for 1913; in the Balkan Peninsula, Russia, and Austria-Hungary the conditions must be even worse. A considerable shrinkage in the head of sheep in the United Kingdom is rapidly taking place, the returns at the close of 1917 showing a decrease of over five million, and a further decrease took place in 1918; it seems doubtful, moreover, whether the quantity and quality of the wool production of the remaining sheep will be maintained, owing to the urgency of selling sheep for slaughter in their wool before they are ready to be shorn. There appears to be no prospect of the expansion of sheep-breeding in Europe, for the industry is declining everywhere with the extension of cultivation. The breed of the sheep in several countries, especially in the Balkan States and Russia, could be improved, however, and larger and superior yields of wool obtained. In Spain, within recent years, Oxford and Shropshire sheep have been introduced, and crossed with Spanish sheep with good results. The production of wool in Europe at the present time is probably less than two-thirds what it was before the war.

North America

There has been a steady decline, in recent years, in the number of sheep in the United States. In 1914, there were about 50 million sheep, a reduction of 5 per cent. as compared with 1910, and in 1916 the number was further reduced by about 3 per cent. About 300 million pounds of wool are produced in the States, and retained for local use. There were about 3 million sheep in Canada before the war, and sheep-breeding was making little progress. Recently, however, much attention is being devoted to this industry, both in Canada and in the United States, and it may be expected that the wool production of North America will advance. There are several million sheep in Mexico, and, although exports of wool are negligible, considerable quantities of wool are required for local use as the woollen industries of the country are of growing importance. It may be estimated that North America produces 320 million pounds of wool.

South America

The following statements show the average exports of wool over a period of years, and the estimated number of sheep in the country.

Name of country.	Average exports, 1901–6. *lb.*	Average exports. 1907–12. *lb.*	Exports, 1912. *lb.*
Argentina	414,085,000	350,763,000	363,570,000
Uruguay	92,877,000	126,568,000	178,070,000
Chile	10,837,000	12,293,000	26,650,000
Peru	8,600,000	9,000,000	8,360,000
Brazil	3,650,000	4,000,000	4,190,000
Falkland Islands	3,500,000	4,200,000	4,500,000
Total	533,549,000	506,824,000	585,340,000

Name of country.	Number of sheep and other wool-producing animals.
Argentina	81,485,000
Uruguay	26,286,000
Brazil	10,653,000
Chile	6,000,000
Peru	2,000,000
Bolivia	1,455,000
Falkland Islands	701,000
Other countries	1,000,000
Total	129,580,000

In addition to the wool exports, a considerable quantity of wool is shipped on the skin, the bulk of which goes to France to be dealt with by the fellmongers in that country. An increasing quantity of wool is being retained in South America for local use; woollen mills have been established in Southern Brazil, Montevideo, and in other places; the hand-loom industry is also to be found in Peru, Chile and in other parts of South America. Judging by the number of sheep and the export statistics, it may be fairly estimated that the production of wool in South America is 600 million pounds.

Argentina.—The sheep first introduced into this country were of the merino type; about 1885 the development of the frozen meat trade, with the consequent demand for large-bodied sheep, led to the introduction of Lincoln and other English sheep.

The merino has gradually been replaced by cross-bred sheep, until at the present time 75 per cent. of the sheep in the country are cross-bred. The exports of wool have declined in recent years; they amounted in 1901 to 500 million pounds, and in 1912 to 363 million pounds. In some provinces sheep-breeding has given place to the growing of crops and cattle raising. At present the most numerous flocks are to be found in the Province of Buenos Ayres, but the future of sheep-breeding seems to be in the Southern Territories, where the climate is unsuited for cattle raising, and where the large area needed for providing the extensive feeding runs for sheep are not devoted to arable land, which is encroaching more and more on pastoral lands in the northern tracts.

The following statement shows the destination of the exports of wool and woolled skins from Argentina in 1912.

	Wool. *Bales.*[1]	Sheep-skins. *Bales.*[1]
United Kingdom	55,579	2,289
United States	40,493	753
France	97,668	61,215
Germany	147,911	1,058
Belgium	47,375	791
Other countries	15,433	776
Total	404,459	66,882

[1] 1 *bale of wool* = 925 *lb.*; 1 *bale of skins* = 881 *lb.*

The bulk of the exports go to the Continent of Europe, the United Kingdom taking on an average about 10 per cent. of her requirements direct from Argentina; a certain quantity of Argentine wool comes, however, to this country from the fellmongers in France.

Uruguay.—In the last fifteen years sheep-breeding has made great progress; the wool exports in 1912 were double the figures for 1902. The growing of crops and cattle raising are now receiving greater attention, and, as they are more profitable industries, it is doubtful whether the production of wool in Uruguay will advance much further. The consular reports show that wool is imported into Montevideo for re-export, the imports in 1910 amounting to 9 million pounds. The source of the supply is not mentioned; the wool must, however, have come either from Argentina or Brazil. France, Belgium and Germany were the principal markets for Uruguayan wool, which consists mainly of the merino type, inferior to both Australian and South African merino.

Chile and the Falkland Islands.—The introduction of sheep-breeding into Patagonia in 1878 by British farmers from the Falkland Islands has made Chile an important producer of wool. The flocks are now estimated to number 6 million sheep, and exports of wool are advancing. Punta Arenas is the centre of the industry, and the trade is mainly with the United Kingdom. Sheep were introduced into the Falkland Islands in 1867; the pasturage being limited, the flocks soon attained their limit, and the sheep-farmers went across to Punta Arenas in Chile, where there is practically unlimited pasturage. To a large extent the new area has been stocked by the surplus sheep from the Falkland Islands. There are about 700,000 sheep in the Falkland Islands, producing between 4 and 5 million pounds of wool. The wool from Punta Arenas and the Falkland Islands has remarkable and distinctive properties; the fibre, being of very light specific gravity, is especially valuable for hosiery and finger-yarn purposes.

Peru and Bolivia.—The wool export trade of Peru, which consists largly of Vicuna and Alpaca, appears to be stationary. The sheep's wool from this area is of a coarse type.

Brazil.—In the provinces of San Paulo and Rio Grande do Sul in Brazil, much attention is being devoted to sheep-breeding, and sheep have been imported from England to improve the local stock. The vast plains of the centre and the south, with their high elevation and good pasturage, are very promising fields for sheep-breeding. In San Paulo an American company has lately undertaken to enter the sheep-raising industry, on a large scale, and has imported Romney Marsh rams from the Argentine to cross with the local sheep. The wool production of Brazil has been estimated at 35 million pounds, of which apparently only 4 million pounds are exported; it is possible, however, that some of the Brazilian production may find an outlet at Montevideo. Some progress has been made in Brazil in the manufacture of woollen and union goods, and woollen yarn, as well as combed and carded wool, is imported from Europe. A considerable quantity of the local output must also be retained for use in the country.

Asia

In the estimates which have been published regarding the production of wool in Asia, only the quantities exported from the various countries have been taken into account. There are no reliable data on which to frame an accurate estimate, but, by examining the trade figures, extent of sheep-breeding, and internal requirements for wool in each country, rough estimates can be made.

India.—Sheep are bred successfully in India in areas receiving a moderate rainfall, especially in the central table-land of the country commencing from the Neilgherries and running north. The wool obtained is usually coarse and of short staple, suitable only for the manufacture of blankets and carpets. According to official statistics there are about 32 million sheep in India; this estimate is, however, incomplete as it does not include several Native States where sheep-raising is of the first importance. The number of sheep in India is probably not less than 50 million, and at a low estimate the production of wool is 125 million pounds. India also imports annually across the land frontiers, principally from Afghanistan, about 25 million pounds of wool. The average exports of Indian and Transfrontier wool have amounted to 63 million pounds, and in 1915–16 the exports were as high as 82 million pounds. By a careful study of the various woollen industries, and of the number of persons engaged in them, it is estimated that the annual consumption of raw wool in the country is between 80 and 90 million pounds. The bulk of the wool retained in India is required for roughly woven blankets, which are made throughout the country and are in universal use. The weaving of carpets and rugs on hand-looms is also an important industry, and a considerable export trade in carpets has been established. The outturn of the woollen mills at work in India in 1915 was over 10 million pounds in weight. In recent years the Agricultural Departments in India have devoted much attention to sheep-breeding, and the sustained and systematic efforts now being made to improve the local breeds of sheep are already showing good results; it remains to be proved, however, whether fine qualities of wool can be produced in the plains of India. It may be roughly estimated that the production of wool in India and the Transfrontier countries trading with India amounts to 160 million pounds.

China.—The average exports amount to about 50 million pounds, which go principally to the United States, and are classed as carpet wool. China also exports about 4 million pounds of camel's hair. In Mongolia, Manchuria, Chinese Turkistan and Tibet wool is largely produced, and with improved communications and trade facilities the export trade could be developed. Wool is extensively used for making felt shoes commonly worn by the Chinese, and the local manufacture of blankets, rugs and cloth also absorbs considerable quantities. The China Year Book for 1916 shows that five woollen mills have been established in the country. Comparing the size of the population, and the climatic conditions of China with India, the requirements for woollen goods in China must be greater than in India. A conservative estimate of the production of wool in China and Tibet would be 200 million pounds.

Persia.—By sea and land Persia exports more than 12 million pounds of wool, and pure woollen carpets to the value of £1,000,000 were exported in 1912. Sheep thrive well and a fair quality of wool is produced. A fair estimate of the wool production of Persia would be 60 million pounds, and it should be possible to develop the export trade when more settled conditions have been established in the country. Sheep and goats are herded together in Persia and other Eastern countries where the flocks suffer from predatory animals. The presence of the goat, a less timid animal than the sheep, prevents the constant stampeding of flocks in the face of danger.

Turkey-in-Asia.—Sheep-breeding is an important industry, and, judging by the imports into the chief manufacturing countries, the exports have averaged about 50 million pounds of wool and mohair. With improved communications, and under a more settled administration, this area should be capable of supplying the world with much larger quantities of wool.

Russia-in-Asia.—This vast country contains large tracts of pastoral land, where sheep are extensively raised. The local consumption of wool for the manufacture of blankets, rugs and cloth must be very great, as the inhabitants are essentially a wool-using people. A certain quantity of wool is exported, but full details of the trade cannot be readily traced. The United States in 1912 obtained 6 million pounds of carpet wool from this source. The production of wool in this area probably exceeds 200 million pounds.

Other Asiatic Countries.—Sheep do not thrive in the moist regions of India, Burma, the Malay Peninsula and Archipelago, Siam, Cochin-China and China, where rice is the principal crop. The intensive cultivation of the land in Japan does not leave any room for sheep-raising. The Japanese Government are now importing Romney Marsh sheep from England with the object of encouraging and developing sheep-breeding within the Empire. Sheep are bred in parts of Arabia, and in recent years small quantities of wool have been exported to India; there is, however, little information on the subject.

Estimate of the wool production of Asia:

	lb.
India and Afghanistan	160,000,000
China and Tibet	200,000,000
Persia	60,000,000
Russia-in-Asia	200,000,000
Turkey-in-Asia	100,000,000
Total	720,000,000

Africa

Before the outbreak of the war Africa was supplying annually about 250 million pounds of wool to the manufacturers in Europe. Sheep-breeding is of growing importance in many parts of the Continent, and there are indications that Africa will be in a position to make good, to a great extent, the shrinkage in wool which has taken place in Europe owing to the ravages of the war.

Union of South Africa.—The following table shows the number of sheep and goats in 1913 and 1916:

	Sheep.		Angora goats.
	Woolled.	Other.	
Cape	12,712,107	3,847,311	2,190,575
Natal	1,927,746	372,547	73,634
Transvaal	3,615,821	877,596	110,805
Orange Free State . . .	8,234,850	392,727	189,275
Total—1916 . . .	26,490,524	5,490,181	2,564,289
Total—1913 . . .	27,331,167	8,557,754	4,395,101

Although periodical droughts cause heavy mortality among sheep, the great advance made in sheep-farming is best illustrated by the growth of the export trade in wool; shipments of sheep's wool which were 23 million pounds in 1860, and 66 million pounds in 1890, advanced to 170 million pounds in 1915. The shipments of mohair also advanced from 9 million pounds in 1893 to 23 million pounds in 1912. About 70 per cent. of the wool is shipped from the Cape and the balance from Natal. South African wool, mainly merino, sells at lower average prices than those obtained from Australia, but the quality is being improved yearly. Within the last few years great improvement has been made in merino sheep; the flocks are becoming more uniform and true to type, and good stud and flock rams are more plentiful, and there is a prospect of a type of sheep being evolved which will be better adapted to the country than the rams and ewes which have hitherto been imported from Australia and elsewhere to improve the local stock. The country is evidently specially adapted for the rearing of the merino type of sheep, as cross-bred Cape wool is practically unknown. Cape wools are known as non-felting wools, and are largely used in the manufacture of flannels. The best sheep in South Africa yield between 6½ and 8½ lb. of wool. The number of hairy sheep belonging to natives is still very large, but in time these will be replaced by the more valuable woolly sheep.

The following table shows the exports of wool and mohair from the Union of South Africa in recent years:

Year.	Sheeps' wool.	Mohair.	Year.	Sheeps' wool.	Mohair.
	lb.	*lb.*		*lb.*	*lb.*
1906 .	88,790,000	15,726,000	1911 .	132,207,000	21,067,000
1907 .	97,772,000	18,700,000	1912 .	161,975,000	23,480,000
1908 .	104,256,000	18,186,000	1913 .	176,972,000	17,356,000
1909 .	130,981,000	19,649,000	1914 .	133,981,000	18,657,000
1910 .	121,669,000	17,817,000	1915 .	170,010,000	16,304,000
Total .	543,468,000	90,078,000	Total .	775,145,000	96,864,000
Average .	108,693,000	18,016,000	Average .	155,029,000	19,373,000

Less than 4 per cent. of the wool is washed and scoured before shipment ; 175 lb. of washed and scoured wool are accepted as equal to 375 lb. of greasy wool.

The average shipments of wool for the five years 1909–13 amounted to 144,760,000 lb., of which 115,118,000 lb., or 80 per cent., went to the United Kingdom. The average quantity retained for use in the United Kingdom was, however, only 49,334,000 lb., or 35 per cent. of the aggregate shipments. For the three years 1910–12 Germany imported on an average 52 million pounds of South African wool, and, as her re-exports were small, it may be assumed that more South African wool was used in Germany than in the United Kingdom. The bulk of the mohair produced in South Africa is taken by the United Kingdom. Since the oubreak of the war the United States and Japan have been buying wool from South Africa on a large scale, and America has also been taking mohair. There are numerous flocks of sheep in Basutoland, Swaziland, Bechuanaland and Rhodesia owned by natives, but at present little wool is produced. There are, however, good prospects that sheep-farming on modern lines can be introduced in these areas.

British East Africa and Uganda.—In the highlands of East Africa and Uganda there are large tracts of land, with good pasturage, where sheep thrive especially well. Some of the finest sheep-country is to be found in the Rift Valley, but there are large areas of suitable land in other parts of the colony, and also in the Rudolf Province of Uganda. The wool industry has made rapid strides in recent years, and is being developed on sound progressive lines. Merino wool of good quality is being produced and placed on the British market in increasing quantities.

In the Agricultural Report for 1915–16, it is stated that the average yield of wool of the sheep is 6¼ lb., and that the general labour expenses in connection with sheep and shearing are much less than in many other countries, while the increase of the flocks is as good and in many instances better. The chief drawback to sheep-farming on a large scale appears to be the presence of wild animals, and the consequent necessity to provide protection for the flocks at night. The number of sheep in British East Africa is estimated at 6½ million, and there are also large numbers in Uganda. Most of these animals are owned by natives, and belong to the indigenous hairy breeds. Now that the grading up of the native sheep has been taken in hand there are good possibilities before the industry in the matter of wool production. The Angora goat has also been introduced into the colony, and mohair, produced locally, has been placed on the market. The improvement in the native goat when crossed by the pure Angora is very marked, and in each successive cross this is clearly to be seen.

German East Africa and South-West Africa.—Before the war efforts were being made by the German Government to create sheep-farms in the African colonies so as to render the supply of wool in Germany less dependent on the Australian clip. Some progress was made, and small quantities of wool were being exported from these colonies. The number of sheep in German East Africa is estimated at about 6 million, but, like those in the adjoining British territory, they are mostly hairy animals. In South-West Africa the sheep number 500,000; in both colonies there are large tracts of land suitable for sheep-breeding, and eventually large supplies of wool should be obtained from these countries.

Egypt.—There are numerous flocks of sheep in the Sudan and some parts of Egypt, and a certain quantity of coarse wool is produced. In 1914 the United Kingdom imported about 4 million pounds, and France 9 million pounds of wool from Egypt; the larger proportion of these shipments consisted probably of wool in transit from other countries.

Algeria.—Sheep-farming is an important industry and the number of sheep in the country is estimated at about 9 million. The wool exports, principally to France, have amounted to over 20 million pounds, and about 1 million live sheep are sent annually to France.

Morocco.—This country contains many sheep, and in recent years the wool trade has been growing. In 1913 the exports amounted to about 12 million pounds, of which about two-thirds went to France, and the balance to Germany. A company was formed in Germany to raise sheep on large tracts of land in Southern Morocco. The wool trade of Morocco should be capable of much greater development when the country is opened up and brought under a civilised administration. The wool production of Northern Africa generally is of poor quality, but by grading up the indigenous sheep much better results will eventually be obtained.

Australasia

Commonwealth of Australia.—The following table shows the distribution of sheep in Australia over a period of years :

	1860.	1890.	1900.	1910.	1915.
	No.	*No.*	*No.*	*No.*	*No.*
New South Wales	6,199,163	55,986,431	40,020,506	45,560,969	32,498,046
Victoria . .	5,780,896	12,692,843	10,841,790	12,882,665	10,545,632
Queensland .	3,449,350	18,007,234	10,339,185	20,331,838	15,950,154
South Australia .	2,824,811	7,004,642	5,235,220	6,267,477	3,674,547
Western Australia	260,136	2,524,913	2,434,311	5,158,576	4,803,850
Tasmania . .	1,700,930	1,619,256	1,683,956	1,788,310	1,624,450
Northern Territory . .	—	45,902	48,037	57,240	57,827
Federal Territory . .	—	—	—	—	102,683
Total . .	20,135,286	97,881,221	70,602,998	92,047,015	69,257,189

In 1891 the flocks reached the highest point, viz. 106,420,000.

Nearly all the sheep-raising sections in Australia are subject to periodic droughts, which often completely destroy all sheep not artificially fed or moved to graze on lands that happen to have a surplus pasture. Owing to four years of drought, between 1898 and 1902, the number of sheep fell from 79 million to 54 million, or by nearly

32 per cent. The climate is, however, favourable for sheep, and a few good seasons suffice for the replenishment of the depleted flocks ; thus in 1910, eight years after the drought, the number of sheep in the country had increased by 38 million. Australia is poorly supplied with natural water-courses, so that much dependence must be placed on ponds constructed to impound surface water, or on wells, which are often 3,000 feet or more in depth. The rarity of predatory animals and mild winters are two important factors in favour of sheep-farming, in Australia, as there is no necessity to provide shelter or feed for the flocks during winter, as is the case in many other parts of the world.

Until about 1885 nearly all the sheep in Australia were merinos, as wool was the dominating factor. When the frozen meat trade was developed the demand arose for a large sheep, and Lincoln, Leicester and Shropshire sheep were introduced into Victoria, Tasmania and the closely settled parts of New South Wales and South Australia, and crossed with the local merino with remarkable results. These crosses all produced large-bodied sheep and useful types of wool. The livestock industry in the more settled parts of Australia is becoming more dependent upon agriculture to supply the feeding-stuffs that must supplement diminishing pastures. The interior stations of the continent, principally in New South Wales, South Australia and Queensland, where the salt bush dominates all vegetation, carry mostly merino sheep, which will thrive where a large sheep would starve. It was estimated in 1915 that of the aggregate number of sheep in Australia 76·50 per cent. were merino, and 23·50 per cent. cross-bred. Sheep-breeding in Australia has developed into a real science, and, notwithstanding the fact that there has been a great decline in the head of sheep during the last twenty-five years, the wool production has advanced. A South Australian farmer, for his 1910 clip, showed the following figures: 18,125 grown sheep cut an average of 13 lb. 7¾ oz. of wool each ; 6,701 lambs cut an average of 4 lb. 3¾ oz. each.

The following table shows the estimated quantity of wool as in the grease, shorn, fell-mongered, or on skins produced in Australia during the years ended June 30, 1911 to 1915, together with the quantity of wool used locally:

	1910–11.	1911–12.	1912–13.	1913–14.	1914–15.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
New South Wales	374,907,068	371,546,415	326,804,000	357,985,000	318,935,000
Victoria . .	101,803,644	110,463,041	88,762,612	106,833,690	95,406,867
Queensland .	139,250,802	142,382,269	136,878,270	154,183,114	155,478,740
South Australia .	63,613,781	60,056,470	56,691,036	55,014,048	38,848,978
Western Australia	29,984,453	30,833,837	26,849,981	26,625,787	24,562,110
Tasmania . .	11,338,540	10,726,593	12,416,014	10,092,564	8,154,824
Northern Territory . .	400,000	400,000	450,000	400,000	400,000
Total estimated production	721,298,288	726,408,625	648,851,913	711,134,203	641,786,519
Locally used .	8,826,520	10,133,512	10,331,375	11,619,575	13,276,409

The exports of wool in the grease were as follows:

	1910.	1911.	1912.	1913.	1914–15.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
United Kingdom.	222,880,000	230,013,000	211,387,000	185,387,000	319,615,000
France . .	155,014,000	155,347,000	151,556,000	159,783,000	12,788,000
Germany . .	122,297,000	105,674,000	107,523,000	94,069,000	3,036,000
Belgium . .	63,306,000	58,469,000	54,680,000	51,882,000	2,985,000
United States .	11,079,000	10,154,000	8,686,000	14,666,000	61,731,000
Japan . .	7,870,000	6,584,000	9,340,000	7,200,000	22,670,000
Italy . . .	3,711,000	5,644,000	4,857,000	5,778,000	18,192,000
Austria-Hungary	—	5,837,000	7,908,000	11,732,000	830,000
Other countries .	936,000	1,100,000	1,896,000	940,000	2,107,000
Total . .	587,093,000	578,822,000	557,833,000	531,437,000	443,954,000

The exports of scoured and washed wool, including tops, from Australia are shown in the following table:

	1910.	1911.	1912.	1913.	1914–15.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
United Kingdom.	35,571,000	35,941,000	28,305,000	26,176,000	48,172,000
France . .	15,861,000	13,989,000	15,038,000	18,808,000	2,154,000
Germany . .	14,145,000	12,148,000	10,542,000	10,136,000	1,748,000
Belgium . .	11,419,000	7,629,000	5,661,000	5,270,000	920,000
United States .	—	—	50,000	124,000	4,558,000
Japan . .	887,000	1,603,000	2,750,000	3,576,000	6,141,000
Italy . . .	212,000	397,000	380,000	188,000	655,000
Austria-Hungary	—	17,000	89,000	63,000	148,000
Other countries .	80,000	46,000	438,000	123,000	452,000
Total . .	78,175,000	71,770,000	63,253,000	64,464,000	64,948,000

Taking 1 lb. of washed and scoured wool as equal to 2 lb. of greasy wool, the average exports for the four pre-war years 1909 to 1913 amounted to 702,626,000 lb. of greasy wool. The following statement shows the shares of the four principal customers:

	lb.	
United Kingdom	275,413,000 =	39·1 *per cent.*
France	187,042,000 =	26·6 ,, ,,
Germany	130,876,000 =	18·6 ,, ,,
Belgium	72,074,000 =	10·2 ,, ,,

The above figures do not represent, however, the quantities imported and retained for use in each of the countries named. For the five years 1909–13 the United Kingdom retained on an average 178,000,000 lb. of Australian wool. The German Customs returns show that the quantity of Australian wool imported in 1912 was about 194 million pounds; as the re-exports were not large it would appear that Germany was using more Australian wool than this country. Besides the raw wool which Germany obtained direct from Australia or through Belgium, she imported about 100,000,000 lb. of washed and scoured wool, and of combed and carded wool from the United Kingdom, Belgium and France, the origin of which is not stated, but a certain proportion of which must have consisted of Australian wool.

