

IMPERIAL
DEPARTMENT OF AGRICULTURE
FOR THE WEST INDIES.



REPORT

ON THE

AGRICULTURAL DEPARTMENT,

DOMINICA,

1918-19.

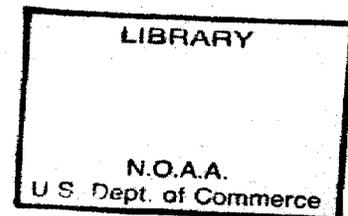
BARBADOS:

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LETTER OF TRANSMITTAL.

*Commissioner of Agriculture for the West Indies—to His Honour the
Administrator, Dominica.*

No. D. 2,095.

Barbados,

August 30, 1919.

Sir,

I have the honour to forward the Report on the Agricultural Department, Dominica, for the year ending March 31, 1919.

2. Owing to the absence of an Assistant Curator and Chemist, the work of the Department has been carried on under considerable difficulties, and certain sections have suffered.

3. The demand for lime plants, etc., continues to decline. This probably means that estates themselves are gradually producing what is required.

4. Information of special interest appears in the Report on Bay oil, Camphor and Shea butter nuts. It seems possible that in the near future camphor may become one of the minor products exported from Dominica.

5. The lime crop for the year under review was much below the average; but the event that affected the industry most was the United States embargo on green limes. The exports for 1918 were only 7,670 barrels compared with 41,243 barrels in 1917.

6. There was considerable reduction in the exports of coco-nuts.

7. As regards plant pests and diseases, the chief event was the outbreak of 'wither-tip' of limes in Trinidad, which necessitated legislative action being taken to preclude its introduction into Dominica.

8. A considerable portion of the Report is devoted to a discussion on the plot experiments with cacao and limes, and will be found instructive. It was not found possible to publish the results of the cacao manurial experiments in this Report. Those carried out with limes are recorded, however, and strongly indicate the value of general manuring.

9. The experiments with budded limes clearly show the early-bearing tendency of such plants.

10. The usual meteorological information is recorded at the end of the Report.

11. As regards matters of administration, it is to be observed that the receipts from the sale of plants, fruit, etc., by the Department, were £747 11s 7d., or £145 4s. 7d. greater than last year, and greater still than the returns of previous years.

12. Whilst the commercial side of experiments and other work yielding useful results is, or should be a secondary consideration, it is worth bearing in mind that in Dominica the plot experiments, etc., are accompanied by some financial return, as well as by great educational and instructional benefit to the planting community.

13. In conclusion I have to express my appreciation of the work of the Dominica Agricultural Department, as recorded in this Report. I consider it continues to serve the best interests of the Presidency in spite of being handicapped by depletion of staff during the year under review.

I have, etc.,

(Sgd.) FRANCIS WATTS,

Commissioner of Agriculture
for the West Indies.

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REPORT ON THE AGRICULTURAL DEPARTMENT, DOMINICA,

For the Year ended March 31, 1919.

Work in the Gardens, and Observations on Plants.

Owing to the prolonged absence on leave of Mr. G. A. Jones, Assistant Curator and Chemist, who left Dominica in May 1917 to undertake war work in England, the routine of the Department continued to be carried on under difficulties. In December 1918, after an absence of nineteen months, and on the conclusion of his work in England, the Assistant Curator and Chemist decided to sever his connexion with the Colonial Service, in order to take up an appointment in Trinidad, and Mr. G. A. Gomez, Manager of the island of Barbuda, was appointed Acting Assistant Curator. At the close of the year, enquiries were being made in England with a view of obtaining the services of a suitably trained man for the post of Assistant Curator and Chemist.

Under such conditions, it has not been possible to do much more than carry on the usual routine, and but little has been effected in the way of special investigations or the undertaking of new lines of work.