At the outbreak of the war there was an extraordinary demand for cross-bred wool on account of army orders. Merino wool, on the other hand, met with small demand, as the continental countries, which had absorbed 60 per cent. before the war, were out of the market. Since then America and Japan have been large purchasers, and this fact, together with a revival in the tissue trade, has considerably improved the market for merino wools.

The following table shows the exports of woolled sheep-skins from Australia:

	1910.	1911.	1912.	1913.	1914–15.
	No.	*No.*	*No.*	*No.*	*No.*
France . .	4,325,000	4,322,000	5,297,000	5,932,000	2,228,000
United Kingdom	3,763,000	3,306,000	3,707,000	3,861,000	5,844,000
Belgium . .	1,283,000	1,021,000	1,277,000	997,000	29,000
United States .	156,000	40,000	130,000	98,000	1,017,000
Germany . .	106,000	110,000	63,000	58,000	2,000
Other countries.	41,000	33,000	2,000	2,000	248,000
Total . .	9,674,000	8,832,000	10,476,000	10,948,000	9,368,000

New Zealand.—This country is essentially suited for grazing purposes, and English grasses thrive well. Sown grass land heads the list of cultivation, and in 1914–15 the area under sown grasses amounted to about 15 million acres. It has been estimated that land in New Zealand sown with English grasses is equal for grazing purposes to about nine times as much Australian land under natural pasture. The estimated number of sheep in 1916 was 24,788,000; since 1909 the number has remained fairly steady, as there is not the same fluctuation owing to loss by drought as in Australia and other parts of the world. Between 1906 and 1916 there was an increase of 4,680,000 in the head of sheep, representing a rate of increase of 23·22 per cent. in the ten years. Cross-breds and other long-wools comprise over 92 per cent. of the flocks. The frozen meat trade has been greatly developed, and is now an important factor in the sheep-breeding industry. In 1914 the value of the wool exports was £9,308,000, and of the frozen meat £5,850,000; in 1917 the New Zealand wool clip was worth £11,854,000.

The following table shows the production and exports of wool from New Zealand:

	Production.	Exports.	Used by local mills.	Percentage of local exports.	
				Greasy wool.	Sliped or scoured.
	lb.	*lb.*	*lb.*		
1896 . . .	132,299,000	128,309,000	3,990,000	—	—
1906 . . .	157,137,000	152,765,000	4,372,000	82·25	17·75
1915 . . .	215,536,000	208,908,000	6,628,000	78·62	21·38
Average 1911–15 .	196,540,000	190,034,000	6,506,000	81·39	18·61

Nearly the whole of the New Zealand clip is shipped to the United Kingdom, and on an average 77 per cent. is retained for use by British manufacturers. In 1912 the German Customs returns showed the receipts of 8 million pounds of New Zealand wool. In 1915 New Zealand exported 769,000 woolled sheep-skins weighing 5,610,000 lb. the average weight of each skin being about 7·3 lb., also 7,549,000 sheep-skins without wool, weighing 22,822,000 lb., an average weight of about 3 lb. per skin; from this it would appear that the average weight of wool on the woolled skins was about 4 lb.

The World's Production and Consumption of Wool

The following table, based on the statistics for 1912, shows the quantities of wool, and hairs classed as wool, produced and used in the various countries of the world. Combed and carded wool, tops, noils and waste, but not rags, are included in the figures, and together with scoured and washed wool have been converted into greasy wool on the average basis of 3 lb. of clean wool to 5 lb. of greasy wool. The trade returns of some countries do not distinguish raw from clean wool, and when this information is not obtainable the whole quantity has been shown as raw wool, consequently in the column "retained for consumption" a certain quantity of clean wool appears.

Name of country.	Production.	Balance of imports over exports.	Retained for consumption.
	lb.	lb.	lb.
United Kingdom	150,000,000	370,100,000	520,100,000
United States	300,000,000	193,000,000	493,000,000
Germany	30,000,000	505,700,000	535,700,000
France	80,000,000	261,800,000	341,800,000
Russia: Europe and Asia	400,000,000	83,500,000	483,500,000
Austria-Hungary	45,000,000	134,000,000	179,000,000
Italy	35,000,000	71,000,000	106,000,000
Belgium	1,000,000	111,000,000	112,000,000
Holland	4,000,000	16,000,000	20,000,000
Sweden	4,000,000	16,100,000	20,100,000
Norway	5,000,000	9,100,000	14,100,000
Denmark and Iceland	5,000,000	2,600,000	7,600,000
Portugal	12,000,000	3,100,000	15,100,000
Switzerland	1,000,000	12,100,000	13,100,000
Rumania	15,000,000	1,000,000	16,000,000
Balkan Peninsula	60,000,000	—	60,000,000
Canada	10,000,000	8,000,000	18,000,000
Japan	—	20,000,000	20,000,000
		Balance of exports over imports.	
Spain	60,000,000	15,000,000	45,000,000
Australia	726,500,000	716,500,000	10,000,000
New Zealand	206,000,000	200,000,000	6,000,000
South Africa	192,000,000	192,000,000	—
South America	600,000,000	580,000,000	20,000,000
Turkey-in-Asia	90,000,000	50,000,000	40,000,000
India	160,000,000	70,000,000	90,000,000
China	200,000,000	50,000,000	150,000,000
Persia	60,000,000	12,000,000	48,000,000
Northern Africa	70,000,000	50,000,000	20,000,000
Total	3,521,500,000	—	3,404,100,000

Even before the war the world's supply of wool did not meet the requirements of the manufacturers in Europe and America, and it had, to a very large extent, to be supplemented by woollen rags converted into yarn. To make yarn for the shoddy trade, rags are reduced to pulp, and then mixed with a proportion of either cotton or wool. It has been estimated that, before the war, the textile mills in the United Kingdom used annually 350 million pounds of clean wool, and 200 million pounds of pulled rags.

Europe is very largely dependent on over-sea supplies of wool. In nearly every country in Europe sheep-breeding has declined with the extension of arable land, and, with the exception of Spain and some of the Balkan States, no country now produces enough wool for its own requirements. In Great Britain, owing to the large proportion of land under grass, the number of sheep was fairly well maintained before the war began.

The manufacturing countries draw their supplies of wool mainly fom Australia, New Zealand, British South Africa and South America, and to a less extent from British India, China, Asiatic Turkey and Northern Africa. The above mentioned countries contributed, during pre-war years, about 1,900 million pounds of wool to the world's trade, and of this quantity the countries belonging to the British Empire supplied more than 60 per cent. Australia, South Africa, and Uruguay supply the bulk of the merino wool; Australia, New Zealand, and South America cross-bred wools; and Asia carpet wools. Asiatic Turkey and South Africa have the practical monopoly in the trade in mohair. The principal manufacturing countries are the United Kingdom, the United States, Germany and France; before the war these four countries used annually nearly 1,900 million pounds of raw wool. The woollen industry is also of considerable importance in Russia, Austria-Hungary, Belgium and Italy, and in nearly every other country in Europe both wool and yarn are imported for local use. Woollen mills have been established in Canada, Japan, Australia, New Zealand, South America, British India and China, and in all these countries, especially in Japan, the industry is of growing importance. In Russia, the Balkan States, the Turkish Empire, Persia, India and China the hand-loom industry is widely distributed and absorbs large quantities of wool.

The Trade in Woollen Manufactures

The following statement shows the world's trade during 1912 in all descriptions of woollen yarns. The figures for the United Kingdom, France, Germany and Austria-Hungary have been taken from the Customs returns of those countries; the figures for the remaining countries have been obtained either from official returns or other sources and are approximately correct.

Name of country.	Imports. *lb.*	Exports. *lb.*
United Kingdom	30,586,000	87,888,000
France	3,936,000	29,037,000
Belgium	2,000,000	26,200,000
Germany	54,851,000	29,751,000
Austria-Hungary	23,643,000	4,539,000
Russia	14,580,000	—
Holland	7,000,000	—
Sweden	4,000,000	—
Norway	3,500,000	—
Denmark	2,000,000	—
Switzerland	3,600,000	2,750,000
Balkan States and Turkey	3,000,000	—
Italy	4,350,000	1,430,000
Japan	10,000,000	—
India	1,000,000	—
China	1,300,000	—
Canada	5,000,000	—
Australia	2,000,000	—
Brazil	1,000,000	—
Total	177,346,000	181,595,000

The following table shows the world's trade in woollen manufactures in 1912. All descriptions of woollen manufactures, including pure wool and union goods, as well as hosiery, are included, but not apparel. The export figures are approximately correct; it is difficult, however, to obtain full details of the imports into several countries, consequently the aggregate value of the exports exceeds that of the imports.

Name of country.	Imports.	Exports.
	£	£
United Kingdom	6,874,000	26,064,000
Germany	2,809,000	14,250,000
France	1,858,000	7,628,000
Austria-Hungary	1,863,000	2,804,000
Italy	1,624,000	531,000
Switzerland	1,512,000	400,000
Netherlands	1,623,000	1,727,000
Belgium	1,482,000	462,000
Russia	1,724,000	—
Sweden	551,000	—
Norway	808,000	—
Denmark	1,121,000	20,000
Spain	300,000	158,000
Portugal	335,000	—
Rumania	1,528,000	—
Bulgaria	252,000	92,000
Serbia	161,000	—
Greece	350,000	—
Turkey	1,700,000	600,000
Japan	1,000,000	—
China	1,000,000	—
Persia	276,000	918,000
Dutch East Indies	114,000	—
Other Eastern Countries	200,000	—
French Colonies	400,000	—
Morocco	100,000	—
United States	3,106,000	336,000
Argentina	1,853,000	—
Brazil	600,000	—
Chile	1,092,000	—
Peru	115,000	—
Mexico	314,000	—
Other American Countries	700,000	—
Egypt	900,000	—
British India	1,700,000	220,000
Hongkong	500,000	—
South Africa	1,200,000	—
Australia	3,000,000	—
New Zealand	660,000	—
Canada	4,460,000	—
Other British Possessions	600,000	—
Total	52,365,000	56,210,000

United Kingdom

The art of spinning and weaving wool was introduced into the British Isles by the Romans, and, owing to the excellence of the local wool, the industry soon grew in importance. For many centuries past British woollen goods have been held in high repute throughout the world, and until the middle of the nineteenth century British manufacturers practically monopolised the world's trade. Since then several countries have developed woollen industries, and with the help of protective tariffs have to a large extent supplied their own requirements, and, especially in the case of Germany, entered into serious competition with British manufacturers in the free markets of the world. That England has survived the strangling influence of the protective policy of certain countries is due to the excellence of her manufactures, which cannot be equalled in any other country. In fine goods the English are superior in designing, colouring, and cloth-making. Lustre wools cannot be manufactured as well in other countries as in Great Britain. The application of the British processes to alpaca and mohair are unrivalled. In recent years, however, before the outbreak of the war, Bradford and Leeds goods were beng sent to Germany to be dyed and finished, because those processes could be carried out more cheaply there than in England.

The following statements compare the exports of British woollen manufactures in 1880, 1904, 1912 and 1916:

		1880.		1904.	
		Quantity.	Value.	Quantity.	Value.
			£		£
Woollen tissues	yards	49,998,000	6,734,000	67,121,000	7,491,000
Worsted ,,	,,	189,939,000	7,240,000	103,931,000	6,535,000
Damasks, plushes and flannels	,,	6,697,000	310,000	10,051,000	377,000
Carpets and carpet rugs	sq. yds.	9,398,000	1,133,000	8,671,000	953,000
Blankets	yards	6,388,000	585,000	1,560,000[1]	842,000
Shawls	No.	736,000	157,000	571,000	66,000
Rugs, etc.	,,	1,168,000	360,000	1,519,000	380,000
Hosiery		—	360.000	—	1,032,000
Small wares		—	418,000	—	315,000
Total		—	17,297,000	—	17,991,000

[1] *Pairs.*

	1912.		1916.	
	Quantity.	Value.	Quantity.	Value.
		£		£
Woollen tissues [1] . *yards*	100,530,000	14,104,000	131,762,000	22,710,000
Worsted ,, [1] . ,,	72,136,000	6,713,000	52,211,000	7,273,000
Damasks, plushes, etc. . . . ,,	8,072,000	387,000	16,697,000	1,132,000
Carpets and carpet rugs . . . *sq. yds.*	8,811,000	1,505,000	6,245,000	1,190,000
Blankets . . *pairs*	1,124,000	524,000	1,286,000	1,079,000
Shawls . . *No.*	690,000	110,000	729,000	105,000
Rugs, etc. . . *sq. yds.*	2,102,000	212,000	940,000	153,000
Hosiery . . .	—	1,928,000	—	2,378,000
Small wares . . .	—	577,000	—	882,000
Total . . .	—	26,060,000	—	36,902,000

[1] *In* 1912, *about* 40 *per cent. of the woollen tissues, and* 30 *per cent. of the worsted tissues, were of pure wool, the balance being unions.*

The most noticeable feature in the trade has been the decline in exports of worsted tissues and the advance in woollen tissues. This was due to the protective policy of foreign countries in shutting out cheap goods which could be manufactured locally. It is, however, satisfactory to record that the value of exports of apparel and slops, which averaged about £1,500,000 between 1885–89, advanced to £3,670,000 between 1908–12. Between 1880 and 1904 the British woollen trade was stagnant. The majority of the witnesses, who gave evidence before the Tariff Commission in 1904, attributed the deterioration in trade conditions between 1880 and 1904 mainly to the operation of foreign tariffs. Between 1862 and 1878 the British woollen industry had increased by leaps and bounds, and then foreign nations one by one commenced to develop and protect their own industries. Continental countries commenced their development at the later stages of manufacture, which employ a larger proportion of labour, and have gradually got down nearer to the raw material stage. The Continental development was aided by the introduction of the latest British machinery, and in some instances by the migration of British firms or of British foremen and workers, and by the importation of tops and other semi-manufactured products from Great

Britain. Witnesses attached great importance to the largeness of the market which Germany had secured by means of her tariff policy. The Germans secured their home market, and this, combined with the British free market, enabled them to sell cheaper, because they have a large production. In slack times, when surpluses accumulated, they kept prices steady in their own country, and flooded the British and neutral markets with goods, which were sold irrespective of price. The British manufacturers complained of the constant disorganisation of trade conditions by this dumping of surpluses. There was also some evidence before the Commission to show that factories in England had been closed because the plant and machinery were not up-to-date, and that in the earlier years British labour had opposed the introduction of labour-saving machinery. In spite of these adverse conditions, the British trade revived after 1904, from which it would appear that between 1880 and 1904 foreign competitors stole a march on the British industry, not in regard to the quality of their wares, but in respect to their business methods, and readiness to meet changes in taste and fashion. Although the volume of the trade in tissues in 1912 and 1916 was less than in 1880, the value was much greater, due partly to appreciation in value, but also to the fact that a larger proportion of the goods were of superior quality. The growth of the hosiery trade, which is centred at Leicester, is very remarkable, the value of the exports increasing from £360,000 in 1880 to £2,378,000 in 1916. The official trade figures for 1916 are very wonderful when it is considered that immense quantities of cloth and blankets manufactured for the military purposes of this country and the Allies are not included in the returns. In 1917–18, the War Office Controller handled over 3,000,000 bales of wool, involving an expenditure of £89,000,000; this wool was made over to the manufacturers in the United Kingdom, two-thirds of the quantity being used for military purposes. The woollen industry of the United Kingdom is at present in a very strong position; nearly twice as much wool is being used by the weaving industry as in pre-war times, and, with the control of the raw material within the Empire, British manufacturers should be able to secure a very large share in the world's trade.

The development of the woollen industries on the Continent, while checking the export of the cheaper classes of manufacturers, resulted in a great advance in the exports of yarns and tops from the United Kingdom to continental countries. The following table shows the quantities of yarn, and of tops, noils and waste exported in 1882 and subsequent years:

	1882.	1891.	1900.	1912.	1916.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Woollen yarns	1,992,000	1,572,000	1,088,000	6,246,000	5,559,000
Worsted ,,	29,840,000	39,510,000	56,075,000	56,779,000	22,380,000
Mohair, etc. ,,	8,752,000	12,959,000	10,397,000	25,000,000	3,843,000
Total . .	40,584,000	54,041,000	67,560,000	88,025,000	31,822,000
Waste .	15,000,000	2,397,000	1,593,000	12,160,000	8,396,000
Noils .		10,234,000	7,897,000	19,567,000	12,887,000
Tops .		9,016,000	28,031,000	44,826,000	28,554,000
Total . .	15,000,000	21,647,000	37,521,000	76,553,000	43,837,000

Until the outbreak of war shipments of tops, noils and waste were steadily advancing; this was in reality an export of raw material, and the country only benefited to the extent of any profit made on the washing and combing of the wool, and the merchanting of it. As a rule, tops, etc., were admitted free by importing countries, the United States, however, levy import duties on tops as well as on yarn. In the years preceding the war, Germany was taking from the United Kingdom 60 per cent. of the aggregate exports of yarns, and 35 per cent. of tops and noils; all this material was worked up into fabrics in Germany. The loss of this trade, if it is of a permanent nature and results in greater activity in the British weaving industry, will be of great benefit to this country.

The following table shows the quantities of sheep's wool imported into the United Kingdom from the principal countries of supply, and the quantities retained in the country:

Exporting Country.	1909–13.			1915.			1916.		
	Average imports.	Average retained.	Percentage retained.	Imports.	Retained.	Percentage retained.	Imports.	Retained.	Percentage retained.
	1,000 lb.	1,000 lb.		1,000 lb.	1,000 lb.		1,000 lb.	1,000 lb.	
Australia	300,270	130,965	43·6	426,164	355,231	83·2	241,722	217,173	89·8
New Zealand	181,137	140,331	77·5	200,032	188,461	94·2	157,852	153,291	97·1
Cape	83,160	29,495	35·4	94,667	71,953	76·0	62,811	57,135	91·0
Natal	32,008	19,839	61·9	41,899	41,332	98·6	27,260	27,086	99·4
British India	55,272	28,842	52·1	65,432	55,614	85·0	64,793	56,969	87·9
Falkland Islands	4,532	3,432	75·7	3,045	2,731	89·7	4,352	4,296	98·7
Egypt	3,493	3,318	95·0	6,526	6,114	93·7	5,418	5,266	97·2
Total, British Empire	659,872	356,222	53·9	837,765	721,436	86·1	564,208	521,216	92·3
Argentina	47,287	43,269	91·5	60,968	59,691	97·9	31,782	31,666	99·6
Uruguay	6,549	6,110	93·3	1,123	842	75·0	879	821	93·4
Chile	22,708	11,189	49·2	15,278	12,958	84·9	8,115	6,847	84·4
Peru	3,379	2,593	76·7	3,003	2,286	76·1	2,734	2,384	87·2
United States	1,845	1,748	95·0	2,372	2,190	92·3	289	—	—
France	26,223	24,592	93·7	229	104	45·4	3,808	3,808	100·0
Belgium	4,195	3,907	93·1	—	—	—	—	—	—
Germany	3,456	3,344	96·7	—	—	—	—	—	—
Russia	5,687	2,169	38·1	—	—	—	212	212	100·0
Portugal	2,054	1,562	76·0	447	261	58·4	349	349	100·0
Asiatic Turkey	9,241	5,523	59·7	867	471	54·3	2,704	2,704	100·0
China	2,362	1,624	68·8	1,156	1,103	95·4	418	418	100·0
Total, Foreign Countries	134,986	107,630	72·3	85,443	79,906	93·5	51,290	49,403	96·3

The average quantities of sheep's wool exported annually from the six principal countries of supply during the four years 1910–13, with the quantities imported into and retained in the United Kingdom, are given in the following table:

	Total exports.	Imports into United Kingdom.	Percentage of total exports.	Quantity retained in United Kingdom.	Percentage of total exports.
	lb.	lb.		lb.	
Australia	633,250,000	297,412,000	46·9	137,434,000	21·7
New Zealand	187,172,000	182,305,000	97·4	142,490,000	76·1
South Africa	148,205,000	114,987,000	77·6	49,892,000	33·6
British India	64,149,000	55,034,000	85·7	29,174,000	45·7
Argentina	343,978,000	45,245,000	13·1	41,152,000	11·9
Uruguay	135,973,000	5,773,000	4·2	5,274,000	3·9

The average quantity of imported wool retained in the United Kingdom for the five years 1909–13 was 463,852,000 lb., and the average for the two years 1915–16 was 685,980,000 lb.; during the first period the British Empire supplied 77 per cent. of the total quantity, and 90 per cent. during the second period. The British trade returns do not differentiate between greasy and clean wool, nor between merino and other classes of wool. It may, however, be assumed that 15 per cent. of the Australian and New Zealand wool had been washed and scoured before export, and that the imports from France, Belgium and Germany consisted of clean wool. On this basis it may be estimated that 80 million pounds imported and retained was clean wool. The bulk of the imports from the Cape, Natal and Uruguay, and about 75 per cent. of the Australian receipts consist of merino wool, and, allowing that half the quantity imported from France, Belgium and Germany was merino, the proportion of merino to the total quantity of wool retained during 1909–13 was about 40 per cent. The proportion of cross-bred wool for the same period was about 50 per cent., the supplies coming mainly from Australia, New Zealand, Falkland Islands, Argentina, Chile and the Continent. The wools from British India, Egypt, Peru, Russia, Turkey and China represent about 10 per cent. of the total, and may be classed as carpet wools.

The following statements show the average annual import and export trade of the United Kingdom in raw materials and manufactures for three years 1911–13, and three years 1915–17:

Description.	Average 1911-13.			
	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	*lb.*	£
Sheep's wool . .	800,647,000	33,479,000	354,181,000	15,631,000
Alpaca, etc. . .	4,943,000	259,000		
Camels' hair . .	7,976,000	339,000		
Mohair . . .	30,185,000	1,502,000		
Tops, noils and waste .	3,244,000	98,000	74,639,000	5,322,000
Total . .	846,995,000	35,677,000	428,820,000	20,953,000
Woollen rags (pulled) .	4,027,000	58,000	12,772,000	378,000
,, ,, (not pulled)	118,717,000	1,051,000	7,860,000	185,000
Total . . .	122,744,000	1,109,000	20,632,000	563,000
Yarn, all kinds . .	30,359,000	3,185,000	86,899,000	8,445,000
Woollen manufactures .	—	6,874,000	—	25,913,000
Woollen manufactures re-exports . .	—	—	—	1,183,000
Total . . .	—	6,874,000	—	27,096,000
Grand total . .	—	46,845,000	—	57,057,000

	Average 1915-17.			
	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	lb.	£
Sheep's wool	723,651,000	43,106,000		
Alpaca, etc.	6,461,000	477,000	85,412,000	6,196,000
Camels' hair	2,672,000	216,000		
Mohair	9,694,000	584,000		
Tops, noils, waste	351,000	12,000	37,216,000	4,411,000
Total	742,829,000	44,395,000	122,628,000	10,607,000
Woollen rags (pulled)	2,592,000	65,000	4,984,000	270,000
" " (not pulled)	42,676,000	823,000	8,362,000	30,000
Total	45,268,000	888,000	13,346,000	300,000
Yarn, all kinds	398,000	55,000	26,192,000	5,097,000
Woollen manufactures	—	912,000	—	36,370,000
Woollen manufactures re-exports	—	—	—	208,000
Total	—	912,000	—	36,578,000
Grand total	—	46,250,000	—	52,582,000

Belgium (£1,448,000), France (£1,113,000) and Germany (£469,000) supplied nearly all the yarn imported before the war; as these supplies are no longer available the imports are now negligible. Carded woollen yarns formed the bulk of the imports, used extensively in this country in the manufacture of dress-goods, hosiery and underwear. The imports of manufactures before the war, which consisted largely of cheap woollen stuffs and flannels, came principally from France (£3,549,000) and Germany (£2,102,000). Since the war began imports have come mainly from the United States and Switzerland.

Before the war Germany was the largest market for British yarn and tops; there was, however, a good demand for these goods in several manufacturing countries. France is now the largest purchaser of yarn, tops and noils, taking between one-third and one-half of the aggregate exports, whereas before the war her trade in these goods was small. In 1916 Norway and Denmark took yarn valued at £940,000 against £344,000 in 1912.

Although the value of the exports of manufactured goods in 1917 rose to £44,341,000 as compared with £36,902,000 in 1916 the volume of the trade was less.

The following statement shows the quantity and value of the two main items of the trade in 1912, 1916 and 1917:

	1912.		1916.		1917.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Yards.	£	Yards.	£	Yards.	£
Woollen tissues, pure and union . .	100,530,000	14,104,000	131,762,000	22,710,000	122,928,000	29,200,000
Worsted tissues, pure and union . .	72,136,000	6,713,000	52,212,000	7,273,000	42,718,000	7,440,000

The average value per yard in the three years was as follows:

	1912.	1916.	1917.
	s.	s.	s.
Woollen tissues . .	2·80	3·44	4·75
Worsted ,, . .	1·86	2·79	3·48

Unions have appreciated more in value than pure wool goods, as the following table will show—value in yards:

	1912.	1917.
	s.	s.
Woollen tissues, heavy, broad, all wool . . .	5·40	6·76
,, ,, ,, ,, unions . . .	2·00	4·00
Worsted tissues, coatings, heavy, broad, all wool .	4·10	6·73
,, ,, ,, ,, ,, unions .	2·10	4·00

The following table shows the value of the export trade of the United Kingdom in woollen goods, with principal customers, in 1912 and 1916:

Name of country.	1912.	1916.	Name of country.	1912.	1916.
	£	£		£	£
Russia . .	330,448	1,931,685	United States .	1,182,728	2,071,701
Sweden . .	126,489	440,861	Chile . .	701,380	494,700
Norway . .	91,544	904,231	Brazil . .	406,166	203,772
Denmark . .	230,343	1,586,802	Argentina .	1,410,962	1,816,878
Germany . .	2,186,521	nil	Egypt . .	701,802	509,244
Netherlands .	681,539	1,395,869	Union S. Africa	1,026,085	1,346,650
Belgium . .	734,214	4,583	British India .	1,004,960	831,729
France . .	1,811,450	8,284,440	Hong Kong .	467,980	312,611
Austria-Hungary	599,577	nil	Australia . .	2,693,156	4,990,728
China . .	674,696	371,802	New Zealand .	601,543	1,116,425
Japan . .	866,099	828,830	Canada . .	4,256,470	4,286,024

Owing to the disorganised state of her woollen industries, France was the largest purchaser of British goods, her share of the aggregate trade of 1916 being 22·5 per cent.

as compared with 7 per cent. in 1912. There was also a remarkable increase in the trade with Russia, Sweden, Norway and Denmark, countries which were largely dependent on German supplies before the war. There was a decline in the trade with Eastern countries and with certain South American States ; Japan and America have now taken the opportunity of developing their trade with these countries, which in pre-war years obtained large supplies from Germany. Australia, New Zealand and South Africa are all taking larger supplies from this country, and the trade with Canada has been maintained. The value of the exports of woollen apparel in 1913 was £3,959,000, and in 1916 £3,123,000. The value of exports of felt hats fell from £1,212,000 in 1913 to £732,000 in 1916.

Germany

In 1885 it was estimated that 250 million pounds of raw wool were used in Germany; at the outbreak of the war the annual consumption was more than twice as large.

Germany's import and export trade in raw materials and manufactures for 1912 are given below:

	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	*lb.*	£
Wool, merino greasy .	253,450,000	10,489,000	5,763,000	227,000
,, cross-bred ,, .	168,964,000	6,222,000	4,560,000	165,000
,, merino, washed and scoured . .	11,313,000	923,000	15,670,000	1,327,000
,, cross-bred, washed and scoured .	47,356,000	2,663,000	12,693,000	682,000
Waste	24,161,000	982,000	29,068,000	1,183,000
Wool, carded and combed, merino . .	21,917,000	2,312,000	17,391,000	2,000,000
,, carded and combed, cross-bred . . .	32,010,000	1,990,000	4,799,000	373,000
Woollen rags, shoddy .	7,057,000	169,000	9,675,000	232,000
Yarn, mohair, etc. . .	14,566,000	1,476,000	193,000	20,000
,, woollen and worsted	40,285,000	3,810,000	29,558,000	4,194,000
Woollen manufactures .	—	2,809,000	—	14,250,000
Total . . .	—	33,845,000	—	24,653,000

Nearly half the imported wool is classed as merino, and the balance as cross-bred. About 50 per cent. of the imports came from the British Empire, mainly merino wool from Australia and South Africa, and tops and noils from England. South America supplied about 25 per cent. of the raw material, France 11 per cent. and Belgium 10 per cent. The origin of the wool received from France and Belgium is not specified, but it consisted largely of British, Colonial and South American wool, which had been washed and scoured, or combed and carded before re-export. In 1912 the quantity of all classes of wool retained for use in Germany was greater than the quantity retained during the same period in the United Kingdom. This result is arrived at by taking into account the export and import trade in tops, noils and waste, and also the home wool production of each country. In the same year also the imports of all kinds of yarn into Germany exceeded the exports by 25 million pounds, whereas the exports from the United Kingdom exceeded the imports by over 57 million pounds. Germany, unlike the United Kingdom, did not appear to import large quantities of woollen rags; but, as the exports of rags from Germany were not large, it would appear that a considerable quantity must have been available for local use. Details of the shoddy trade before the war are not available, but since the supply of wool was cut off this side of the woollen industry must have been fully developed.

With reference to the textile industry, the following remarks appeared in the British Consular Report on the trade of Germany for 1912: "The intensified protection has pre-eminently affected the textile industries. The export has been steadily rendered more difficult in consequence of the growth of foreign competition, which was protected in reply to the German protective measures. The textile industries of Germany are satisfied if they can at least hold their own. When the fashions are in their favour, they succeed in doing so, as is at present the case, owing to the great demand for velvet. The export is at present undergoing a change in character in so far as the export of the cheaper goods in bulk, which former customers now manufacture themselves, is steadily receding; efforts are being made to replace these cheap goods by goods of a higher quality."

The export trade of Germany in woollen manufactures was steadily advancing before the war, especially in the markets of the British Empire. From the statement made in the Consular Report it would appear that efforts were being made in Germany to produce goods of a superior quality, which so far had been manufactured mainly in the United Kingdom. German manufacturers had secured valuable markets for their goods on the Continent, especially in Russia, Scandinavia, Rumania, Austria, Holland, Switzerland and Italy. The imports into the United Kingdom of manufactures, excluding yarn, from Germany had advanced from an average value of £705,000 between 1889–93, to £2,170,000 between 1909–13. German goods were also competing successfully with British trade in various markets of the British Empire, in South America, and elsewhere.

The following figures show how successfully the German trade had been developed in India:

	Imports of Woollen Manufactures into British India.			
	1885–6.		1913–14.	
	Value.	Percentage of total.	Value.	Percentage of total.
	£		£	
Total value of trade . .	1,391,000	100	2,568,000	100
Share of United Kingdom .	1,278,000	91·9	1,482,000	57·7
Share of Germany . . .	51,000	3·6	716,000	27·8

The British trade returns for 1912 show that woollen manufactures to the value of £2,200,000 were exported to Germany; the bulk of the trade was represented by pure woollen tissues. The German trade figures for the same year show that goods to the value of £1,230,000 were imported from the United Kingdom; it is evident, therefore, that a large proportion of the British exports were in transit to other countries. The export trade in woollen apparel in 1912 was worth £2,383,000; the best markets were, the United Kingdom, £420,000; Holland, £661,000; Switzerland, £356,000; and South America, £208,000. The value of woollen felt hats exported the same year was £229,000, and of other woollen felt goods, £350,000.

The war has completely disorganised the German woollen industries, which were entirely dependent on overseas supplies of wool, largely obtained from the British Empire. Even after peace has been declared it seems doubtful whether Germany will be able to draw so freely on all her former sources of supply, in view of the world's shortage in wool, and the increased consumption which has taken place in the United Kingdom, America, Japan and other countries outside Europe.

France

The imports in 1912 amounted to 418,712,000 lb. of wool, and 147,899,000 lb. of woolled sheep-skins. The skins came principally from the Argentine and Australia, and were dealt with at Mazamet, the most important centre in Europe of the fell-mongering industry. The British Empire supplied 48 per cent. of the gross imports, including woolled skins, Australia being the chief source of supply; South America's share was 42 per cent., of which more than 80 per cent. came from the Argentine. Spain and Northern Africa each sent about 18 million pounds. The production of wool in France itself was about 80 million pounds.

The following table shows the import and export trade during 1912 in raw materials and manufactures:

	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	*lb.*	£
Raw wool and woolled skins	566,611,000	25,602,000	87,661,000	5,372,000
Combed and carded wool .	950,000	96,000	67,220,000	7,051,000
Waste, etc.	32,796,000	1,710,000	51,284,000	2,075,000
Yarn, woollen and worsted	3,936,000	288,000	29,037,000	3,541,000
,, Mohair . .		311,000	—	—
Woollen manufactures .	—	1,858,000	—	7,628,000
Total . . .	—	29,865,000	—	25,667,000

The exports of wool, mainly washed and scoured in the country, went chiefly to the following countries: United Kingdom, 31 million pounds; Belgium, 30 million pounds; Germany, 10½ million pounds; and Italy and Switzerland, each about 5 million pounds. The principal customers for combed and carded wool, and wool waste, were Belgium and Germany. The United Kingdom was the largest market for French yarn, and was also the principal supplier. In 1912, the United Kingdom imported from France manufactures to the value of £3,672,000, and the exports to France were worth £1,600,000. In recent years, before the war, there was a considerable decline in the imports of French woollen goods into the United Kingdom; in 1905, the value of the imports was over £6,000,000. The woollen industry of France has been disorganised by the war, as Roubaix and Tourcoing, two large manufacturing centres, were in enemy possession for over four years. The markets of the world are, however, open to France, and she has been able to obtain the necessary raw material to carry on the industry, to a smaller extent, at other manufacturing centres.

Belgium

Before the war Antwerp was one of the large wool marts on the Continent. The imports came principally from South America and Australia, and a large proportion went on to other countries in Europe, especially to Germany. A considerable quantity of wool was retained in Belgium to be washed and scoured, and combed and carded before being re-exported. Verviers was the centre of the industry, where also large quantites of yarn were manufactured for export. The position of Antwerp, as a distributing centre after the war, will be a difficult one, as the trade of the port was largely carried on with Germany. There is, however, every reason to expect that the woollen industries of Belgium will be revived after the war, when she will be able to obtain raw materials. Between 1903–5 the annual value of imports of woollen manufactures, excluding yarn, from Belgium into the United Kingdom averaged £740,000, for the three years 1910–12 the value of these imports had fallen to £230,000.

Austria-Hungary

The following table shows the import and export trade in raw materials and manufactures of Austria-Hungary during 1912:

	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	lb.	£	lb.	£
Raw wool	44,084,000	1,572,000	5,051,000	150,000
Clean ,,	22,317,000	1,462,000	4,809,000	349,000
Combed and carded wool	24,562,000	2,597,000	306,000	34,000
Mohair, etc.	1,005,000	31,000	313,000	5,000
Waste	19,870,000	735,000	8,204,000	273,000
Shoddy	3,083,000	72,000	—	—
Woollen and worsted yarn	19,356,000	1,897,000	4,539,000	540,000
Mohair, etc., yarn	4,287,000	530,000	—	—
Woollen manufactures	—	1,863,000	—	2,804,000
Total	—	10,759,000	—	4,155,000

The production of wool in Austria-Hungary was about 48 million pounds. The raw wool came principally from Australia, Argentina and Germany, and the clean wool from Germany and Belgium. Germany supplied the bulk of the combed and carded wool and the waste. The United Kingdom supplied nearly all the mohair yarn, and 5 million pounds of woollen and worsted yarn, Germany's share being 6 million pounds. The value of the imports of woollen manufactures from the United Kingdom was £721,000, and from Germany £670,000. The best markets for Austrian manufactures were the Balkan States and Turkey, the value of the exports to these countries, in 1912, amounting to £900,000. Germany took goods to the value of £370,000, and the trade with the United Kingdom was worth £152,000. At the outbreak of the war the woollen industries of the country were of considerable importance, and the export trade was growing. Austria has been largely dependent on Germany for raw materials; in future she must look, however, for other sources of supply.

United States of America

Before the war the woollen industries of America were using about 500 million pounds of raw wool, of which about three-fifths was produced in the country, and the balance imported. Since 1914 imports have been made on a much larger scale, due partly to the abolition of import duties on unmanufactured wool in November 1913, and to war conditions, which have disorganised the textile industries on the Continent of Europe, and thus given American manufacturers the opportunity of extending their business.

The following table shows the imports of wool for the five years ending June 30, 1913–1917:

	1913.	1914.	1915.	1916.	1917.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Wool for clothing	67,238,000	125,088,000	222,017,000	403,121,000	279,481,000
Carpet wool .	111,168,000	103,720,000	74,534,000	65,710,000	67,672,000
Wool combings .	16,886,000	18,839,000	15,054,000	13,292,000	17,056,000
Mohair, etc. .	—	1,717,000	5,301,000	9,145,000	8,162,000
Total . .	195,292,000	249,364,000	316,906,000	491,268,000	372,371,000

The principal sources of supply were as follows:

	1913.	1914.	1915.	1916.	1917.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
United Kingdom	57,566,000	79,393,000	61,726,000	63,427,000	4,713,000
Australia and New Zealand . .	12,066,000	28,700,000	66,835,000	174,215,000	1,065,000
South Africa .	371,000	1,140,000	25,032,000	73,835,000	32,015,000
South America .	29,087,000	72,840,000	95,734,000	156,603,000	271,170,000
China . .	35,927,000	30,540,000	36,085,000	47,406,000	41,366,000
Russia . .	23,858,000	28,714,000	2,273,000	3,374,000	—

From Australia, South Africa and South America supplies have been received, which formerly went to Europe. In 1917 the United States took nearly half the normal exports from South America. The great increase in the consumption of wool in the United States will be a very serious consideration for Germany, when peace is restored, as she is entirely dependent on over-sea supplies.

High protective duties have enabled American manufacturers to extend their mills, and to secure the very important local markets, with the result that the annual average value of woollen and worsted tissues exported from the United Kingdom to America fell from £4,260,000 between 1885–9, to £1,255,000 between 1908–12. Before the war the export trade of America in woollen manufacture was negligible, but the trade is now being rapidly developed. The output of the mills, which is much larger than in pre-war years, has not only enabled manufacturers to supply the local markets with goods which formerly came from Europe, but to create a large export trade.

The following statement shows the annual average value of exports of woollen manufactures, and of woollen wearing apparel for 1912–14 and 1915–17:

	Average 1912–14.	Average 1915–17.
	£	£
Woollen manufactures	296,000	4,166,000
,, apparel	461,000	2,195,000
Total	757,000	6,361,000

In 1916 the value of exports of woollen manufactures was £6,665,000, and of apparel £3,873,000. The principal customers in 1916 were:

	Woollen manufactures.	Wearing apparel.	Total.
	£	£	£
Russia-in-Europe	2,141,000	641,000	2,782,000
Italy	1,064,000	1,706,000	2,770,000
Russia-in-Asia	974,000	522,000	1,496,000
Canada	1,064,000	419,000	1,483,000
France	367,000	207,000	574,000
United Kingdom	232,000	145,000	377,000

Japan

The woollen industries of Japan were of growing importance before the outbreak of war; since then there has been a rapid advance. In 1901 Japan imported wool to the value of £313,000, and yarn worth £87,000; between 1912 and 1914 the annual average value had risen to £1,600,000 for wool and £760,000 for yarn. In 1915 the wool imports were worth £3,100,000 and yarn £40,000; the wool came principally from Australia, about 35 million pounds, and 7 million pounds from China. In 1916 Japan purchased over 18 million pounds of wool, valued at £1,230,000, from South Africa. Japan is now manufacturing and exporting both yarn and woollen goods, and is securing the trade formerly done by Germany in the Eastern markets; she is also competing with England, especially in travelling-rugs, which have hitherto been a British speciality. The average annual value of imports of woollen cloths and stuffs, pure and mixed, was about £1,100,000 between 1909–11, £770,000 between 1912–14, and £291,000 in 1915. Between 1909–13 the average value of the imports from the United Kingdom was £640,000, and from Germany £169,000.

PAPER YARNS: THEIR MANUFACTURE AND INDUSTRIAL UTILISATION

The manufacture of textiles from paper has undergone a rapid development during the last few years, especially in Germany and Austria, where, since the commencement of the war, supplies of the ordinary fibres, such as jute and cotton, have been increasingly difficult to obtain. The industry in these countries has now attained great importance, and, although paper yarns are chiefly employed as substitutes for other materials, there is little doubt that their use will be continued to some extent after the war. The manufacture of paper textiles has also been developed to some extent in the United Kingdom, but, as this country has not suffered to nearly so great a degree from a shortage of jute and other fibres, the progress of the industry has been much less rapid. In fact, it appears unlikely that any extensive development of the industry will take place in countries where ample supplies of jute are obtainable at a reasonable price.

The paper used for spinning paper yarns is almost entirely made from wood pulp, a brief account of the manufacture of which has been given in this Bulletin (1913, **11**, 136). The yarns are made from long, narrow strips of thin paper, which can be loosely or tightly twisted or "spun." The yarns can be made of various thicknesses, and have now been employed for weaving a great variety of fabrics. They can be readily dyed to any desired shade, and certain kinds can be bleached to a snowy whiteness. In manufacturing the yarns, other materials have sometimes been combined with the paper, but recently the tendency has been to make them of paper only. In the production of fabrics, paper yarns are sometimes woven in conjunction with other yarns, such as those of cotton, flax, hemp and jute.

Among the chief advantages of paper yarns are the low cost of production, which, at any rate in normal times, is much less than that of yarns made from other fibrous materials, and the cleanliness of the manufacturing operations which create little or no dust.

The following account of the manufacture and utilisation of paper textiles has been prepared with the object of giving a general indication of the nature and scope of the industry.

Historical

Although the use of paper for the manufacture of textiles has only been developed during recent years, the idea is by no means new. The Chinese have for a long time used paper twine for tying up parcels. The strips of paper are kept ready cut and tied up in a bunch, and when a piece of string is required, a strip is removed from the bunch, and dexterously and rapidly spun into a thread with the hands. In Japan, paper-yarn has been used for many years for making fabrics, and an interesting account of the manufacture of a fabric known as "shi-fu" is given by J. J. Rein in his work on *The Industries of Japan*, published in 1889, from which the following details are extracted. Shi-fu is a peculiar fabric, manufactured only in Shiroïshi, a small town on the Ôshiukaidô, 13 ri south of the city of Sendai.

The warp consists of silk and the weft of paper yarn. The paper used in its manufacture is made in several places in the province of Iwaki from the fibre of the paper-mulberry (*Broussonetia papyrifera*). The method of spinning and weaving this paper is described as follows:

"Half a Jô (25 sheets of the size of ordinary writing paper) of this paper is often folded lengthwise, and laid together so that the two parallel edges are over one another and project 3 or 4 centimetres over the edges. The paper is laid lengthwise over the one narrow side of a thick board provided with feet for firmness, and fastened at both ends with iron bent clamps, so that the two projecting edges of the paper form a right angle with the principal part of the sheets, and hang down. Then the folded part of the paper parallel to the width of the sheet is cut with a broad, hatchet-like, very sharp knife into narrow strips of scarcely 2 millimetres' breadth, which hang together by the projecting edge which has not been touched by the knife. Now follows the rolling of these strips of connected paper ribbons on a smooth stone slab, with the flat of the hand, a work which is continued, with frequent twisting, till every ribbon has become a slack thread. The connecting edges are then cut on both sides so far through that the single threads hang together by a width of only 2 millimetres broad, and then the connecting places are twisted also. In this way continuous threads are obtained. The finished fabric made from such entwined paper threads for woof and silk warp is called Fukusaji, *i.e.* 'ground for Fukusa.' Fukusa otherwise denotes the silk covers for fine presents, such as lacquer-ware and the like; but here quadrangular pieces which are printed with flowers or landscapes, and serve for covering presents.

"In making Shi-fu fabric for clothing, the paper threads are twisted beforehand, right and left, similarly to those of the silk woof for Chirimen or crape-silk, and run in the fabric alternately once in and out, *i.e.* two right-twisted woof-threads follow two left-twisted threads, and so on. When the Shi-fu fabric is finished it is placed in boiling lye made of straw ashes, then washed, dried and stretched. It acquires in this process a twilled appearance and is considerably shrunken. It is now given to the dyer before being worked up, and is printed in various patterns.

"This peculiar branch of industry which I have described was introduced in Shiroïshi 90 or 100 years ago, and was carried on by Samurai families. It is said to have been at its height 50 years ago, when the Shi-fu material, which can also be washed, was very popular for women's summer clothing. Later, when, in consequence of the commercial treaties, the incomparably finer and more durable English cotton fabrics were brought in such quantity and at such low prices into the country, this industry declined rapidly, so that twelve years ago it was carried on in six or eight houses only."

It has been stated by C. P. Hellberg (*Textile Institute Journal*, 1911, **2**, 34) that in modern times the first attempts to use paper for textile purposes were made in the United States of America, where the yarn was chiefly employed for making mats. In Europe, a patent was obtained in 1890 by Mitscherlich for a method of producing spinnable fibre from wood.

Methods were also devised for manufacturing yarn from pulp (or rather half-made paper) and patents were obtained by Türk in 1892, Kron in 1901, and Leinweber in 1901. Yarn was first made from pulp at Waldhof, near Mannheim, and was known as "Licella" yarn. In the manufacture of this product, the pulp, freshly prepared from wood or other material, is drawn off on to wire-cloth drums or frames so as to form narrow bands of paper. These are partly dried by passage over hot cylinders, and collected either in tubs or on rollers. In this slightly moist condition the bands are spun by an ordinary spinning machine into yarn, which can be woven either immediately or after being air-dried. The manufacture of "Licella" yarn was abandoned in 1908 owing to the inefficiency of the machinery, the high cost of production and the unsatisfactory strength of the yarn. Kron's method of spinning pulp has been used for the production of "Silvalin" yarn, but this method is regarded by Hellberg as unsuitable for the establishment of a large industry on account of the great amount of waste produced, the large quantity of labour required, and certain technical difficulties. Hellberg states that a stronger yarn is obtained by the use of finished paper, and that the idea that the cost of producing yarn direct from pulp is less than from finished paper is incorrect.

The spinning of yarn from finished paper was invented by Emil Claviez, who in 1895–7 took out patents for the production of yarn from paper strips and a spindle for the purpose. The manufacture of this yarn, which is known as "Xylolin," was first carried on in Saxony and subsequently in Austria. Claviez's invention has formed the basis of all the later methods of spinning paper.

Raw Materials

The paper used for the manufacture of paper yarns may be made of any of the usual raw materials, such as chemical and mechanical wood pulp, cotton rags, various kinds of fibre waste, and old ropes, etc. In most cases, however, the paper is made from chemical wood pulp. Wood-pulp manufactured by the digestion of wood with caustic soda (as in the soda and sulphate methods) is regarded as superior for this purpose to that made by the sulphite process, and is said to yield a more supple and flexible paper.

" Kraft " paper is considered to be the most suitable paper for spinning, and has been found to furnish yarns 20–25 per cent. stronger than other kinds of paper. Kraft pulps are made either by the sulphate or the soda process, and the digestion is carried out under such conditions that the wood is not completely resolved into its ultimate fibres, but a certain proportion of the binding material remains. Such products are brown pulps, which do not bleach, but produce remarkably strong paper, which is very resistant to wear.

Pure sulphite paper produces serviceable yarns, which for many purposes are quite satisfactory, but are not so highly valued on account of their being less elastic. For the manufacture of specially fine yarns, tissue paper gives the best results.

Methods of Manufacture

The paper intended for spinning is packed in wide rolls. These rolls are placed in the cutting machine, which at one operation cuts the whole width into strips of the breadth required, usually from $\frac{1}{6}$ to $\frac{1}{2}$ inch. These strips are wound on to narrow discs or bobbins, and are then twisted on spinning frames, similar to those employed in the manufacture of jute and cotton yarns. Before being twisted the strips are moistened by being led over a damping roller which dips into water (or a solution of some substance designed to increase the strength of the paper). The method of damping the strips varies, however, in different types of machinery. Jute-spinning machinery is considered more adaptable than cotton-spinning machinery for making paper yarn, the latter requiring greater modification to render it suitable for the purpose.

In the process employed by the Textilite Engineering Company, Ltd., of Southwark, the paper in rolls 30 in. wide is cut by machinery into strips varying in width from $\frac{1}{16}$ inch to 1 inch or even more. The paper is conveyed by means of two feed rollers to another pair of rollers, each provided with cutting discs, which are so arranged that, while cutting, they are automatically sharpened. The strips are then led to two winding-on rollers, one taking even-numbered discs and the other odd-numbered discs. The discs are next transferred to a spinning machine, and are mounted on uprights over the middle of the frame, each disc being provided with a light spinning brake to prevent over-running. As the discs contain a long length of strip, they provide practically a lasting feed to the spinning-frame. Moisture is imparted to the paper by passing the strips first over a guide-rod, extending the length of the machine, and then over a roller partly submerged in a liquid contained in a trough. The strips next pass over guide-pulleys, and are then spun or curled and wrapped on to bobbins by the ring and traveller method on the long-lift principle. Each spindle is provided with a hand-stop motion. The machines employed in subsequent operations are almost identical with those used in the jute and flax trade.

The yarns, in spools of weft and warp, are subsequently transferred to the looms, in which they are woven to any desired pattern.

The yarn can be toughened by impregnation with size, tannin, aluminium formate, or sodium silicate (water-glass). It has been stated (*Chem. Zeit.*, 1917, **41**, 43) that the best method of increasing the strength of paper yarns and rendering them more resistant to moisture is to pass the yarn first through a glue, tannin and silicate bath at 50° C. (120° F.), and then, without previously drying it, to pass it through a cold bath of basic aluminium formate, and afterwards to dry it. The yarn, when thus treated, is found to have its tensile strength increased 10 per cent. when dry and 30 per cent. when wet.

The dyeing of paper textiles is effected on the same lines as cotton dyeing. Substantive, sulphur and vat dyestuffs are employed, but greater care is required in turning and handling the materials. For this reason, the use of dyeing machines is preferable to dipping by hand; the baths must not be too strongly alkaline, and the temperature should be kept below the boiling point, preferably at about 50–60° C. (120–140° F.). Either the fabric or the yarn may be dyed, but, in the case of materials to be used for clothing, it is necessary to dye the pulp before making the paper in order that the colour may completely penetrate the material.

Bleaching may be effected by treating the yarn or fabric with a dilute solution of bleaching powder, afterwards transferring it to a weak acid bath, and finally rinsing well with water. In order to obtain a pure white material, it is usually necessary to employ paper made from bleached pulp.

Utilisation

Paper yarns are now being used for an extremely wide range of purposes. One of the principal uses is for the manufacture of cordage, ranging from fine twine up to coarse rope. Paper string is mostly made from paper yarn alone, but in some cases the paper is spun on a central core of fine hemp twine, and in other cases on a fine metal wire. Another important use is for the manufacture of sacks and bags to replace those made from jute and hemp. The sacks are employed for various kinds of produce, such as grain, flour, potatoes, seeds, coffee, salt, wool, artificial manures and cement, and possess the advantage of being free from odour, and having no loose fibres on their surface which could become mixed with the contents. During the war enormous quantities of paper yarn have been used for making sand-bags for army purposes. Experiments which have been made by British military authorities with captured German sand-bags have shown that sand-bags made entirely of paper-yarn are less resistant than those of jute, and are more liable to break on impact, and that snow and frost have a deleterious effect on them. It has been found, however, that sand-bags made with a jute warp and a paper weft form a satisfactory substitute for jute bags, but that the paper weft is less resistant than the jute warp.

Paper yarns are also employed for the manufacture of braiding, webbing, tent canvas, waterproof canvas, tarpaulins, mats, upholstery and carpeting materials, wall coverings, as a foundation for linoleums and oil-cloths, and for woven boards which are said to form a suitable substitute for three-ply wood.

Another use of the yarns is for the manufacture of a leather substitute, especially for machine belting. For the latter purpose the yarns are spun from parchment paper, and are afterwards impregnated, wound on spools, and woven into fabrics which are stitched together to make belting of the required thickness.

Paper yarns, which have been specially impregnated, are stated to be used in the cable industry, chiefly as a partial or complete substitute for jute as a packing between the lead sheath and the iron armour of the cables. In the coating of lead-sheathed cables with waterproof composition, the winding of paper yarn is as efficient as the old jute winding, since it adheres better to the lead sheath, and blends with the composition to form a perfectly flexible and water-proof covering.

For the purposes mentioned above, the paper yarn is chiefly used in place of jute, but it is of course obvious that the products of its manufacture cannot possess properties equal to those of materials made from jute. Many references, however, have been made in the foreign press to the utilisation of such yarn as a substitute for cotton yarns, but it seems very doubtful if its use in this direction can be really satisfactory except as a temporary makeshift. It is stated that the methods of manufacture have been so much improved recently that paper textiles can be washed, and even boiled, without detriment, and that a process has been devised which is capable of rendering such fabrics almost as soft as cotton. In Germany paper yarn is now being employed for the manufacture of towels, underclothing, linings, aprons, overalls, workmen's clothing, handkerchiefs, table-cloths and counterpanes, etc. For wearing apparel, a mixed fabric of cotton and paper is preferred to one made of paper only, as garments composed of the former do not tear so easily, and do not lose their shape on exposure to the weather ; such fabrics are also said to be used for making imitation linen for collars, cuffs and shirt-fronts. For some purposes, the paper yarn is woven in conjunction with shoddy.

Comparatively recently, a number of factories have been started in Germany for making a product termed "Cellulon," which, in reality, is merely a yarn made direct from the pulp or half-made paper by a process originally devised by Türk and similar to those formerly employed for the manufacture of "Licella" and "Silvalin" yarns (see p. 552). Astounding claims have been made in the German press with reference to the merits of this product, which has been stated to be a thoroughly efficient substitute for cotton, hemp, jute and flax.

Present Position and Prospects of the Industry

As has already been pointed out, the manufacture and utilisation of paper yarns have hitherto progressed most rapidly in Germany and Austria, where the industry has now attained great importance. It has been stated that, whilst before the war there were only two mills in Germany manufacturing paper yarn, at the end of 1917 there were more than 250 mills engaged in this work, and that early in 1918 there were about 300 mills and factories in Austria-Hungary producing paper yarns and fabrics. The quantity of paper yarn produced in these two countries was estimated in March 1917 at about 260,000 tons per annum. The use of paper yarn has undoubtedly compensated to a large extent for the lack of other fibrous materials, and has especially relieved the situation produced by the cutting off of the jute supply. Many firms which formerly manufactured jute and cotton goods would have been obliged to close their works if they had not been able to find some substitute for the raw materials which were no longer procurable.

Some difficulty has been experienced in Germany in obtaining a sufficiency of wood-pulp for the paper-yarn industry. An enormous increase has taken place in the imports of pulp, and also of paper-yarn from Sweden, and efforts have been made to increase the production of pulp in Germany. In this connection, several new pulp-mills have been started, and an endeavour is being made to utilise timber from the German forests to a greater extent.

With regard to the future of the industry, it may be pointed out that the use of paper-yarn as a jute substitute is only likely to be adopted in cases where the supplies of jute are deficient in quantity or only available at abnormally high prices. With a normal jute market and an ample supply of the fibre, the paper yarn industry would probably make but little progress.

There seems little doubt, however, that this industry, which has been developed in the Central Empires during the war on account of the lack of supplies of fibres, especially jute and coarse cotton, will continue after the war for the following reasons. A large amount of capital has been invested, and the industry encourages the utilisation of home-grown products and reduces dependence on imported materials. Moreover, the price of jute is likely to remain high for some time after the war, even if there should be no restriction of the supply from India, whence practically the whole of the fibre is derived.

In other European countries the manufacture of paper textiles has not shown any very notable advance. In Sweden, where it would be naturally expected that, owing to the abundance of the raw materials, the industry might flourish, only three or four companies have been formed to carry on the manufacture, and this is attributed chiefly to the difficulty of obtaining the necessary machinery. In Norway the industry does not appear to have made much headway, and only one undertaking has been established. Similarly, in Denmark there is only one factory in operation. It is reported that in Holland paper textiles are now being manufactured in some of the cotton mills owing to the inadequacy of the cotton supply.

In the United Kingdom the manufacture of paper yarns and fabrics has not assumed large dimensions as fortunately the need for fibre substitutes has not been nearly so urgent as on the Continent. The industry has been carried on, however, by the Textilite Engineering Company, Limited, which was originally formed for the manufacture of machinery for spinning and weaving paper yarns. This Company has a factory at Southwark for experimental and demonstration purposes, and, under the style of Celltex, Ltd., is engaged at Manor Park and elsewhere in producing paper textiles on a large scale. The activity of this firm has been principally directed to the manufacture of sand-bags for the army and sacks for grain, potatoes, wool and other produce. In addition to these articles, however, they are making twines, carpeting, mattings, webbing, tapestries and cloth of various descriptions.

Specimens of yarns and fabrics made from paper are available at the Imperial Institute, and can be seen on application.

INDIA AND THE IMPERIAL INSTITUTE

THE following is a reprint from the *Pioneer* of India (October 1918) of four articles by Sir Harvey Adamson, K.C.S.I., lately Lieutenant-Governor of Burma.

THE IMPERIAL INSTITUTE

BY SIR HARVEY ADAMSON, K.C.S.I.

I

"The popular conception of the Imperial Institute is that it is a spacious building in London where vast collections of the raw materials and the products of industries of India and other parts of the Empire are arranged for exhibition to the public, and in whose secluded cloisters a large amount of scientific research is conducted. This conception is not confined to India, for Lord Haldane in a debate in the House of Lords in 1916 described the objects of the Imperial Institute in similar terms. Such a description of its functions gives no adequate idea of the work which the Imperial Institute is doing for the Empire. The demonstration to the public in England of the resources of the Empire is only one part of the activities of the Institute. Scientific research is not in itself an object. The main purpose of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by bringing the Indian and Colonial producer into touch with the home manufacturer, and by communicating to the manufacturer in India and the Colonies the accumulated experience of the manufacturer at home.

"The chief agencies within the Institute for carrying out this purpose are the Public Exhibition Galleries, the Scientific and Technical Research Department, and the Technical Information Bureau.

"Collections of raw materials and products of industries illustrative of the resources of all parts of the Empire are arranged on a geographical system in the Public Exhibition Galleries, which are open to the public daily. Arrangements are made to conduct parties from educational institutions through the collections and to explain the exhibits, and lectures on the countries of the Empire and their resources are given periodically. Hand-books, pamphlets and circulars containing information relating to commerce, agriculture, mining and other industries, and also in regard to emigration, are available for free distribution or sale. The Public Exhibition Galleries are visited annually by nearly 200,000 persons.

"The Indian Section of the Public Exhibition Galleries contains a very comprehensive collection of Indian raw materials and a collection not so complete of samples of the products of Indian industries. Their Majesties the King and Queen have presented some hundreds of exhibits, many photographs and pictures of India, and many interesting souvenirs of Indian loyalty. The contributions made by the Government of India in recent years have not been very numerous, and the Indian Section has to depend to a considerable extent on private contributors. Consequently it is not so complete as it might be. The value of such a collection cannot be over-estimated, and it will be very regrettable if it is not systematically kept up to date. For this purpose what seems to be wanted is an agency in every province of India whose duty would be to send to the Institute samples of all important new raw materials and illustrations of new industries. The best agency would probably be the Agricultural Department of India.

"It will be realised that besides serving an important educational purpose these collections are the starting-point for investigation and the means of answering enquiries as to the resources of the various countries of the Empire.

"The Scientific and Technical Research Department comprises laboratories and work-rooms where the investigation of new and little-known raw materials, and of known products from new sources, is carried on with a view to their utilisation in commerce. A reference sample-room is maintained in which are arranged samples of the principal raw materials which have been investigated, and in respect of which full information has been accumulated. This Department works in co-operation with the Agricultural, Mines and other technical departments in the Dominions, Colonies and India, undertaking investigations of a scientific and technical nature connected with agricultural and mineral development, and commercial valuations and discussions which can be more efficiently conducted at home in consultation with manufacturers and merchants. A large number of reports on these subjects has been made to the Governments concerned.

"The Technical Information Bureau, the business of which is the collection and dissemination of information, deals with the many enquiries received by the Imperial Institute from manufacturers and others throughout the Empire. The Bureau has devoted special attention to questions arising out of the war, particularly those relating to the opportunities presented for the development within the Empire of industries the raw materials of which were formerly monopolised by enemy countries. Merchants, manufacturers and users in the United Kingdom, as well as producers in India and the Colonies, have applied in increasing numbers for information on these subjects, and the Institute has gradually come to be recognised as a central clearing-house for information of this character.

"The Library and Reading-rooms contain a large collection of works of reference, and are supplied with the more important official publications and with newspapers and periodicals. The Map-room is provided with a large collection of recent maps of the Dominions, Colonies and India. The BULLETIN of the Institute is published quarterly. It contains records of the principal investigations carried out at the Institute, and special articles chiefly relating to the industrial utilisation of raw materials, tropical agriculture and the resources of the various countries of the Empire.

"The establishment comprises the Director, superintendents and assistant superintendents of departments, a scientific and technical staff, including officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology in their relation to commerce and to the industrial utilisation of raw materials, and a clerical and labour staff.

"So much for the object of the Imperial Institute and the machinery by which its work is carried on. In subsequent articles the functions and work of Committees will be explained, the Indian Trade Enquiry will be described, and the correlation between research agencies in India and research at the Institute will be shown. The process of investigation of a raw material will be traced from its arrival at the Institute to the concluding stage when it is placed on the market, and finally some account will be given of the work which the Institute has done in relieving difficulties caused by the war.

"These articles are mostly a précis of extracts from official papers, selected, abbreviated and arranged so as to give a comprehensive account of the functions and work of the Institute, which it is hoped will enable readers in India to understand and appreciate the great work which the Imperial Institute is doing for India and the Empire."

II

"Under the provisions of the Imperial Institute (Management) Act of 1916 the control of the Institute is vested in the Secretary of State for the Colonies. The management is conducted by an Executive Council of twenty-five members, including representatives appointed by the Governments of the Dominions, India and the Colonies. The Executive Council is assisted by a Finance and General Purposes Committee, and by other Committees selected from its members. Advisory Committees have been appointed for each Dominion and for India. These Committees include representatives with special knowledge of the trade and industries of these countries. Each High Commissioner in London is the Chairman of the Committee for his Dominion. The Chairman of the Committee for India is Sir Charles McLeod, of McLeod, Russel & Co., an East India merchant and Chairman of the East India Section of the London Chamber of Commerce. Technical Committees, including commercial, technical and scientific specialists, are appointed for special purposes, such as the Raw Materials Committee, composed of representatives of the principal Chambers of Commerce, the Mineral Resources Committee, the Rubber Research Committee, the Silk Production Committee and the Timbers Committee.

"In connection with war problems the Committee for India has been charged by the Secretary of State for India to enquire into the possibility of increasing the commercial and industrial utilisation of Indian raw materials. For the purpose of the Indian Trade Enquiry the Committee for India has appointed numerous special committees with co-opted members, including specialists on jute, cotton, wool and other fibres, on food-grains, on hides and tanning materials, on gums, resins and essential oils, on drugs, tobacco and spices, on oil-seeds, and on timber and paper materials. For each material investigated information is collected and arranged by the staff of the Institute as to the present position of production and the amounts exported to the United Kingdom and to other countries. The principal industries in which the material is used at home and its industrial uses in other countries are ascertained. Merchants and manufacturers are consulted as to the possibilities of the Indian material for their special purposes. Matters of export, transport and freight are considered, and the best opinions available as to the steps necessary to secure trade with India are obtained. The groundwork of these enquiries is often to be found in the information of a technical character which the Institute has accumulated during the past twenty years.

"An important aspect of the Indian Trade Enquiry is to find outlets for Indian products which before the war had gone on a large scale to enemy countries. Another aspect is to find British markets for materials which occur in India but are not at present exported, the British supply of which is now obtained from other countries.

"When full information has been collected and considered the Committees submit reports to the Committee for India, and this Committee in its turn reports to the Secretary of State. The reports are confidential until permission is given for their publication. It is understood that they will contain recommendations for improvement in methods of production of raw materials and in their preparation for the market, encouragement of export by the aid of preferential tariffs, and many other useful purposes. Considerable progress has been made with the Indian Trade Enquiry, and several reports have been made by the Committee for India to the Secretary of State, while others are in course of preparation.

"The Committee for India, in promoting the employment of Indian raw materials in other parts of the Empire, may be regarded as complementary to the Commission that is sitting in India to investigate and report on the extension of industries in that country. Similarly the whole course of research and investigation of raw products at the Imperial Institute neither reduplicates nor overlaps the research work conducted at Indian Institutions such as the Central Research Institution at Pusa or the Forest Research Institute at Dehra Dun, but is complementary to it.

"Every country desires to develop its own resources within its own territory, and much has been done in this respect in India. In the development of agriculture India has in recent years made great progress. The Central Research Institute at Pusa has taken up the investigation of the scientific problems of Indian agriculture and has rendered great service, notably in the subject of plant-breeding in its relation to the selection of the type of plant best adapted for the production of the economic product required. This Central Institute and the provincial Departments of Agriculture are equipped for scientific research. The experimental farms which have been established in the provinces are essential to the practical adoption of the results of scientific research. In forestry the Forest Department of India has in the Forest Research Institute at Dehra Dun an organisation which renders great service in developing the utilisation of the forest products of India. But neither the Department of Agriculture in India nor the Forest Department, however well equipped, can by itself reach complete commercial or industrial success. In determining the relative quality of the actual products of Indian agriculture or forestry, in ascertaining their suitability for particular purposes, and suggesting new fields for their use, a knowledge is required of European industrial conditions at the moment, of the requirements of the various markets, and of the results of similar technical and commercial undertakings in Europe. This knowledge can be obtained only by discussions with manufacturers and merchants at home, and it cannot be doubted that this work can best be conducted through one central organisation in London which possesses special facilities for the expert examination of materials, and for ascertaining the facts at first hand.

"Research in India is mainly concerned with improvements in the production of existing materials, or with securing the production of new materials which have been proved to be of value.

"Research at the Imperial Institute, in communication with the Indian Departments, is mainly concerned with ascertaining the value of new materials for the purpose of British industry and commerce, or in other words with investigating and introducing new materials and with finding new outlets for materials already known. These two lines are closely interrelated, the one in India tending to the production of the material required, the other at home for securing its use."

III

"In the previous two articles it has been shown that the main purpose of the Imperial Institute is not merely scientific or educative, but is mainly commercial, viz. the utilisation for trade and manufacture of the material resources of the Empire. The machinery by means of which the work is carried on has been described, viz. the Collections, the Scientific and Technical Research Department, and the Technical Information Bureau. The management of the Institute has been outlined, and an account has been given of the functions of the Committees, and especially of the work of the Committee for India in its enquiry into Indian trade. It has also been shown that the research and investigation work of the Institute neither conflicts with nor overlaps similar work conducted by Government agencies in India and elsewhere, but is the necessary complement of such work.

"The agency for investigating a raw material has been described in general terms, but the process will perhaps be more readily understood if a concrete example is chosen and traced through the various stages of the enquiry.

"A new material of possible utility as a tanning agent has been received from India.

"The first stage of the investigation is scientific. The uses to which raw materials may be put or adapted can best be ascertained in the first instance from a knowledge of their composition and properties, by which their industrial use is determined. This aspect of the investigation is dealt with in the laboratory. The question whether the new material is of value for tanning leather must depend first on the nature and amount of its constituents. The first stage is therefore chemical analysis.

"The second stage is technical. If the necessary constituents needed for tanning leather are proved to be present, the actual suitability of the material for tanning leather, and its capacity for tanning certain classes of leather, have next to be ascertained. Small-scale trials of the material as a tanning agent are made at the Institute, and samples of the leather produced become available. Then follows consultation with the practical tanner. If the results of the small-scale trials are favourable they will be sufficient to induce the tanner to give attention to the subject, and to decide whether the material is worth development, in which case he is usually ready to make further large-scale trials at the factory.

"The third stage is commercial. The material has now been proved to be suitable for tanning purposes, and the question arises what price will be paid for it. To ascertain this the views are taken of several manufacturers of the particular classes of leather for the production of which the material has proved to be suitable. Assuming that the price provisionally fixed is one which is satisfactory to the manufacturers, the next question is whether the price will be profitable to exporters from India, and whether sufficient supplies will be obtainable. Enquiries are made as to the sources of supply in India, the amount which could be annually exported from India, the export price and the arrangements for export. At this stage reference to India becomes necessary, and ultimate success depends on the means which exist there for assisting the enterprise. Lastly, assuming that everything is satisfactorily arranged in India, the final step is the export of a large trial consignment to test the market at home and to open the new channel of business.

"The Imperial Institute is provided with research laboratories, technical testing plant and machinery for conducting the whole of the work in the scientific stage, and for all the preliminary work in the technical stage. The staff includes trained workers, to whom are allotted separate sections of the materials to be dealt with, which include fibres, food-grains, tanning materials, gums, drugs, oil-seeds, rubber, feeding stuffs, minerals and many others. Arrangements exist for small-scale technical trials to determine provisionally the suitability of a material for a specific purpose. The Institute has established relations with special technical Institutions in connection with various industries, and with manufacturers and users of all classes of raw materials, who are ready to assist it in discovering new industrial openings for the raw materials of the Empire. Samples of the products which have been investigated are added, with full descriptive labels, to the reference collections and to the collections in the public galleries. These collections have frequently served to initiate important investigations, and have been used as a means of verifying the nature of materials required by manufacturers, and have been invaluable for reference purposes. Efficient arrangements have been made for obtaining information respecting the existing sources of supply of the raw materials of commerce and the advances which are being made in their utilisation in all countries. This information has been systematically collected at the Institute under expert supervision, and arranged for use. There has been a steadily increasing flow of enquiries from British manufacturers, merchants and brokers for information of this character.

"It is when a material has reached the stage of having been proved to be of commercial value that the greatest difficulty is experienced. It then becomes necessary to arrange for supplies and to interest Indian exporting firms to do all that is needed to develop enterprise in India. There is no Government organisation in India whose special business it is to deal with this side of the question. The work is usually outside the scope of a special department such as that of Agriculture or Forests, which is able to assist chiefly by collecting information as to the principal sources of supply available for export. The Chambers of Commerce may be able to render considerable help in the future, since there is a general awakening to the importance of utilising as far as possible our own materials for our own industries, and for this reason the Raw Materials Committee of the Institute is important.

"So far as the advancement of the utilisation by British manufacturers of the raw materials of India is concerned the exceptional value is evident of a central scientific and technical organisation in London, with special knowledge of Indian raw materials, and in close and direct communication with the manufacturers through whom their utilisation will be chiefly secured. There is still much to be done in interesting British capitalists in industrial development in India, and the work of the Imperial Institute in bringing raw materials to the direct knowledge of British manufacturers is of great value in this direction."

IV

"Within the wide limits of the British Empire there is to be found practically every kind of raw material that is necessary for manufacture, but before the war much of this raw material was not manufactured within the Empire, but went for that purpose to enemy countries and especially to Germany. For instance: Indian oil-seeds of the value of several million pounds went annually to Germany; more than half of the total export of Indian hides, which exceeded five million pounds in value, was taken by Germany and Austria-Hungary; over three-fourths of the exports from India of copra went to Germany; wolfram, a mineral of first importance in the manufacture of high-speed steel, was taken exclusively by Germany from India and other parts of the Empire. Atropine, a drug in great demand both at the front and at home for operations on the eye, is an example of another class of shortage due to the war. It had been manufactured in Germany, almost entirely from plants grown in Germany or in Northern Europe, and in the first stages of the war it became unobtainable in Great Britain. To relieve these difficulties it became necessary that the gaps caused by cessation of trade with enemy countries should be filled, that the raw material which used to be exported to enemy countries for manufacture should be manufactured at home, and that new materials should be introduced to meet an increased demand or diminished supply. The information accumulated as the result of the work of many years enabled the Imperial Institute to be of material assistance in these directions. Largely through the technical information and advice of the Institute producers of materials that used to be exported to Germany for manufacture have found a market in the United Kingdom. The Institute was able to give assistance to manufacturers and traders in regard to a number of substances the supply of which was cut off or curtailed by the war, and it was the means of introducing new raw materials as substitutes for materials that were formerly supplied only by enemy countries.

"Out of a long list of the activities of the Imperial Institute in these respects a few examples may be quoted. Thymol, an important surgical antiseptic, was after the commencement of the war scarcely obtainable in England because it had been manufactured solely in Germany. It was indicated by the Institute that this drug was readily obtainable from the ajowan seed of India, which had formerly been taken by Germany for this purpose, and the result of the technical advice of the Institute was that thymol of British manufacture was in a very short time put on the English market. When atropine became unobtainable from Germany the Institute was able to show that Egyptian henbane had been examined a few years previously and found to furnish considerable quantities of atropine. The result of the investigation was that this plant was brought into general use for the manufacture of atropine. There was difficulty in obtaining opium and morphia for medicinal purposes because before the war the supplies had come from Turkey and Persia. An investigation at the Institute showed that the opium of India could be used in medicine in place of Turkish opium, and that it was equally suitable for making morphia. The result is that Indian opium is now largely used in medicine, and that manufacturers of morphia are now employing that material. The dearth of dyes led to considerable difficulty in the manufacture of khaki cloth. The Institute was able to indicate the existence in some colonies of a wood known as fustic which gave the right tint, and it is now used extensively for dyeing khaki cloth. In the early stages of the war the United Kingdom experienced a great scarcity of boxwood which was formerly obtained from Turkey. The Institute knew that boxwood with similar properties occurred in South Africa. Samples were obtained and tested and introduced to the trade, with the result that this wood is being used by manufacturers for the same purpose as the wood that formerly came from Turkey. The Institute has done useful work in connection with minerals. It found outlets in England for the plumbago of Ceylon, and introduced new sources of monazite and similar materials required for the manufacture of incandescent gas-mantles which had hitherto been a German monopoly. Other examples of the successful activities of the Institute are in connection with wolfram, cotton, fibres, oil-seeds, groundnuts, copra, paper pulp, tanning materials, aconites, turpentine and rosin.

"Mention may also be made of mineral surveys which the Institute has arranged in co-operation with the Governments of certain Crown Colonies and Protectorates of which the mineral resources are little known. These surveys have been of great utility, and among other results have led to the discovery of coalfields in South Nigeria, of iron ore and limestone in North Nigeria, and of thorianite in Ceylon.

"The Institute has given special assistance in respect of Indian raw materials. There are few important materials mentioned in Sir George Watt's comprehensive Handbook of the Commercial Products of India that are not referred to as having been at one time or another investigated and valued for commercial purposes at the Institute. The contribution of the Government of India for the support of the Institute at present amounts in all to £1,400 a year. With a more generous endowment the Institute could do much more to assist in making the possibilities of Indian industries and trade better known in England.

"The foregoing list of recent activities, incomplete as it is, will give some conception of the part played by the Imperial Institute in commercial development within the Empire. The Institute had for many years been doing valuable service in helping to develop and utilise the resources of the British Dominions. Its work had been quiet and unostentatious, and scarcely attracted the attention which it deserved. The outbreak of war opened a wider field of usefulness. It was fortunate that at this period the Institute had in its Director, Professor Wyndham Dunstan, an officer who combines distinguished scientific attainments and great administrative ability with a sound knowledge of the requirements of commerce. It is in large measure due to his skill and energy that the new opportunity was fully utilised, and that the Imperial Institute has now come to be recognised not only as a centre for scientific research, but as a great channel for practical communication between manufacturers and producers throughout the length and breadth of the Empire."

The following series of four articles is reprinted from the *Times of India, Illustrated Weekly*, of August, September and October 1918:

INDIA AND THE IMPERIAL INSTITUTE

I

Imperial Institute Developments under the Act of 1916

"Amid the preoccupations of the war and of the Indian political problem insufficient attention has been paid in this country to the value from the standpoint of Indian industrial development of the reorganisation of the Imperial Institute rather more than two years ago. One reason for this, no doubt, is that the reports of the special Indian committees which have investigated the prospects of further utilising the various raw products of India have remained unpublished, though in one or two cases some indication has been given of the conclusions reached.

"It is beyond dispute that the Imperial Institute, when opened a quarter of a century ago, was started on wrong lines, and that the mistakes then made created prejudices in some quarters which have died hard. As the *Times* pointed out when the last reconstruction took effect two years ago, a sound, practical, efficient machine has been evolved *solvitur ambulando*, by a process of improvement 'carried out mainly since the transfer of the Institute to the Government in 1903, and the appointment of the present Director, Professor Wyndham Dunstan.' From 1903 onwards control was exercised by the Board of Trade, though a few years later some share in management was given to the Colonial Office, and, in lesser degree, to the India Office. It is obvious that the Board of Trade, with its many preoccupations in domestic affairs, was not the best department for subserving the interests of the overseas Empire. And, since unity of control is essential, it was fitting that the Act of 1916 should vest the chief authority in the Colonial Office, as the link between Whitehall and the self-governing Dominions and Crown Colonies.

Indian Representation

"The Act entrusts the detailed management of the Institute to an Executive Council which is made as representative as possible, within the limits of a membership of 25. Like the Dominion Governments, the Government of India appoint a representative (now Sir R. W. Carlyle), while two others (Sir John Hewett and Mr. Kershaw, the Secretary of the Revenue and Statistics Department of the India Office) are appointed by the Secretary of State for India. In addition he nominates one of the appointees of the Colonial Secretary, the present holder of the office being a member of his Council, Sir Marshall Reid, so well known in Bombay business circles. Thus the direct representation of India is, quite rightly, much larger than that of any other part of the Empire. It is reinforced in an indirect sense by the fact that the chairmanship of the Council devolves upon the present Parliamentary Under-Secretary for India, Lord Islington, while experience as a former member of the Government of India is further secured by the presence of Sir W. H. Clark, representing the Board of Trade. It may also be mentioned that the Secretary of State for India is one of the four statutory ex-officio trustees of the Institute.

"Not only is India strongly represented on the Finance and General Purposes Committee, but questions of more direct Indian interest are referred to a distinct committee for India which, in addition to the Indian representatives on the Executive Council, includes leading business men and those who can bring to bear special knowledge of this country. Sir Charles McLeod is the chairman, and further mercantile experience is supplied by Sir Charles Armstrong, Sir Ernest Cable and Sir George Sutherland. The other members include Mr. Chadwick, the Indian Trade Commissioner, Mr. Yusuf Ali, and Sir James Dunlop Smith. Moreover, in connection with the Indian Trade Enquiry undertaken at the request of the Secretary of State there are no less than seven special committees, all of them including well-known experts on the products dealt with, investigating the commercial possibilities of various groups of Indian raw materials. Detailed reference to the work of these committees must be left to a subsequent occasion.

India and Scientific Research

"It is fitting that the Indian side of economic research should be so strongly emphasised under the reorganisation of two years ago both because of the vastness of her still undeveloped resources, and because she led the way in practical recognition of the more strictly scientific side of the possibilities of the Institute. When the Institute was established India did not possess a distinct Commercial Department. There was, however, a Reporter on Economic Products, whose principal duty it was to make a survey of economic resources, to take steps to secure their investigation, and to seek to introduce to commerce products either wholly neglected or very inadequately utilised. The holder of the office, Sir George Watt, found a convenient medium for such investigation in the Imperial Institute, and for some years Indian materials chiefly occupied the attention of the laboratories at South Kensington. Other parts of the Empire, and especially the tropical colonies, gradually began to follow the example of Sir George Watt, and increasing use was also made of the Scientific and Technical Research Department by the home manufacturer and merchant.

"It is no disparagement of other activities of the Institute to recognise that the Department, with its various ramifications and under the new conditions created by the war, is the medium of its most important work. A distinct branch is the Technical Information Bureau, which collects and critically collates all published information respecting the production and industrial uses of Empire raw materials. The activities of this Bureau have been greatly increased by the urgent economic problems to which the war has given rise. In the interests of India, even more than of the self-governing Dominions, it has dealt with a large number of enquiries as to Empire products and their possibilities. Moreover, it has taken the initiative with British manufacturers and merchants in bringing to their notice important Indian materials which await a new market.

"Through its research activities and its efficient bureau of information the Institute has in fact been helping to fill some of the gaps caused by the cessation of trade with enemy countries. This work has had a fourfold aspect. In the first place the Institute has given technical advice and assistance to manufacturers and traders in regard to a number of substances the supply of which was at first cut off or very seriously curtailed by the degree to which we had allowed ourselves to be so largely dependent on Germany as a market for many of our raw materials. Secondly, assistance has been given in promoting the manufacture in the United Kingdom or in the country of origin of raw materials produced in the Empire which were formerly exported to Germany for the purpose. A third line of development has been the introduction of new materials to meet an increased demand or a diminished supply. A fourth field has been the exploitation of new Empire sources for increasing the supply of materials for 'key' industries. Many examples under each head could be given if space permitted.

Central Information and Research

"The problems which the Institute exists to deal with were thus made urgent in many directions by the war, and they are intimately bound up with that closer union, economically and politically, of the component parts of the Empire which will be an inevitable sequel of Allied victory in the present long-drawn struggle. Gratifying as has been the progress of late in scientific economic research in India, it is unquestionable that this central institution for the Empire as a whole must have in some respects better facilities and advantages than can be at the command of any Indian or other laboratories overseas for fruitful investigation aiming at extended utilisation of Empire products not only in the United Kingdom, but also in the countries of their origin under the stimulus of industrial enterprise.

"It is to be remembered that chemical analysis and experiment do not carry the question of utilisation beyond a certain stage, though an essential one. Take, for instance, a new material for tanning leather, one which perhaps grows wild in the Indian jungle. When its suitability has been tested and proved, the commercial question has next to be determined, and notably the price that will be paid for it. Assuming that the price provisionally fixed is one that is satisfactory to the manufacturer, the next question is whether this price will be profitable to the producer or exporter. Ultimate success will depend on the means which exist in India for assisting the enterprise. Assuming that everything is satisfactorily arranged here, the next step is for a large trial consignment to be exported to test the market at home and to open the new channel of business. In a word, over and above the laboratory work it is necessary to demonstrate the practical application of the ascertained results, and to indicate the probable commercial outlook for the industry affected.

"For these various operations an all-Empire clearing house is needed, not as in any sense the jealous rival of research activities conducted in the countries of origin of these products, as for example under the authority of the Board of Scientific Advice in India, but in hearty co-operation therewith. By means of the great clearing-house at South Kensington, waste of effort, overlapping of work, inadequate knowledge of relevant conditions in other parts of the Empire, and misunderstandings are avoidable. By such an agency alone unity and directness of purpose can be secured.

The Indian Section

"Valuable educative work is done by means of the Indian Section of the exhibits in the public galleries. It comprises a representation of the important raw materials of India, illustrations of its chief industries and their results, tabular information and diagrams respecting Indian trade and commerce, maps, pictures and photographs. There are systematic efforts to render the section intelligible and attractive to the general public, and large numbers of schools use it for the purpose of teaching India's great part in the commercial geography of the Empire. It also provides a means of reaching 'Eye-gate' for a series of lectures given from time to time at the Institute on 'Our Tropical Industries.' To the interest and generosity of the King and Queen are due some hundreds of illustrations of Indian industries in various materials. But there would seem to be need of a closer measure of co-ordination with the Indian authorities than has hitherto been attained in extending this collection and keeping it thoroughly up to date. There should be no great difficulty in devising some systematic plan of enabling the Section to typify and mirror to the utmost possible extent that economic development of India to which the Institute has contributed much more largely than is recognised by the general public."

II

Scientific and Technical Researches

"The advantages of the rearrangement caused by the war of the Central Clearing House for technical information and research to promote the economic strength of the Empire were broadly indicated in the first of these articles. Important as this work was in pre-war days, the benefits of such investigations were inadequately realised both in England and in the overseas possessions of the Crown; but the lengthening out of the war has brought home to our business men, our publicists and our politicians the impossibility of maintaining the easy-going and self-confident ideas which gave our present enemies such opportunities to prepare the way for the economic domination of the world they were seeking as an eventual goal. Of this awakening the legislation of two years ago for reorganising the Imperial Institute, and making better provision for its activities, was a satisfactory evidence. The Institute has years of experience of research, scientific and commercial, behind it. We must confine attention, however, to researches carried out in relation to India alone since the reorganisation, though many of them are but sequels and developments of investigations steadily pursued for years. And it will be necessary for our brief survey to be typical rather than comprehensive, since the fields of enquiry have been so numerous and varied.

Minerals and the War

" As was inevitable, many of the matters referred to the Institute from India in the last couple of years have had relation to war industries, or to possible substitutes for products in great demand consequent upon the war. Many samples of minerals, including manganese ore, asbestos, mica, etc., received from Government authorities and from private firms and individuals have been dealt with. It is well known that difficulty has been experienced by makers of electric batteries in obtaining manganese dioxide of a sufficient degree of purity for their purpose, supplies having formerly come from Russia via Germany. Material having the required composition was found from the Institute records to be available in India, and enquirers were placed in communication with the producer. Subsequently enquiries were made by makers of paint and varnishes and other manufacturers for high grade manganese ore, and detailed information was given with regard to Indian material.

" Again, the enormous call of the present great struggle gives remarkable opportunities for developing the Indian drug trade. Early in 1917 a sample of the stem and leaves of Indian henbane (*Hyoscyamus muticus*) was sent to South Kensington for examination. The yield of the valuable alkaloid atropine was satisfactory though somewhat below that usually present in wild henbane plants from Egypt and the Soudan, which since the Imperial Institute first examined the drug in 1903 have been the chief commercial sources of atropine.

" The work done on Indian opium has shown that, contrary to the common opinion, this material, if properly selected, is quite suitable for use in medicine and for the manufacture of opium alkaloids, and since the war began considerable quantities have been sold in the United Kingdom for such purposes. In respect to consignments of crude codeine from the Ghazipur opium factory, a method of analysis was devised, and on the basis of the results obtained the consignments were sold at satisfactory prices to British alkaloid manufacturers, thus solving a difficulty experienced by the factory in utilising an important by-product under the present difficult conditions. Reference may also be made here to investigations, made at the instance of the Director of Agriculture in Madras, with a view to maintaining and increasing the home market for Tinnevelly senna, which has suffered from an accumulation in London of stocks of inferior grades of the leaves.

Foods and Fibres

"During the past two years various aspects of India's contribution to the food supply in Great Britain have been under consideration, special attention being given to cereals, including wheat and millet. An important branch of this work has been carried on in conjunction with the Department of Agriculture in Burma in its efforts to improve the types of rice cultivated in Burma. The principal object of the enquiry has been the elimination from the exported commodity of unduly soft and other types of grain not desired by manufacturers. The samples sent, after preliminary examination, were submitted to commercial experts for opinions as to their suitability for the United Kingdom market and the majority of them were favourably reported on. The Institute also furnished the Agricultural Department with a memorandum on the industrial use of rice for brewing and starch manufacture. Mention should be made of the exhaustive monograph on the production and uses of rice published in the BULLETIN OF THE IMPERIAL INSTITUTE last year for which there has been a large demand. The possibilities of placing sweet potato starch on the home market have been investigated, at the request of the Imperial Agricultural Chemist at Pusa, and the prospect appears to be good, subject to improved methods of cleaning the sweet potatoes and a more thorough washing of the starch.

"The voluminous evidence recorded by the Cotton Commission last cold weather renders unnecessary any detailed reference to the recent work of the Institute in promoting production of improved cottons in this country, which has included the examination and valuation of samples supplied from various official sources, and in ascertaining their suitability for the Lancashire market.

"A great deal of work has been done in relation to fibres. In some cases, notably that of samples of nettle fibre from Bengal, improved methods of cleaning and degumming were suggested as the prelude to any satisfactory demand from the United Kingdom. A sample of flax from Assam was found to be fairly strong, medium quality warp flax, suitable for use by spinners in Ireland and comparing favourably with the medium qualities formerly received from Belgium. There can be no question but that the present is a favourable time for the development of flax growing in India.

Gums, Resins and Oils

"Note may be taken of the reports furnished to authorities in this country in connection with the investigations of resinous exudation of *Boswellia serrata* begun in 1915, at the request of the Forest Department. It has been shown that the resin can be utilised in certain cases as a substitute for common rosin. Varnishes made from it give a fairly brilliant but rather soft coat, similar to that given by good grades of ordinary rosin. But it would be a great advantage for other products of the frankincense tree, such as heavy oil and gum—the light oil will be an excellent substitute for the best French turpentine—to be marketed concurrently, and investigations of these by-products are still in progress. The special interest of this work lies in the possibilities of Boswellia furnishing an additional source of turpentine.

"Turpentine was one of the first Indian products examined at the Imperial Institute, and, as Mr. Troup states in his recent monograph on the work of the Forest Department in India, the Institute has given the Forest Department much helpful assistance and advice in the establishment of its now flourishing turpentine industry.

"Much could be said of other investigations, such as those in relation to Indian aconites and various qualities of tobaccos, the latter a subject of great importance in view of the large market for tobacco which exists in the United Kingdom to which India and the Colonies are as yet small and almost negligible contributors. Although some of the results are negative, rather than positive, the investigations from which they flow are valuable in preventing waste of money on new fields of possible industrial activity before the possibilities of commercial utilisation have been duly explored. Not infrequently though results of the research work may seem discouraging, they lead to improved methods of cultivation or preparation, with a view to better chances in competition with other products. Thus recently the Institute drew the attention of the Indian authorities to the adulteration of beeswax, pointing out that the prevalence of the practice is particularly unfortunate in view of the possibilities of the development of a considerable direct export trade to Europe.

Assisting Indian Manufactures

" While the provision of new markets for Indian products holds a high place in the activities of the Scientific and Technical Department, it must not be forgotten that the Institute is an important and helpful medium in promoting Indian manufacturing enterprise. To take an example from this Presidency [Bombay] : some time back information was supplied to the Secretary of the Indigenous Industries Committee as to the methods of manufacturing strawboard, and the plant required. The details supplied included an estimate of the cost of a suitable plant for the preparation of wrapping paper and board from straw with samples of paper made from oat and wheat straw by a new process. From the Director of Industries, Madras, enquiries were received regarding certain difficulties met with at the experimental factory there. The information desired related to the stamping, colouring and finishing of different kinds of pencils. Technical particulars regarding the processes used for this purpose were accordingly collected and supplied, and details were given as to the prices of the necessary material and firms able to supply them.

"Special attention has been devoted to certain Indian textile materials believed to be suitable for the West African market. Enquiries were received at the Institute from West Africa regarding sources of supply of bast cloth made in India. The enquiries were answered, and samples were received from firms in India, together with particulars of prices at which the cloth would be supplied. Another matter on which the Institute has given helpful advice is that of the best methods of refining beeswax. Again, the great timber industry in Burma is indebted to the Institute for undertaking, at official instigation, enquiries as to the relative value in London of different sized logs of teak, the object being to ascertain whether there is any advantage in marketing very large logs, which are sometimes difficult to extract. It was ascertained that first-class logs should measure up to 33 ft. in length if possible, but that second-class logs could be reduced in length without greatly depreciating their value.

"Enquiries such as these should be stimulated by the new arrangement under which the Government of India are directly represented in the City of London by a Trade Commissioner. Mr. Chadwick, the first holder of the appointment, is, as mentioned in the former article, a member of the Indian Committee of the Institute, and will doubtless welcome requests to submit scientific and technical investigations and enquiries to the Institute. In this connection it may be pointed out again that the Institute carries out its work in co-operation and consultation with the technical Departments of the Governments in India and the Colonies, supplementing their operations by conducting for them those investigations and enquiries which can be best carried on in the United Kingdom in consultation with manufacturers and merchants."

III

Propaganda on Natural Resources

"In the great State paper published early in July the Viceroy and the Secretary of State laid down the proposition that, both on economic and military grounds, Imperial interests demand that the natural resources of India should henceforth be better utilised. That these high authorities have ample ground for the declaration that there is immense scope for the application of scientific methods is patent to any student who will examine the ever-growing material placed on record by the Imperial Institute. Research, carried on both in this country and at South Kensington, has been of great advantage in bringing India out of her long industrial sleep, and leading her to a point where the Viceroy and the Secretary of State can discuss as practicable the possibility of the country being economically self-contained in time of war.

"It must always be remembered that, while research lays the foundations for industrial development, the superstructure is largely dependent on the right dissemination of information. A great deal has been done, though far more remains to be done, by the Technical Information Bureau of the Institute to provide the 'practical information about the commercial potentialities of India's war products,' to the inadequacy of which the historic Report draws attention. The work of the bureau is carried on by a staff of experts in communication with Government departments and producers overseas, and in consultation with manufacturers, users of raw material, and importers in Great Britain. Though such work goes back many years, the organisation of the bureau on the present thorough basis was not effected until the first war year. In the course of the first six months after its establishment, no less than 300 enquiries relating to India and her products were received. Though the long continuance of the war and the Government acquisition for essential purposes of some important Indian products, combined with tonnage shortage, have temporarily limited the field of private business activity, enquiries continue to be numerous. Even in these exceptional days the information provided bears fruit, though in many cases it is stored up by the investigators against the day of reconstruction, when Indian industrial development will give fresh opportunity for a large exchange of commodities between this country and England.

Ground Nuts and other Products

" By way of illustration, note may be taken of three or four early lines of enquiry having their origin in Indian trade difficulties caused by the war. It is well known that India is the largest producer of ground nuts in the world, and that in pre-war days four-fifths of her shipments went to France. When the French trade was greatly diminished by the work of keeping back the invader, the bureau called the attention of business men in the United Kingdom to the possibilities of the industry, and in addition to Press notes some hundreds of copies of a more detailed circular were distributed to firms likely to be interested in the product. Subsequently the whole field of the branch of tropical produce of which ground nuts are but a part was surveyed in the first of the Institute monographs relating to the war and new British industries—*Oil Seeds and Feeding Cakes.* (London : John Murray, 2*s.* 6*d.* net.) The uses of these products in seed-crushing, in soap-making, and in margarine and edible oil manufacture were set forth, and the book showed how Germany had secured a virtual monopoly of certain oil seeds which form some of the most valuable produce of India and other possessions of Great Britain.

" Similar action, which cannot be detailed here, was taken in the case of copra, a product which in the past was mainly shipped to Germany. Considerable attention was also devoted to the subject of thymol, an antiseptic, previously almost entirely supplied by Germany from ajowan seeds shipped from this country. In view of the enhanced prices of cereals commonly used for poultry food, attention was drawn to the merits of dari, or juar, the seed of *Sorghum vulgare*, one of the chief Indian food grains which merits further attention as an article of export than it has yet received. Successful action was also taken by the bureau with the object of finding an increased market in England for Ceylon plumbago, which is of importance in the manufacture of steel works crucibles.

Publications

"Such activities (and we have given only ready illustrations arising in the early days of the war) by no means exhaust the activity of the Institute in what may be termed propaganda for turning to profitable account within the Empire, and especially in the countries of origin, the raw materials available in the King's dominions. With this end in view the quarterly BULLETIN provides a store-house of information of very great value in pursuing the trade policy recommended two years in succession by the Imperial Conference. India bulks largely in this repository of commercial facts, as can be seen, for example, by looking over the four issues for 1917. Among the subjects dealt with, often in the form of reports of recent investigations at South Kensington, may be mentioned Burmese black varnish or lacquer, Indian henbane, the Madras fisheries, improvement of the Indian cotton crop, development of the oil seeds trade, and the Indian production of turpentine oil and rosin.

"Reference has already been made to the Institute monographs relating to efforts to make the Empire industrially self-reliant. Note may also be taken of the series of handbooks dealing with the commercial resources of the tropics; and of the selected reports from the Scientific and Technical Department now and again presented to Parliament; of the series of mineral surveys of Ceylon and other countries; of the contributions made by Professor Dunstan, the Director, to the literature of cotton cultivation; and to the handbook on *The World's Supply of Potash*, which, published soon after the outbreak of war at a shilling, went out of print within a month or two of issue, and is under preparation for a new edition. It is intended to issue a series of such monographs on the mineral resources of the Empire. The first of these, dealing with Zinc Ores, has now been published, and in it attention is directed to the possibilities of the zinc industry in Burma. These monographs are being prepared with the assistance of the Imperial Institute Advisory Committee on Mineral Resources, of which the late Lord Rhondda was Chairman until his recent death.

The Indian Galleries

"An important branch of this propaganda in the capital of our Empire for Imperial Trade and industry is that of the exhibition galleries. These may not be particularly attractive to the populace in search of idle amusement; but they are visited largely by the investigator, whether a man of business or a student of economics, by teachers and pupils in public schools, and even in these hurried and pre-occupied days about a quarter of a million people pass through the turnstiles per annum. The Indian Section, with which we are the more directly concerned, was reorganised shortly before the war, so as to provide a more comprehensive nucleus of an exhibition illustrative of the principal natural resources and modern industries of this country. The illustrations of the latter shown in the pavilion have received several hundred important additions from the King and Queen, who have presented selections shown in groups representing modern industrial handiwork in metals, wood, ivory, lacquer, etc., and constituting a highly instructive collection. There have also been gifts from private donors; but care is taken not to allow the distinctive purpose of the exhibition to be disregarded. From time to time a number of offers of loans of artistic or historic objects from private owners have had to be declined with thanks on the ground of not being relevant to the general purpose in view.

"But while the collections cannot comprise mere curios unrelated to existing industries and handicrafts, every effort is made, consistently with their general purpose, to render them attractive to the general public, and also to enable schools and colleges to use this unique representation of modern India from the economic standpoint in connection with the teaching of the commercial geography of the Empire. For some years now the London County Council has included conducted visits to the Institute galleries on the programme of the extra educational arrangements for the very large number of schools under their administration. Children outside the great metropolitan area are not without similar facilities, though of course of a more restricted character, through the agency of branches of the Victoria League and other patriotic organisations who obtain loan collections from the Imperial Institute.

"The popular lectures given on different countries of the Empire, illustrated by the exhibits in the galleries, have been most successful, and the public schools in particular have been glad to make use of them. India stands easily first among the overseas countries in the popularity of these addresses. The fascination of her history, the attractiveness of the study of a land whose ancient civilisation differs so much from that of Great Britain, and a growing recognition of the vastness of her potential resources—these all contribute to the attention paid to the Indian collections and to the lectures relating thereto. To these general factors have been added the wide-spread recognition of the noble part played by Indian troops in the work of saving civilisation for mankind, and, in the last few weeks, the far-reaching proposals for reform contained in the momentous State paper signed by Lord Chelmsford and Mr. Montagu.

"It is of great importance that the only complete and general exhibition of Indian economic resources in the capital of the British Empire (or indeed anywhere outside this country) should be maintained efficiently and thoroughly. This is especially necessary at a time of rapid industrial advance. But satisfaction of the ideals of the responsible authorities in respect to the collections is largely dependent upon finance. India might well follow the example of many of the Dominions and Crown Colonies in making special grants for show cases, providing economic maps, and supplying material for additional exhibits illustrating the latest developments. The readiness of Japan, which has profited so largely from war conditions, to spend freely on efficient economic propaganda abroad should be borne in mind in this connection. There is every reason for the utmost care to maintain at South Kensington a comprehensive and up-to-date series of exhibits relating to the India of to-day such as will be useful alike for the business man with practical ends to serve, for informing the general public, and for educational purposes."

IV

Developing the Use of Indian Raw Materials

"There is abundant evidence that public opinion, especially in business circles, from the early days of the war has been far in advance of Government action in respect to the crucial importance of conserving and developing the economic interests of the British Empire, in face of the attempts certain to be made when peace comes to renew the German domination of essential industries which had been carried so far up to the summer of 1914 as to greatly hamper the operations of the Allies. In the United Kingdom the Government, largely perhaps on account of the pressing preoccupations of the war, have been more ready to assent to resolutions, such as those of the Paris Conference, and to appoint committees to make practical recommendations than to give effect to them by administrative action or preparatory legislation.

"Presumably we may attribute to some such cause the non-publication officially of the reports of conclusions reached in respect to the Indian Trade enquiry undertaken by the Committee for India of the Imperial Institute, at the request of the Secretary of State for India, into the possibility of increasing the demand for the raw materials of this country within the Empire. There may be excellent reasons for not publishing all the details of these reports in their entirety; but there is the less ground for withholding the main conclusions of the special committees for the various groups of raw materials, since they are already generally known in the various branches of trade concerned, and some of them have been publicly indicated in the utterances of specialists in the various materials who have served on, or been in close touch with, the special committees. For instance, the keenness of the Committee on Hides and Tanning Materials to ensure the non-repetition of pre-war German control of Indian Hides was made clear in a paper Sir Henry Ledgard, a former President of the Upper India Chamber of Commerce, gave before the Royal Society of Arts last February. That the other special committees had similar considerations in mind cannot be doubted, having regard to the express purpose of their enquiry.

Scope of Investigations

" Naturally the degree of attention paid to enemy alien influence, past or potential, has varied with the raw materials dealt with. Products such as tea, having hitherto been taken chiefly or entirely by Great Britain, have come only incidentally within the ambit of the question of German penetration. But most of the materials dealt with belong to three categories in which that question cannot be neglected—those taken partly by Great Britain and partly by foreign countries, such as jute ; those taken chiefly or entirely by foreign countries, such as cotton and hides ; and those which are known to occur in India (turpentine for example) but are at present not exported in any quantity and the British supply of which has been derived from other countries. Incidentally the question arose as to whether the quality of each Indian product of which there is or could be an exportable surplus needed improvement, and if so the action which should be taken to secure such improvement, especially in the case of materials competing with those of other countries. In order to make the investigations effective much preliminary spadework had to be done by the permanent staff of the Institute in collecting and arranging information as to the existing position of production and export ; in getting into touch with representatives of the industries in which each product is used ; and also in ascertaining the industrial uses made in other countries of Indian raw materials.

Hides and Tanning Materials

" With all the help that an efficient secretariat could give much work devolved upon each of the special committees, whose co-opted members were in every case either business men or technologists with specialised knowledge, or distinguished past or present Indian officials. As already indicated, the conclusions of the Hides Committee have been publicly indicated by one of its expert members.

They relate to measures for transferring permanently, and not merely during the war, the export trade in raw kips from German and Austrian to British firms, and for re-establishment of the tanning of the kips in the United Kingdom. This is not the occasion for discussion of the controversy evoked by this particular question. But since nothing is more certain than that the Central Powers will endeavour hereafter to regain their control of the Indian hide trade, the Committee take the right ground in urging the need for adopting really effective measures to prevent this from happening, and to secure the supply of the available exportable hides for tanners within the Empire.

Jute and Other Fibres

"This branch of the investigation, presided over by Sir Charles McLeod, Chairman of the Committee for India, had not to thread its way through so difficult a problem as that of the Hides Committee. It is known to have laid down the sound principle that the monopoly of jute production we possess should secure Indian and British mills first consideration in the distribution of available supplies in times of shortage. It is understood that a comprehensive scheme was formulated for the investigation of problems affecting the production of jute and approved jute substitutes. To this end the provision of an adequate technical staff, and the establishment and maintenance of an experimental area in each of the village communities engaged in jute cultivation are held to be essential. The encouragement of the production of Bimlipatam jute, the most important jute substitute, should be encouraged. The purview of the Committee even extended to the Bhita Bazaar, suggestions being made for regulating the operations of that speculative centre.

"The work in respect to other fibres has also been considerable, and it is understood that important new possibilities are indicated of a much more extensive use of the short and medium-stapled cottons of this country in the United Kingdom. The possibilities seem especially favourable in respect to the manufacture of cheap underwear, hosiery and flannelettes.

Food Grains

"The Special Committee on Food Grains, of which Sir Marshall Reid is Chairman, has dealt principally with the rice trade, which was growingly being diverted to Germany before the war, particularly for the final cleaning and polishing of rice for the European markets, and not least for that of Great Britain. The possibilities of increased direct trade with England depend largely on the recovery of the home and export trade by the British mills, the popularisation of rice as a food in the United Kingdom, and its increased use in brewing, distilling and other industries. The suggestions made by the Committee for securing these desiderata might well be published for consideration and discussion.

Oil Seeds

"Closely allied with food problems, especially in these days of shortage of dairy produce, is the work of the Special Committee on oil seeds, presided over by Sir Charles Armstrong. It goes without saying that much capital is invested in the United Kingdom in industries dependent on oil seeds, and notably margarine and other forms of edible fat, as well as soap and glycerine. In this as in so many other Indian export trades, Germany held a predominant position up to the summer of 1914. The continued development of margarine manufacture in the United Kingdom, the reorganisation and modernisation of existing mills, and the erection of new mills and refineries for oils and oil-cake are among the requisites of an increased market at home. They should all be prepared for further development when the war is over, and material, labour and plant cease to be so scarce. The Committee are understood to have made suggestions of a practical kind for preventing a return of the conditions of the last 15 or 20 pre-war years under which British re-export and transit trade in oil seeds declined, whilst that of Germany greatly increased.

Other Products

"Great importance attaches to the investigations of the Committee on Gums, Resins and Essential Oils presided over by Mr. A. Yusuf Ali. Shellac, one of the first branches of its investigations, is of primary consequence in the manufacture of munitions of war. It is also essential in the electrical industry, and in certain branches of textile manufacture. There are unquestionable possibilities of increasing the use of shellac both here and in the United Kingdom if manufacturers are given such preferences and facilities as will enable them to compete with foreign imports containing shellac. The Committee is understood to have suggested a scheme for the encouragement and organisation of the production of lac and for the manufacture of lac wares in India, based on State assistance, which should go far to eliminate the great fluctuations in prices which have had so hampering an effect upon the industry. Mr. Yusuf Ali, it should be added, is also Chairman of the Committee concerning itself with drugs, tobacco and spices.

"In respect to timber and paper materials (the Committee for which is presided over by Sir Robert Carlyle) it is well known that, apart from teak and a small number of other woods, Indian timbers are not familiar in the English market. Yet there are excellent opportunities for a considerable export of certain hardwoods, if they are available in commercial quantities, supplies are regular, and prices satisfactory. Tests and practical trials have been suggested, it is understood, to be carried out by the Imperial Institute, and to be followed by bringing approved timbers to the notice of the trade, under the auspices of the standing Imperial Institute Advisory Committee on Timbers.

Government Responsibility

"This brief survey is little more than a general indication of the scope and findings of these special enquiries. It will be seen that, while they have in view the needs of the United Kingdom and other portions of the Empire, the proposals, if adopted, cannot fail to promote greatly the economic and industrial development of India. They go to support the conclusion reached by the Viceroy and the Secretary of State in their historic Report that in relation thereto there must be a definite change of view, that Government must admit and shoulder responsibility for furthering the industrial development of this country, and that both on economic and military grounds Imperial interests demand that the natural resources of India should henceforth be better utilised. To this great end the work of the Imperial Institute can and will materially contribute. It is therefore deserving of whole-hearted support from India. If the Trade Enquiry Committees were placed on a permanent basis they would serve a valuable purpose in stimulating continued interest in the utilisation of Indian raw materials."

NOTES

The Imperial Institute and the Association of Chambers of Commerce.—At the quarterly meeting held in London on October 15 last, the Association of Chambers of Commerce of the United Kingdom considered the Final Report made by the Committee on Commercial and Industrial Policy after the War, of which Lord Balfour of Burleigh was Chairman. The Report had previously been circulated to the affiliated Chambers throughout the country, and 130 representatives of these Chambers attended the meeting.

The recommendations made by Lord Balfour's Committee include one to the effect that special enquiries should be instituted with a view to securing the detailed systematic collection, examination and dissemination of information as to the needs and resources of the Empire, in respect of commodities of economic and military importance, and that in these enquiries advantage should be taken of the organisation, which already exists for this purpose at the Imperial Institute.

In connection with this recommendation the following resolution was moved by Mr. A. C. Powell (Bristol Chamber of Commerce):

"That in view of the importance to British trade and commerce of the operations of the Imperial Institute, more especially in investigating methods of utilising the raw materials of the Empire, and the serious limitations at present imposed on this work by the inadequacy of the grant made by the Home Government, representations should be made to the Government urging the need of a contribution more in proportion to the value of the services which the Imperial Institute is rendering, and could still more largely render, to the development of inter-Imperial trade."

The resolution was seconded by Sir Algernon Firth, and was adopted unanimously, and is referred to as follows in a letter addressed by the Association of Chambers of Commerce to the Prime Minister:

"I am to say that this Association has had for some time a Committee working in collaboration with the Imperial Institute, investigating the question of supplies of raw materials for industries in this country. The Association desires to submit that in consequence it has knowledge of the needs of this Institute, and in view of the importance to British Trade and Commerce of the operations of the Institute, more especially in investigating methods of utilising the raw materials of the Empire, and in view of the serious limitations at present imposed on this work by the inadequacy of the grant made by the Government, it is of opinion that a financial contribution more in proportion to the value of the services which the Institute is rendering, and could still more largely render, to the inter-Imperial trade, should be granted. I am to express the hope that this recommendation will receive your most favourable consideration."

The Imperial Institute and Trade in Indian Hides and Skins.—The following leading article appeared in the *Leather World* for November 21, 1918:

"The excellent work done by the Imperial Institute has, we think, never received the recognition it was entitled to in bringing to the attention of British manufacturers and merchants the abundant supply of raw products to be found within the Empire. Much of the data given in the Institute's BULLETIN has been of the highest possible value, but the Ancient Briton had 'no time to read trade papers'—and he alone has been the loser thereby. However, one result of this prolonged war has been to attract attention to industrial literature, and we hope the data published by the Imperial Institute will at last receive their rightful recognition. For years past valuable articles have appeared in the BULLETIN, giving reports, for instance, on many tanning materials, few of which were known to our tanners, whilst we have often read of supplies of greases and oils suitable for leather work—in fact, our industry has been well treated by the Imperial Institute, in spite of the apathy with which it has been received. However, the Institute have 'carried on the good work' in spite of all, and in the April-June issue of the BULLETIN—just published owing to war delays—we have before us one of the most complete summaries of the Indian hide and skin trade which it has been our lot to peruse. It appears that as far back as 1916 the Hides and Tanning Materials Committees of the Imperial Institute have been at work on the difficult question of finding markets within the Empire for the Indian raw hides and skins, which before the war were exported to foreign countries—the hides chiefly to Germany and Austria, and the skins to the United States. The Committee have presented several reports, which are under consideration by the Government of India, and in due course full information as to the results of their deliberations will be made public.

"As readers will remember, Sir Henry Ledgard lately gave a most instructive lecture before the Royal Society of Arts, which was fully reported in this journal, and it was clear from this that the Committee were convinced that a market for these hides could be found within the Empire, partly by increased tannage in India, and partly by export to the United Kingdom and to the Dominions, especially Canada, Australia and South Africa. We have already stated in this journal that the Committee have already taken action to familiarise tanners in Canada and South Africa with the good qualities of Indian hides.

"Evidence has been forthcoming that the lecture of Sir Henry Ledgard—himself a member of the Committee—attracted a fair amount of notice from our readers, so much so, that the issue containing the lecture was soon out of print. The Federations utilised the interest it evoked to again discuss the matter, and although the action of the Government was criticised in some directions, yet there is no doubt but that the impetus given to the matter has proved very useful, especially as the War Office encouraged the tanner and currier of Indian kips by ordering large supplies of the finished article for some classes of military boots and other kinds of footwear coming within the control of the Department. For this and other reasons we welcome the exhaustive survey of the matter in the BULLETIN; it bears evidences of long and laborious investigation, as the work of collecting and collating the statistics alone must have entailed a very large amount of labour. It is obvious the first step towards effective post-war action in connection with hides and skins, as with other raw materials, is complete and accurate knowledge of the trade, and those of our readers who realise the immense importance of the future of the business will do well to make a careful study of the Bulletin article. It consists of upwards of seventy pages of well-printed matter and statistics, and deals exhaustively with Indian sources of the supply of hides and skins, estimates the present output in comparison with other competing countries, and discusses in detail the trade figures in pre-war times and the changes in destination brought about by the war.

"It is not generally known, even by leather trade readers, that hides and skins, both raw and tanned, stand very high in exports from India; as a matter of fact, in 1913–14 they figured in the sea-borne trade of British India to the extent of 1,900,000 cwts., of a value of about ten and a half millions. Cow-hides were the chief constituent, the value for 1913–14 being about five millions, goat-skins over three millions, and buffaloes over one and a half million. As readers know, the trade in cow-hides —or raw kips, as they are usually called—was formerly almost solely controlled by British firms, but for a variety of reasons, which we have often pointed out, it drifted into enemy hands, until the pre-war period found the British tanner almost a suppliant for any decent 'run' of raw Indian kips, as the bulk of the prime grades found their way into Germany and Austria. In fact, it is hardly too much to say that the German Army could hardly have been shod at all had it not been for this limitless supply of British material. So strong had the enemy become entrenched that, as the article points out, 'in India itself the merchant side of the business was controlled by German or quasi-German firms, who constituted a strong ring.' A good deal has been said and written on this point, but the matter appeared so complicated and contradictory that few of us here understood just how the game was 'rigged,' and whether Codlin or Short was the friend! It is therefore satisfactory to read that ways and means of recapturing the trade have been under careful consideration by the influential Committee of the Imperial Institute, including representatives of British tanners and of Indian firms interested in the subject. The conflict of interest in connection with Indian hide and skin trade matters seems very great; at the same time, the whole pivot of the matter should be the effort to keep the supply of raw material in British hands."

The Fuel Supply of Egypt.—The question of the Egyptian fuel supply is dealt with in a note by the Acting Financial Adviser, Egypt, on the Budget of 1918, published recently. The war caused a great scarcity of coal in Egypt, and the whole question of the supply of fuel has been a serious one for the authorities during the war. Before the war Egypt was mainly dependent on the United Kingdom for coal, of which she imported normally 1,500,000 tons. At present coal is used only for public purposes, that required by the railways being supplied by the Admiralty. For private purposes, alternative fuels have had to be found. The available wood of the country has been largely drawn on, perhaps to a greater extent than was prudent, and miscellaneous produce of the farm has also been used. The situation has been saved, however, mainly by the development of the oil-fields in Egyptian territory on the Red Sea, and the adaptation of engines to producer gas distilled from vegetable refuse.

Of the various companies formed to search for oil, only one was in operation at the beginning of the war. In 1914, as a result of the geological researches carried out by the company's experts a field was discovered at Hurghada, the yield of which has steadily increased until it now stands at over 15,000 tons of crude oil per month. The refinery at Suez has been enlarged, and there is every reason to hope that as much oil will shortly be available for internal consumption as can be dealt with by the existing transport facilities.

The development of producer-gas plants has been due to the initiative of Mr. J. Wells, formerly Inspector-General of the Mines Department, who has designed plant for the distillation of gas from vegetable refuse which, it is stated, is being adopted by many engine owners.

A further alleviation of the situation has resulted from the decision to crush in Egypt as much of the cotton seed crop as the local plants can deal with, the resulting cake being used as fuel. Under existing circumstances the cake cannot be exported for feeding purposes, and Egypt should therefore benefit during the current season by about 100,000 tons of this additional fuel.

Kerosene has been largely used for ordinary household purposes, and the Government has been able to secure a supply of this commodity at comparatively moderate prices. The products of the Hurghada oil-field are deficient in oils of low specific gravity, and the bulk of the kerosene required has had to be imported.

Magnesite in New South Wales.—The following information regarding the development of magnesite mining and magnesite brick manufacture in Australia has been supplied to the Imperial Institute by the Mount Morgan Gold Mining Co., Ltd., who are now working a deposit of this mineral at Piedmont, Murchison Co., 21 miles from the township of Barraba, New South Wales, where the company hold three ten-acre leases for the mining of the mineral. The magnesite has been traced across the leases for a distance of ¾ of a mile, and the outcrop shows an average depth of approximately 20 feet. A 40-ft. shaft has been sunk, indicating its downward continuation for that depth. At the present time, sinking and cross-cutting are being carried on to determine the quality and extent of the deposit. The magnesite is quarried by open cut, and is conveyed by dray to the nearest railway station at Barraba, being taken thence by rail to Sydney, a distance of 342 miles. From Sydney it is shipped to Rockhampton by sea, a distance of over 1,000 miles, and from Rockhampton it is conveyed by rail 23 miles to the principal treatment works of the company at Mount Morgan, Queensland, where tests have been made to determine its suitability for making magnesite bricks. The company had previously used bricks made in the United States from Austrian magnesite, the supply of which was cut off by the war.

The following is an analysis of a typical sample of the raw material from Piedmont:

Magnesia	MgO	44·47	Ferric oxide and alumina	Fe_2O_3 Al_2O_3	0·80
Lime	CaO	1·76	Water	H_2O	0·25
Carbon dioxide	CO_2	50·15			
Silica	SiO_2	2·40			

After calcination the product has the following composition:

Magnesia	MgO	88·34	Ferric oxide and alumina	Fe_2O_3 Al_2O_3	2·39
Silica	SiO_2	4·34	Lime	CaO	3·72

Imported Austrian magnesite bricks gave the following results on analysis:

Magnesia	MgO	80·90	Ferric oxide	Fe_2O_3	6·80
Silica	SiO_2	4·80	Lime	CaO	6·50
Alumina	Al_2O_3	1·60			

It is stated that bricks equal in quality to the best of those imported can be made from the Piedmont magnesite. The company have used all the bricks made experimentally and expect to be able to make all they require from this source and to supply any outside requirements. Further experiments and tests are now in progress at Mount Morgan preparatory to erecting a calcining and brick working plant.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Citrus Fruits.—The *Rhodesia Agric. Journ.* (1918, **15**, 243) contains a series of extracts from the Report of the Director of Agriculture for 1917, in which a short account is given of the citrus fruit industry. The chief areas in which citrus trees are at present grown are Mazoe, Lomagundi, Salisbury, Umtali and Makoni; but the cultivation is being undertaken also in the Hartley and Marandellas districts. There are also other localities which have been found well adapted for citrus trees and a further extension of the industry is anticipated. At the date of the report there were 116,283 orange trees under cultivation, of which 37,799 were in bearing, and 78,484 had not yet reached maturity. There were also 20,626 lemon trees and 12,520 trees of other varieties of citrus. It is pointed out that the export of the produce will shortly become a serious problem. Export was entirely suspended in 1917, but large quantities of the fruit found a market among the native employees at the mines. The Rhodesian oranges are described by the trade as of the highest quality, and it is considered that if the present standard of care in grading and packing is maintained the active sympathy of buyers may be depended on in securing outlets for the crop.

In the *Report of the Administrator, Norfolk Island, for the year ended June 30, 1917*, reference is made to the lemon industry. Lemon trees grow wild in nearly all parts of the island, and the fruit is collected for sale. During the year under review the price of lemons rose from 10*s.* to £1 per thousand; but, owing to the low prices ruling in Australia, it is unlikely that this rate will be maintained. The produce of 4,000,000 lemons was exported, amounting to 901 casks of lemon juice and 1,121 casks of drained peel and peel in brine. There is also a trade in lemon seeds, which are shipped to Australian seedsmen. Many of the residents in Norfolk Island have planted lemon trees on their holdings, and a large number of Lisbon lemons have now become established, and in a few years should prove remunerative. Oranges are also being produced in the island, and small quantities were exported to Australia.

The orange groves of Southern Louisiana have, with certain exceptions, been declining during the last seven or eight years. Owing to the complaints of orange growers that this decline was due chiefly to injury occasioned to the trees by the Argentine ant (*Iridomyrmex humilis*) an investigation was undertaken in 1913 by the Bureau of Entomology of the United States Department of Agriculture to determine the economic importance of the ant as a citrus pest and to devise means for preventing damage in citrus orchards. The results of this work have been published as *Bulletin No.* 647, 1918, *U.S. Dept. Agric.*, entitled "The Argentine Ant in Relation to Citrus Groves," by J. R. Horton, Scientific Assistant, Tropical and Subtropical Fruit Insect Investigations. Enquiries made of the Louisiana orange growers elicited the general opinion that the ant causes severe injury to the trees, resulting in a total loss of the crop and the ultimate death of the trees. The results of the investigation have shown, however, that the amount of damage attributed to the ant has been exaggerated and that the only injury it causes is the destruction of a small number of orange blossoms. The deterioration of the crop is due principally to lack of care in cultivation. Many of the orchards are not cultivated at all, and manuring and spraying are neglected or only practised intermittently. The armoured scale insects, the white fly, the rust-mites and other pests cause much injury to the citrus trees and could be controlled without difficulty. The Argentine ant can be best controlled by a method of trapping which is described in detail. It is considered, however, that the cost of destroying the ants would not be compensated by the increase in the crop, and it is shown that many deteriorated orange groves could be so much improved by one season's thorough spraying and cultural treatment as almost to double the production- The success of certain orchards in southern Louisiana has proved that oranges can be profitably grown there if the trees are carefully selected and planted and adequate care is taken to practise the best methods of cultivation and to adopt suitable methods of insect control.

Oils and Oil Seeds

Cokerite Palm.—Fruits of the cokerite palm (*Maximiliana regia*, Mart.) from British Guiana have been investigated at the Imperial Institute (this Bulletin, 1916, **14**, 8). The pericarp of the fruit was found to contain 17 per cent. of oil, whilst the kernels contained 64 per cent. of oil similar to coconut and palm-kernel oils and would realise about the same price as palm kernels in Europe.

According to Hohenkerk (*Journ. Bd. of Agric., Brit. Guiana*, 1918, **11**, 43) the cokerite or kokerit palm is found in all the easily accessible areas of British Guiana on more or less swampy land and also on the slightly elevated clay and sandy-clay soils. The palms usually produce 2 or 3 bunches of fruit at a time, averaging about 100 lb. in weight. The principal fruiting season is between May and August, while a smaller crop may be obtained from December to February. As a result of surveys made by the author along the Canje and its tributaries, he estimated that there were over 1,000,000 trees on an area of 90 square miles in the Canje district alone. The extraction of oil from the pericarp does not seem to be a promising problem, as it would involve collection of fruit from the trees, whereas the nuts can be picked up easily when they fall from the trees. The shelling of the nuts is the chief difficulty in the exploitation of this oil seed, although machines are said to be used in Brazil for shelling babassu nuts which are similar in form to cokerite nuts ; such machines are not obtainable at present, but it is suggested that an attempt should be made to induce natives to shell the nuts by hand and produce kernels for export.

Various other palms yielding oil seeds exist in the colony, and concessions have already been granted to two firms to collect palm fruits, the concession in one case being restricted to the " Ité " palm (*Mauritia flexuosa*).

Ground Nuts.—A marked feature of the agriculture of the Southern United States in recent years is the rapid increase in the cultivation of ground nuts; or, as they are generally known in that country—peanuts (*Year-book, U.S. Dept. Agric.*, 1917, pp. 113, 289).

Ground nuts first became important commercially in the United States in 1870 and gradually increased in importance up to 1900, since when the industry has expanded enormously; in 1889 only 3,588,143 bushels of nuts were produced; the production increased to nearly 12,000,000 bushels in 1911, and to over 40,000,000 bushels in 1917, in which year the area under ground nuts amounted to over 2,000,000 acres.

The development of the industry is due to improvements in machinery for planting, harvesting and handling the nuts, to the recognition of the value of ground nuts as human food and for feeding animals, and to the planting of ground nuts on cotton land infested with the boll-weevil.

Two different types of ground nut are grown; the Virginia type, including the "Virginia bunch," "Virginia runner," "North Carolina," and other varieties; and the Spanish type, including the true Spanish "Georgia red," "Valencia" varieties, etc. Planting is done by a machine which opens a furrow, drops in the nuts and covers them with soil. Great reductions in the cost of growing have been effected by the use of large "cultivators." As ground nuts have to be "cultivated" three to six times during the growing season, it is obvious that a great saving of labour can be effected in this way.

Harvesting was formerly done by pulling the plants by hand or by ploughing followed by removal of adherent earth by hand; now it is done by the large growers by a special harvester similar to a potato-digger, which is capable of harvesting 8 to 12 acres a day. The plants are still stacked by hand to dry, the object being to keep the nuts off the ground and protect them from rain so that the nuts "cure" to a light colour.

Removal of nuts from the plants by hand is tedious, and is being superseded by machine pickers, in which the plants are drawn over a wire mesh; the nuts drop through the meshes and are broken off the plants by rubber brushes attached to moving belts; after removal from the plants the nuts fall on to a grid which retains them but allows earth, etc., to pass through; finally the machine removes the stems of the nuts. These picking machines deal with 200–400 bushels of nuts a day, but are somewhat fragile and are not adapted for treating other crops. An ordinary threshing machine with a special cylinder and run at slow speed will deal with 400–

600 bushels of nuts a day, but it damages the shells of a good many nuts, though this is of no great importance where the nuts are not to be sold in the shell.

From the farm the ground nuts, with the exception of those sold to oil mills, are sent to factories which clean and grade them before sale to manufacturers of roasted nuts or other food products; for the latter purposes the large "Virginia" nuts are roasted in the shell, the lower grade small nuts, *e.g.* "Spanish" and "African," being mostly shelled before sale. One ton of nuts as they leave the farm produces 1,300–1,400 lb. of cleaned nuts.

Cleaning and grading are mostly carried out at present in numerous small works, chiefly in Virginia, and the cost of producing cleaned graded nuts is in some cases rather high. To avoid the cost of transport of the nuts over long distances from the farms to the factories, larger central factories in the more important producing areas seem desirable. Although Texas, Alabama, Georgia and Florida each produce more ground nuts than Virginia, there are no important cleaning and grading factories in these States with the exception of Texas.

Ground nuts are consumed in enormous quantities in the United States, chiefly in the form of roasted nuts, but also as salted nuts, candy, ground-nut butter, and in confectionery and baked products. A number of recipes for dishes in which ground nuts are used are given. Ground-nut flour made either from the raw or roasted nuts, or from oil-cake, is also coming on the market and is well suited for use as a partial substitute for wheat flour in making bread, biscuits and other foodstuffs.

The production of ground-nut "butter" is already very large and is increasing. No statistics for the total output are available, but three large factories produced over 7,000,000 lb. in 1916, and one of these factories increased its output by 50 per cent. in 1917; probably over four million bushels of nuts were used for this purpose in 1916. The process of manufacture of ground-nut "butter" is comparatively simple and consists in roasting high-grade kernels in a machine similar to a coffee roaster; the roasted kernels are then cooled and "blanched" in machines which brush off the red skins; the kernels are then hand-picked to remove defective kernels and finally ground with the addition of a small amount of salt. Different varieties of nuts are generally blended before grinding with a view to improving the taste and texture of the product.

Up to 1914 ground-nut oil was not imported or produced to any considerable extent, but in 1916 over

2,000,000 gallons of the oil were imported, and 3,488,649 gallons were produced in the United States, mostly from unshelled nuts. The consumption of this oil is likely to increase, while the popularity of the oil with manufacturers of lard substitutes, who harden the oil by hydrogenation, is said to be increasing.

The manufacture of ground-nut oil in the future will be carried out at cotton-seed oil mills, as the machinery is mostly suitable and the supplies of cotton seed are often insufficient to keep these mills fully employed. The local manufacture of oil has proved beneficial to growers of ground nuts, as it gives them a market for low-grade nuts.

The ground nut is also of importance as a fodder crop, and, as the crop is well suited for feeding pigs, its cultivation for this purpose is likely to increase in the future; it is stated that the ground nuts produced on one acre, when fed to pigs, will yield 400 lb. of pork, while if the hay is harvested before pigs are turned into the field the hay practically pays for the cost of growing the crop. A further advantage of growing ground nuts as a fodder crop is that nitrogen and humus are supplied to the soil, which, in the ground-nut growing districts, is often deficient in these important constituents. Ground-nut hay is superior to grass hay, and about equal in feeding value to clover hay.

As ground nuts withstand drought well, they are suitable for growing in the south-west, where maize cannot be grown advantageously; ground nuts are also said to be valuable on alkaline soils.

The future of this industry in the United States appears to be promising, as the demand for the nuts is increasing rapidly, especially for the manufacture of oil, owing to the general shortage of fats brought about by the war and of cotton seed caused by the ravages of the boll-weevil.

Linseed.—Rabak has made extensive investigations of the influence of the variety of seed and of varying conditions of soil, climate and altitude on the yield and character of linseed oil (*Bulletin* 655, 1918, *U.S. Dept. Agric.*). Four varieties of linseed were grown in different localities in Montana, North and South Dakota, Wyoming and Oregon. It was found that varieties possessing certain properties maintain these characteristics from season to season. The yields of oil varied in the different varieties of linseed and also with the locality of growth; certain varieties gave constantly high or low yields of oil during the two years of the experiment, and certain localities grew seed with high or low oil content. The physical characters of the oils showed a good deal of variation and their characters were difficult to correlate with variety of seed or locality of growth. Oils possessing high specific gravity and a relatively high iodine value invariably dried most rapidly, while the palest coloured oils also possessed the most marked drying powers.

Oil-palm.—A recent number of the *Kew Bulletin* (1918, No. 6, p. 197) contains some interesting information about the oil-palm in the Cameroons extracted from a German article (*Ergänzungsheft* No. 13, *Mittl. aus d. Deutschen Schutzgebieten,* 1917). It appears that the oil-palm is far more plentiful in the Cameroons than was formerly thought to be the case, and it is considered probable that the oil-palm industry may be of more importance in the future than cotton, cocoa or rubber. The oil-palm occurs principally in the lowlands occupied by primeval forest, the most important districts from the point of view of production of oil and kernels being Duala, Jabassi, Edea and Rio del Rey; farther inland in the territories of Bakundu, Kabo and Bangwa the oil-palm is very abundant. Large areas of grassy highland are also rich in oil-palms and are a marked feature of the declivities where transition from grass to forest takes place.

On some large areas almost pure growths of oil-palms are found, *e.g.* on the slopes of the Bambuto range and in valleys of the Mbo Mountains. Dense growths of oil-palms exist around the villages, the trees being in a semi-cultivated state.

Although the oil-palm requires a rainfall of 40 to 60 inches a year, and is fairly sensitive to drought, it is moderately adaptable, and even on grassland at considerable elevations it continues to give good yields. The limit of altitude is usually placed at between 4,000 and 4,300 ft., but on the Bana highlands the palm reaches 4,750 ft., and bears plenty of fruit, whilst on the Cameroon range it only reaches 3,300 ft., the limit for productive trees here being only 2,300 ft.

Palms of the ordinary variety bearing thick-shelled nuts are called "Dilombe," or "Dipobe," and although a thin-shelled variety is known it is of isolated occurrence, and is entirely absent in some districts.

At present transport difficulties prevent the exploitation of areas far from the coast, but a further extension of the northern railway should lead to an increase in exports. The following river territories near the coast are the chief sources of the present exports: Lower Sanaga, Wuri, Mungo, Rio del Rey and Cross River; the Cross River produce mostly goes across the border to the British coast factories. Cultivation of the oil-palm in plantations is said to be extending near the coast.

According to van Heurn (*Communications of the General Experiment Station of the A.V.R.O.S., General Series,* No. 2, *Medan, Sumatra,* 1918), many oil-palm plantations on the east coast of Sumatra are bearing fruit, and the export of palm oil is to be expected shortly. This author has investigated the methods of estimating dirt, moisture and acidity of palm oil; it appears to be the intention of the above-mentioned Experiment Station to examine the palm oil produced and to issue certificates of analysis prior to export.

Soy Beans.—An article in the *Year-Book, U.S. Dept. Agric.,* 1917, p. 101, contains interesting information relating to the soy-bean industry in the United States of America. Although soy beans have been cultivated for many centuries in China, Japan and Korea, and used very largely as human food in these countries, it is only in recent years that the beans have assumed importance in Europe or America, though the cultivation of soy beans in England in 1790 is recorded and the beans were mentioned in the United States as early as 1804.

In 1875 Haberlandt commenced cultivation experiments in Austria which excited considerable interest, but did not lead to any economic developments. The first attempts to export soy beans and cake from Manchuria to Europe after the Russo-Japanese War were unsuccessful owing to deterioration due to poor shipping facilities. About 1908, however, the beans were successfully imported into the United Kingdom as an oil seed, and the industry rapidly reached a position of much importance, and was subsequently taken up on the Continent. In recent years soy beans have assumed considerable importance in the United States, considerable quantities of beans, oil and cake being imported, while the cultivation of soy beans has also increased. They were first grown as a forage crop, but attention has now been turned to the production of beans as a source of oil, cake and food. The limits of adaptability to climatic conditions are similar to those of maize, and the crop can be grown successfully on most types of soil. In the United States the cotton-belt and the southern portions of the corn-belt are the most favourable for soy beans, though some of the improved early varieties do well farther north. The yields of seed vary from 15 to 25 bushels in the Northern States to from 25 to 40 bushels per acre in the Southern States. Cultivation and handling of the crop are almost entirely effected by the usual farm machinery.

Over 500 varieties have been experimented with by the Department of Agriculture, and about 50 varieties are cultivated commercially. Yellow-seeded varieties are preferred for the production of food, oil and meal, and include the following: Mammoth, and Tokyo (late varieties), Hollybrook and Haberlandt (medium late), Medium Yellow and Mikado (medium), Ito San, Manchu and Elton (early). Black or brown-seeded varieties, such as Barchet and Biloxi (late), Peking and Wilson-Five (medium), Virginia (medium late), and Early Brown and Black-Eyebrow (early), are grown for forage.

As a forage crop soy beans form an excellent pasture for swine, while the hay is relished by all animals, and has been shown by the Department of Agriculture to be comparable with alfalfa (lucerne) and red-clover hays. In the Northern States soy bean and corn (maize) silage is used and has been found to keep well and to give good increases in weight and milk production. The soy bean is superior to the cow-pea as a forage crop, being much easier to handle and more nutritious, and appears to be replacing the latter. In 1910 an oil-mill on the Pacific coast commenced the production of oil and meal from imported Manchurian beans; the results were evidently successful, as the production of oil and importation of beans have increased considerably. American-grown soy beans were first worked in 1915 by some Carolina cotton-seed oil mills at a time when cotton seed was scarce; in 1916–17 no home-grown soy beans were worked owing to the high prices of beans, but in 1917 many southern cotton-seed oil mills made contracts with planters for the 1917 crop, while large quantities of Manchurian beans were also imported. The production of soy-bean oil has not necessitated any appreciable changes in oil-mill equipment. From the results obtained at a number of different oil mills it is stated that 1 ton of beans yields 28–31 gallons of oil and 1,600 lb. of meal.

Soy-bean oil was at first used in an unrefined condition, mainly for the manufacture of soft soap, but is now being used largely by manufacturers of butter and lard substitutes and in certain classes of paints. The meal after extraction of oil is used as cattle food, as a manure and in human foods. As a cattle food soy-bean meal has not yet been used to a very large extent, but should meet with a ready market when its valuable properties are properly recognised. As a human food soy-bean meal has been used until recently chiefly in the preparation of special foods containing small amounts of carbohydrates, and therefore suitable for diabetic patients ; experiments show that the meal, or rather flour, can be advantageously employed in bread, pastries, etc., one part of soy-bean flour to three parts of wheat flour having been found most suitable in the majority of cases ; but equal parts of soy-bean flour and wheat flour can be used in some pastry products. It is considered that the popularity of soy-bean flour as an ingredient of human foods is certain to increase.

The whole beans are also of value as human food, and one canning firm in 1916 utilised about 100,000 bushels of beans for the production of "baked beans." The immature green pods form a useful green vegetable, and have been canned successfully by one firm.

Several other food products are described, among which may be mentioned soy sauce, soy-bean milk, soy-bean cheese, which is an important article of the diet of orientals, and the young sprouted plants which are used by the Chinese as a vegetable.

The following figures for the imports of soy beans and their products into the United States in recent years serve to indicate the rapid increase in this industry :

Imports of Soy Beans and Products

	Beans. *lb.*	Cake. *lb.*	Oil. *lb.*
1913 . . .	Nil	7,004,803	12,340,185
1916 . . .	3,003,065	10,468,001	98,119,695
1917 . . .	5,344,334	11,760,935	162,690,235

The quantity of beans imported into the United States is still far below that taken by the United Kingdom. The maximum quantity entering this country was 421,531 tons in 1910, when soy beans were first recorded separately in the trade returns, and the minimum was 25,025 tons in 1917, when, owing to scarcity of oils and fats, preference was given to seeds richer in oil.

Miscellaneous.—Oil obtained from the kernels of *Jessenia polycarpa*, Karst., a palm occurring in Colombia and known there as the "sejen" or "unamo" palm, has been examined by Bacharach (*Analyst*, 1918, **43**, 289), who finds that the oil is similar to olive oil. In Colombia the oil is used medicinally instead of cod-liver oil, and for culinary purposes. The same author has examined the seeds of *Caryodendron Orinocense*, Karst. (N.O.

Euphorbiaceæ), known as "tacay" seeds in Colombia, where they are roasted and the kernels eaten; the latter contain 53 per cent. of oil (*loc. cit.*, p. 290).

Further investigations (*cf.* this BULLETIN, 1917, **15**, 279) by the United States Department of Agriculture on the digestibility of certain oils by human beings have been carried out and the results published in two *Bulletins* (Nos. 630 and 687). The oils investigated include corn (maize), soy bean, sunflower seed, Japanese mustard-seed, rape seed, and Charlock seed oils, as well as the following oils (*Bulletin* 630), which are consumed indirectly in various dessert nuts, viz.: almond, black and English walnut, Brazil nut, butternut, hickory nut and pecan nut oils. In all cases the oils were readily assimilable and no appreciable differences in relative digestibility were recorded; slight physiological disturbances were noted in the case of unrefined Japanese mustard-seed oil and of English-walnut oil.

Nut-bearing palms, *Orbignia speciosa*, occur in abundance in certain areas in the provinces of El Oro and Azuay in Ecuador (*U.S. Commerce Rept.* 1918, No. 152, p. 1219). Each tree is estimated to yield annually 1,000 lb. of fresh nuts; these on drying lose about one-third of their weight, the kernels representing about one-third of the weight of the dried nuts and containing 60 per cent. of oil. Machinery is said to have been installed for crushing the nuts and extracting the oil, which is exported to the United States.

RUBBER

Parthenium argentatum (Guayule).—The rubber obtained from this North American plant and generally named "Guayule" excited a good deal of attention some years ago, and since 1906 large quantities of the rubber have been produced, and sold chiefly in the United States, nearly 20,000,000 lb. having been exported from Mexico in 1910–11. During the last few years the amounts of rubber produced have fallen very considerably, owing partly to exhaustion of supplies of plant and partly to the disturbed state of the country. Recently interest in guayule rubber appears to have been renewed, largely owing to its possible importance in supplying the need for raw rubber caused by the restricted imports into the United States of plantation and other raw rubbers due to the war, and several interesting articles dealing with the growth of the plant, extraction, purification of the rubber, etc., have appeared in American technical journals (*e.g.*

King, *Chem. and Met. Engin.*, 1918, **19**, 23, 141, 203; Pearson, *U.S. Commerce Reports*, 1918, No. 149, p. 1172).

The guayule plant, *Parthenium argentatum*, Gray, is a low woody shrub of slow growth, and occurs over large areas of arid, desert land on the Central Mexican plateau and is also indigenous to a portion of South-West Texas and Northern Mexico. The amount of rubber obtainable from the plants varies considerably in different localities, but a fair average yield of about 10 per cent. from the dry plant appears to be generally accepted. The rubber, which exists chiefly in the bark, being absent in the wood, cannot be obtained by tapping, but is extracted from the ground-up plants either by (1) chemical methods involving the use of rubber solvents, or (2) mechanical methods in which the ground-up bark tissues, etc., are separated by sifting, washing and similar means from the agglomerated rubber, which may be subsequently purified by de-resination. Processes of the latter type are chiefly, if not entirely, employed at the present time, as the process of mechanical separation of the rubber is more suited for use in the regions where guayule grows than chemical processes involving the use of more complicated plant. The crude rubber containing a considerable amount of resin (about 25 per cent.), and also some woody matter, is of low value; many processes have therefore been devised for improving its quality by removing the resin; most of these may be divided roughly into (1) processes in which both the rubber and resin are dissolved, either together or consecutively by suitable solvents (and so separated from the woody matter); or (2) processes in which the resin is removed from the rubber by a suitable solvent (*e.g.* acetone), the rubber being afterwards washed on washing rolls to remove bark, etc. According to King (*loc. cit.*, p. 207) de-resination of crude rubbers "is now almost a lost art," and, of about 50 de-resinating plants formerly worked, nearly all have been dismantled or used for other purposes (*loc. cit.*, p. 26); it seems probable, however, that the treatment of guayule will be resumed owing to the war. This author gives a detailed description of a small plant used for de-resinating guayule rubber and capable of producing annually about 400 tons of purified rubber. In this plant the ground-up guayule shrubs were treated with four successive charges of hot solvent (a mixture of acetone and gasoline was used, the latter swelling the rubber and so assisting action of the acetone as a resin-solvent) in closed vessels or churns provided with agitating paddles. After drawing off the last charge of solvent the rubber was steamed to remove absorbed solvent, and was finally washed on rolls, converted into sheets, and dried *in vacuo*. The resin obtained does not meet with a ready sale, but it can be used to some extent in the compounding of low-grade rubber goods.

The guayule plant is of slow growth, in its natural surroundings, and ten or more years must elapse before an area can be re-harvested. It became necessary, therefore, to investigate the possibilities of regeneration and cultivation. In harvesting, the plants are either rooted up or cut, natural regeneration taking place under favourable conditions from the stumps, from the small roots left in uprooting the plants, or from seed.

American investigators commenced cultivation experiments in Mexico, but, owing to disturbances in that country, they transferred their activities to the United States, chiefly Arizona and California. Great difficulty was at first experienced in germinating the seed, but this difficulty was eventually surmounted, and one company is said to have planted an area of 10,000 acres near Pacheco in Arizona. Investigation has shown that there are many varieties of the plant, differing in rate of growth, yield of rubber, and in other characteristics; hybridisation seems likely to yield improved strains. Dr. Kalb claims that in California the guayule plant grown under irrigation will produce in four years a crop of 25 tons of dry plant per acre. The use of machinery for planting out seedlings, cultivating, and harvesting the crop reduces the need of manual labour to a minimum. From the amount of research expended it appears that considerable financial hopes are based on the cultivation of guayule in the United States.

Fibres

Paper-making Materials.—An account of the investigation of the Assam grasses, *Saccharum spontaneum* and *Phragmites Karka*, is recorded by the Forest Economist in the *Annual Report of the Board of Scientific Advice for India for* 1916–17. The object of the enquiry was to ascertain the yield per acre of a uniform one-year-old crop as compared with the yield of a virgin crop, and to determine whether stems of the same age would yield better results in paper-making than an admixture of stems of all ages. The yield of green grass per acre in the case of *Saccharum spontaneum* from a virgin crop was 21,221 lb., and on cutting the same area nine months later a crop of 11,736 lb. was obtained. This reduction in yield is attributed to the grazing of the new shoots by buffaloes and to the growing period being restricted to nine months, or to the area not having been burned, or possibly to a combination of all these factors. Further sample plots are being established in order to determine the annual yield.

Samples of the *Saccharum spontaneum* and *Phragmites Karka* grasses were forwarded to the Titaghur Paper Mills for trial. The results were not conclusive, as the samples were too small for treatment in a high-pressure digester. It was found, however, that *S. spontaneum* stems of uniform age furnished pulp which could be more easily bleached than that from stems of uneven ages. *P. Karka* gave poor results, the pulp being practically unbleachable. It is pointed out that the value of these grasses for paper-making cannot be accurately estimated until large-scale trials have been carried out in high-pressure digesters.

In a paper by Dr. C. F. Juritz on "The Grasses of the Eastern Coast Belt," which has been published in the *South African Journal of Industries* (1918, **1**, 431, 516), an account is given of the papyrus of Zululand (page 525), which is found on at least nine unallotted Crown Lands farms, and all along the Umfolozi, Umpata, and Inyalazi banks for miles. It grows in swamps and remains green throughout the winter. It is stated that there are thousands of acres of papyrus in the neighbourhood of Insezi, Empangeni, where it generally attains a height of 10–12 ft. In 1914 a concession was granted to Mr. L. Walmer which covers certain unallotted Crown lands in the Mtuzini, Lower Umfolozi, and Hlabisa Divisions. This concession was granted for a term of 21 years on condition that machinery, plant and buildings to the value of not less than £10,000 should be erected within two years of the close of the war. A mill is to be erected at Umfolozi for converting the papyrus into pulp or "half-stuff" for export. The railway station at Umfolozi is 190 miles from Durban, and the lagoons, where large quantities of papyrus grow, are about six miles from the station, with which they are connected by a narrow-gauge railway.

The suitability of papyrus for paper-making has been investigated at the Imperial Institute, and a report on the examination of a sample from Zululand in comparison with samples from the East Africa Protectorate and the Sudan, has been published in this BULLETIN (1916, **14**, 165).

The *World's Paper Trade Review* (1918, **70**, 303) contains a report on the same subject by Messrs. Cross

& Bevan in connection with the projected establishment by the Walmer Papyrus Pulp Co., Ltd., of a mill in Zululand for the manufacture of pulp. Trials on a manufacturing scale by paper-makers have shown that the papyrus yields from 35 to 38 per cent. of dry bleached pulp (expressed on the dry material), the variation depending on the severity of the treatment with alkali. In general, the yields are similar to those obtained in the case of Algerian esparto grass. By varying the method of treatment a wide range of effects can be produced, such as would be obtained with esparto, straw, wood, and even rags. The pulp is therefore regarded as being suitable for a great variety of purposes. The manufacturing operations are those which are ordinarily in use, and the papyrus could thus be dealt with by mills accustomed to the preparation of half-stuff. It is suggested that the yield could be increased to some extent by crushing the material as it is cut so as to expel the juices together with a certain amount of the cellular tissue which is of no value for paper-making. This mechanical treatment would not only reduce the cost of transport but would also facilitate treatment at the mill, and economise chemicals and mill space. The conclusion is drawn that papyrus has a value at least equal to that of the better qualities of esparto, and that if, by a suitable selection of the material on the spot, followed by crushing and press packing, the papyrus could be so concentrated as to yield 50 per cent. or more of bleached fibre, its value would be largely increased. It is considered that the results of the trials afford evidence of the great utility of papyrus and its adaptability to present paper-making requirements.

Cotton

Rhodesia.—In the *Report of the Rhodesia Munitions and Resources Committee*, 1918, an account is given of the results of experiments with cotton which have been made in Northern Rhodesia on areas both north and south of the Kafue River. These trials have been carried out since 1908, but on the whole the results have not proved satisfactory and have indicated that the districts selected would not yield profitable cotton crops. The lack of success is attributed chiefly to the erratic nature of the rainfall, the incidence of a prolonged drought after the first rains, the late setting in of the rains, and the prevalence of insect pests, especially aphis (green fly) and boll-worm. The cotton soils in Northern Rhodesia, apart from the alluvial belts on the Kafue Flats, require a rainfall of 30 inches during the growing season, though, if better distributed, 20-25 inches would suffice, especially if good and constant cultivation were practised. It is improbable, however, that sufficient labour would be obtainable to meet the requirements of the industry if carried out on a large scale. The most suitable soils are situated along watersheds at a considerable distance from large rivers, and irrigation schemes are therefore impracticable.

It is considered that parts of the Zambesi Valley offer much better prospects, as the necessary water could be pumped on to the land from the Zambesi River. The soil is good in most localities, whilst the temperature is tropical and probably suited to Egyptian varieties. Transport would present a difficulty, but if the proposed line from Sinoia to the Kafue is constructed, the cotton could be easily conveyed to this railway by means of boats. It is suggested that experiments in cotton growing might well be undertaken in the Zambesi valley and in other suitable areas in the low and warm districts of Rhodesia.

India.—In connection with the improvement of Indian cotton, reference is made in the *Ann. Rept. Dept. Agric., Bombay*, 1916–17, to the position in the Bombay Presidency. In Sind, the only seed distributed was that of the American variety, "Triumph," grown at the Government Seed Farm. The crop was damaged by wet weather in August, and in the neighbourhood of Mirpurkhas gave very poor results. Most of the cotton was purchased by a Bombay Syndicate, who stated that the product was of poor quality and irregular staple; it realised about the current price for ordinary Broach cotton. The deterioration in quality may have been due to the unfavourable season or possibly to the substitution of roller ginning for saw ginning. This question is to be investigated in future years. During 1917 American cotton could not be planted in Sind, as the Jamrao Canal was not working at the sowing season.

N.R., or Selected Khandesh cotton seed, was distributed in the Deccan, and this variety is growing in popularity on account of its high yield. Seed Societies have been formed to facilitate the extension of the distribution of this seed.

In the Southern Maratha country, Broach and Cambodia are still grown on a fairly large scale, and the area under the latter is increasing. These cottons show an advantage of about 20 per cent. over the local Kumpta cotton chiefly owing to their larger yield on ginning;

their quality is also somewhat superior to that of the local variety.

The value of superior strains to the cultivator is greatly affected by the question of marketing. Fraudulent mixing of long and short stapled cotton prevails extensively, and partly accounts for the insensitiveness of the market to superiority of staple. An attempt is being made to solve this difficulty by the formation of Cotton Sale Societies with the object of establishing a reputation for supplying cotton of good quality and honest dealing.

NOTICES OF RECENT LITERATURE

DOCUMENTS OF THE CANADIAN CONSTITUTION 1759–1915. Selected and Edited by W. P. M. Kennedy, M.A. Pp. xxxii + 707, Med. 8vo. (Toronto and London : Oxford University Press, 1918.) Price 21*s*. net; post free, United Kingdom 21*s*. 6*d*., abroad 21*s*. 11*d*.

The editor states in his preface that his "primary object in publishing this collection of documents has been to provide students of Canadian Constitutional developments in the Department of Modern History, University of Toronto, with a handy and convenient volume." The documents are therefore not edited in close detail, and the few notes which have been provided are meant to encourage work rather than to give full information.

The Acts of Parliament, Resolutions, Speeches, Official Despatches, etc., included in the volume are arranged in chronological order in six well-marked periods. The first period ends with the Royal Proclamation of October 7, 1763, which set up the Governments of Quebec and other North American lands ceded to Great Britain by the Treaty of Paris of the same year. The second period closes with the Quebec Act of 1774, which placed the power of government in the hands of a nominee Council and gave the French-Canadians the free exercise of their religion and equality with the English as regards civil rights and laws. The Constitutional Act of 1791, which provided for the division of Quebec into the two Provinces of Upper and Lower Canada, and conceded representative government, terminates the third period, whilst the fourth closes with the Union Act of 1840 which reunited the two Provinces under the title of Province of Canada. The formation of the Dominion of Canada by the union of the Provinces of Canada, Nova Scotia and New Brunswick, in accordance with the British North America Act of 1867, closes the fifth period. As Mr. Kennedy remarks, the workings of this Act lie largely outside the sphere of constitutional history and belong to that of constitutional law, and the section relating to the sixth period is therefore comparatively short, and includes only the Acts providing for the formation of the Provinces of Manitoba and Alberta, certain Imperial Acts of Parliament dealing with the Constitution of Canada and some documents connected with the office of Governor-General of the Dominion.

Students of constitutional history are under a debt of gratitude to Mr. Kennedy for collecting in this convenient form such a large mass of material. There is no index, but a useful feature is the inclusion in the list of contents of a précis of most of the documents.

Selected Speeches and Documents on British Colonial Policy, 1763–1917. Edited by Arthur Berriedale Keith, D.C.L., D.Litt. Two vols. Pp. xvi + 381, viii + 424, Pott 8vo. (London: Humphrey Milford, 1918.) Price 2*s.* net per vol.; post free, United Kingdom and abroad, 2*s.* 2*d.*

The purpose of these two small volumes, which form Nos. 215 and 216 of the *World's Classics, Pocket Edition,* is stated by the editor in his preface as follows: "The main objects of these volumes is to trace, by a series of speeches and documents, the growth of the system of responsible government in the British Colonies, the gradual formation of powerful federations from groups of separate and rival colonies, the development of their local autonomy, and the process by which schemes of imperial federation have been laid aside in favour of the conception of the equal partnership in the Empire of units retaining and developing their legislative and administrative independence, but firmly resolved, by frequent and frank consultation to co-operate in the carrying into effect of their common ideals of freedom, justice, and peaceful economic development." The speeches and documents reproduced have been judiciously selected for the end in view and are grouped under the following headings: Vol. I., The Origin of Representative Government in Canada, The Deadlock in Canada and the Grant of Responsible Government, Responsible Government in Australasia, The Federation of Canada, The Commonwealth of Australia; Vol. II., The Union of South Africa, The Autonomy in Internal Affairs of the Self-governing Dominions, The Relations of the Dominions to Foreign

Powers, and The Unity of the Empire. Volume II. contains a full index to the whole work. The book should be read by all interested in the development of the British Empire.

Wool. By Frank Ormerod. Pp. xii + 218, Demy 8vo. (London: Constable & Company, Ltd., 1918.) Price 6*s*. 6*d*. net; post free, United Kingdom and abroad, 6*s*. 11*d*.

This book is the first volume of a series on "Staple Trades and Industries" which is being prepared under the editorship of Gordon D. Knox with the object of supplying such information as will enable the individual citizen to realise the factors on which the prosperity of the Empire depends, and to acquire a knowledge of the sources both of the raw materials and of the manufactured products which are produced within the British Empire.

In the present volume a comprehensive survey of the wool industry is given in a somewhat popular form, and in language as free as possible from technical expressions. The earlier portions of the book afford an interesting review of the introduction of the wool trade into this country, and in later chapters descriptions are given of the various breeds of sheep, the nature of the wool fibre, the methods of shearing the sheep and of sorting, preparing and marketing the wool, and of the manufacturing processes by which it is spun, woven and finished. A special chapter is devoted to the development and present position of the pastoral industry of Australia. In connection with the wool manufacturing industries of the United Kingdom, the author, after describing the manufacture of woollens and worsteds, refers to the two extreme branches of production, viz. the manufacture of home-spuns, particularly the Harris tweeds, and the utilisation of shoddy and mungo. The various uses of woollens and worsteds are enumerated and an indication is given of the extent of the production of woollens, worsteds, hosiery, blankets and carpets in the different parts of the British Isles. Statistical information is given, including the number of sheep in various countries of the world, the imports of wool into the United Kingdom, the quantities dealt with at the London Colonial Wool Sales, and estimates of the wool grown in the different countries of the United Kingdom in 1915. The effect of the war on the British wool manufacturing industries and the future of the trade are discussed.

As already pointed out, the book is intended for the general reader, and is consequently not sufficiently detailed to be of special service to the expert and the manufacturer. It is, however, well suited for the purpose in view, and is written in an interesting style and provided with some excellent illustrations.

COTTON. By George Bigwood. Pp. viii + 204, Demy 8vo. (London: Constable & Co., Ltd., 1918.) Price 6*s*. 6*d*. net; post free, United Kingdom and abroad, 6*s*. 11*d*.

This book, which forms Volume II. of the series of "Staple Trades and Industries," referred to above, gives an account of the development of the cotton industry from the earliest times to the present day. It is written in a popular style, and briefly describes the various inventions which, by continued improvement and modification, have resulted in the production of the highly elaborated machinery employed in modern cotton mills and factories.

Comparatively little space is devoted to the subject of cotton cultivation and the varieties grown in different countries, and this part of the work is somewhat loosely written and is not altogether free from inaccuracy. For example, on page 78 it is asserted that Ashmouni cotton (which is still the predominant variety grown in Upper Egypt) has "now practically gone out of cultivation."

Other chapters of the book deal with the marketing of cotton, the methods of manufacturing yarns and fabrics, and the organisation of the industry. Appendixes to the work contain (1) a reprint of a paper on cotton "futures" read by Mr. Charles Stewart at the meeting of the British Association in 1896; (2) a statistical table, quoted from Worrall's *Cotton Spinners' and Manufacturers' Directory*, giving the number of spindles and looms in Lancashire and adjoining districts; and (3) an account of the action of the Board of Control set up in 1917 by the Board of Trade to regulate the industry in view of the special conditions created by the war.

The book is well illustrated, deals with its subject in an interesting manner, and should prove acceptable to the general reader.

FUNGI AND DISEASE IN PLANTS. An Introduction to the Diseases of Field and Plantation Crops, especially those of India and the East. By E. J. Butler, M.B., F.L.S. Pp. iv + 547, Super Roy. 8vo. (Calcutta and Simla: Thacker, Spink & Co., 1918.) Price Rs. 15; post free, United Kingdom 20*s*. 6*d*., abroad 20*s*. 10*d*.

In a country like India, where such a great variety of crops is cultivated, and where the people depend so largely on locally grown food, the importance of a study of the cause and prevention of fungoid diseases in plants is specially evident. It has been calculated that the loss caused by the smuts of jowar (*Sorghum vulgare*) alone in the Bombay Presidency amounts to over a million pounds each year. Fortunately the agricultural authorities in India have paid special attention to this subject and much valuable information has been collected by the mycologists attached to the Imperial and Provincial Departments of Agriculture. Foremost among these workers has been Dr. Butler, Imperial Mycologist to the Agricultural Research Institute, Pusa, who has embodied in the work under notice the results of his long experience, as well as those of other botanists in all parts of the world.

The book is divided into two parts. The first, which occupies about 150 pages, deals with the structure of fungi, their reproduction, classification and modes of nutrition, the life-history of parasitic fungi, the causation of disease by fungi, and the principles of the control of plant diseases. The second part treats of special diseases, arranged under the crops. In the present volume only diseases of the field and plantation crops of India are considered, and it is hoped to deal with those of fruit and forest trees in a subsequent volume. Nearly 200 diseases are dealt with, and in each case an account is given of the geographical distribution of the disease, its symptoms, life-history, mode of infection and methods of control.

The book is well illustrated and contains a useful bibliography. Although written primarily for the Indian agriculturist, it will appeal to a much wider circle of readers, and can be thoroughly recommended as a guide to this important subject.

Coal and its Scientific Uses. By William A. Bone, D.Sc., Ph.D., F.R.S. Pp. xv + 491, Demy 8vo. (London: Longmans, Green & Co., 1918.) Price 21*s.* net; post free, United Kingdom 21*s.* 6*d.*, abroad 21*s.* 9*d.*

In this work the subject of the uses of coal is dealt with in a skilful manner by an author whose enthusiasm for his subject is clearly shown by his quotation from Jevons on *The Coal Question*, 1865, viz. "Coal in truth stands not beside, but entirely above, all other commodities."

The book opens with a short review of the gradual development in the application of coal to industrial purposes, its influence in the development of national power, its origin and formation, the world's coal reserves, and the chief features of British coal-fields. This preliminary statement is followed by an exposition of the principles and developments of the combustion of coal, and of heat-transmission in boilers, and the difficulties and complications attendant on a much-needed reform of methods in domestic heating.

The smoke nuisance and its abatement are critically dealt with, and some idea of the waste and baneful effects evidenced in the misuse of coal may be gathered from the statement that the average deposit of soot over the whole of Leeds amounts to at least 220 tons per square mile per annum.

The production and use of gaseous fuels from coal are explained in considerable detail. The distinction between calorific value and calorific intensity of a fuel is clearly defined, more clearly, perhaps, than is the term "calorific value" on page 59. The practical application of calorific intensity is well shown in a chapter on water-gas.

Two chapters are devoted to reviewing briefly the salient feature of the problem of fuel economy in the metallurgy of iron. Readers would have welcomed a fuller treatment by the author of the different methods of power production from coal, particularly at this period of industrial reconstruction, but the problems involved are made to stand out clearly against a background of scientific and practical data. The policy of the large development of electric generating stations in this country is strongly advocated.

One of the most interesting parts of the book is the last chapter and appendix explanatory of "Surface Combustion," a subject in connection with which the author's name is so well known.

It is to be hoped that the publication of this book will help to reduce the amount of waste that accompanies the utilisation of coal.

PETROLEUM REFINING. By Andrew Campbell. Pp. xvi + 279, Med. 8vo. (London: Chas. Griffin & Co., Ltd., 1918.) Price 25*s*. net; post free, United Kingdom 25*s*. 6*d*., abroad 25*s*. 7*d*.

This book, written by a petroleum refinery manager who has been for many years with the Burmah Oil Co., Ltd., fills a gap in the English literature on petroleum. The first chapter deals with the examination of the crude oil, and includes a comprehensive account of the methods of determining the usual chemical and physical constants of petroleum products. Succeeding chapters discuss the arrangement of the refinery, storage of crude oil and products, distillation, the extraction and refining of paraffin wax, manufacture of candles, chemical treatment, processes used in petroleum refining and the distribution of products (including an account of the manufacture of containers). The concluding chapter contains detailed specifications for certain plant used on the refinery, such as storage tanks, stills, preheaters, condensers, etc.

The appendix (55 pp.) gives a useful subject list of references to literature likely to be of service to the petroleum refiner.

The value of the descriptive matter is considerably enhanced by numerous illustrations and plates.

Piece Goods Manual. Compiled and illustrated by A. E. Blanco, Second Assistant, A, Chinese Maritime Customs. Pp. xxviii + 181, Demy 8vo. (Shanghai: Statistical Department of the Inspectorate General of Customs; London: P. S. King & Son, Ltd., 1917.) Price 5*s.*; post free, United Kingdom and abroad 5*s.* 5*d.*

This book contains a glossary of the technical terms used in the piece goods trade. The various cotton, woollen, silk and other fabrics are described under their trade names, information is given regarding their weaves and finishes, and explanations are supplied of the many expressions liable to be encountered in the course of commercial or fiscal negotiations. The principal styles of weave are shown by a series of clearly drawn diagrams, and notes are given on the classification of samples.

The work has been carefully prepared, and, although compiled particularly for the use of members of the Chinese Maritime Customs Service, it will doubtless prove very useful to persons engaged in this and other countries in the various branches of the textile trades.

BOOKS RECEIVED

Oils, Fats and Waxes. By Percival J. Fryer, F.I.C., F.C.S., and Frank E. Weston, B.Sc., F.I.C. Vol. II., Practical and Analytical. Pp. xvi + 314, Demy 8vo. (Cambridge: University Press, 1918.) Price 16*s.* net; post free, United Kingdom and abroad, 16*s.* 6*d.*

The Natural Organic Colouring Matters. By Arthur George Perkin, F.R.S., F.R.S.E., F.I.C., and Arthur Ernest Everest, D.Sc., Ph.D., F.I.C. Pp. xxii + 655, Demy 8vo. (London: Longmans, Green & Co., 1918.) Price 28*s.* net; post free, United Kingdom 28*s.* 6*d.*, abroad 28*s.* 8*d.*

Catalysis in Industrial Chemistry. By G. G. Henderson, M.A., D.Sc., LL.D., F.R.S. Pp. x + 202, Demy 8vo. (London: Longmans, Green & Co., 1919.) Price 9*s*. net; post free, United Kingdom and abroad, 9*s*. 6*d*.

Modern Chemistry and Chemical Industry of Starch and Cellulose (with reference to India). By Tarini Charan Chaudhuri, M.A. Pp. viii + 156, Crown 8vo. (Calcutta and London: Butterworth & Co., 1918.) Price 5*s*. net; post free, United Kingdom and abroad, 5*s*. 3*d*.

Powdered Coal as a Fuel. By C. F. Herington. Pp. xi + 211, Med. 8vo. (London: Constable & Co., Ltd., 1918.) Price 12*s*. 6*d*. net; post free, United Kingdom and abroad, 13*s*.

A Manual of Geometrical Crystallography. By G. Montague Butler, E.M. Pp. viii + 155, Foolsc. 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1918.) Price 7*s*. net; post free, United Kingdom and abroad, 7*s*. 3*d*.

Farmers' Clean Milk Book. By Charles Edward North, M.D. Pp. xi + 132, Crown 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1918.) Price 5*s*. net; post free, United Kingdom and abroad, 5*s*. 3*d*.

Rural Water Supplies and their Purification. By A. C. Houston, M.B., B.Sc., F.R.S.E. Pp. xv + 136, Demy 8vo. (London: John Bale, Sons & Danielsson, Ltd., 1918.) Prices 7*s*. 6*d*. net; post free, UnitedKingdom and abroad, 7*s*. 10*d*.

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Botanical names and titles of books received are printed in italics

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