Very few herbarium specimens were forwarded to Kew Gardens during the year. Amongst those sent were leaves and flowers of a climbing weed which has recently made its appearance in lime fields and which rapidly covers the trees. It is a strong grower and now completely occupies waste places along the Roseau River which were formerly bare of vegetation. This new weed pest was identified as *Mikania scantens*, Willd. It spreads rapidly and is exceedingly troublesome in limefields.

Herbarium specimens of a local weed known as 'Fromboisin' which is said to yield a valuable oil and is much used by peasants for making tea for colds, etc., was sent to Kew and identified as *Ocimum micranthum*, Willd.

Work in the Nurseries and Distribution of Plants.

The demand for plants for orchard cultivation continues to decline. It is hoped that the lowest point has been reached, and from now onwards, a more healthy condition of affairs will become in evidence.

PLANT IMPORTATIONS.

The number of plants sent out during the year was as follows:—

Limes	...	...	...	...	...	...	...	30,645
Budded Washington Navel oranges	...	...	...	...	...	...	...	121
„ grape fruit	...	...	...	...	...	...	...	25
„ limes	...	...	...	...	...	...	...	170
„ Portugal oranges	...	...	...	...	...	...	...	4
„ tangerines	...	...	...	...	...	...	...	2
„ sweet limes	...	...	...	...	...	...	...	23
Grafted mangoes	...	...	...	...	...	...	...	52
Cacao	...	...	...	...	...	...	...	50
Coffee	...	...	...	...	...	...	...	650
Vanilla	...	...	...	...	...	...	...	200
Eucalyptus	...	...	...	...	...	...	...	89
Nutmegs	...	...	...	...	...	...	...	45
Male bamboo	...	...	...	...	...	...	...	159
Miscellaneous	...	...	...	...	...	...	...	374
Total	...	...	...	...	...	...	...	32,609

The following supplies of miscellaneous seeds, seedlings and cuttings were also distributed:—

Vegetable seeds	...	...	...	...	...	2,516 packets
Onion seeds	...	...	...	...	...	60 lb.
Onion seedlings	...	...	...	...	...	5,000
Horse beans	...	...	...	...	...	245 lb.
Tephrosia candida	...	...	...	...	...	20 lb.
Peanuts	...	...	...	...	...	20 lb.
Congo coffee seed	...	...	...	...	...	6 lb.
Cane cuttings	...	...	...	...	...	4,000
Dracaena cuttings	...	...	...	...	...	150
Shade tree cuttings	...	...	...	...	...	13,750

PLANT IMPORTATIONS.

The Mexican apple (*Casimiroa edulis*), introduced seven years ago, fruited early in 1919. This species does not do well in the Gardens, but it grows with considerable vigour in the stiff soil at Morne Bruce. The two specimens were blown over in 1916, though not uprooted. Vigorous sucker growth followed, and fruit was produced as stated. Owing to the exceptional drought experienced at this time, only a few fruits matured. These were found to possess an agreeable taste. The seeds are said to be poisonous.

A couple of plants of the Rambutan (*Nephelium lappaceum*) were raised from seed received from the Botanic Gardens, Buitenzorg, Java, one of which is growing vigorously. Seeds of *Nephelium mutabile*, received from the same place, failed to germinate.

The Gardens now possess four healthy young trees of *Poutaria suavis*, native to Uruguay, which is said to yield an agreeable fruit. Several plants have been distributed to planters for trial.

The two specimens of the Jaboticaba (*Myrciaria cauliflora*), a fruit tree of Brazil, are not so promising as when in their early stages. It would appear that the climate of this island is not altogether suitable for them.

All attempts to establish the Brazil nut (*Bertholetia excelsa*), which have extended over a number of years and under varying conditions, have resulted in failure. A few plants of *Lecythis Zabucajo*, the Sapucaia nut, grown by the Department, make poor growth and are apparently not well suited to our climatic conditions. On the other hand, the Suwarri nut (*Caryocar nuciferum*) grows extremely well, and fruits at an early age. This

fine tree should be largely grown in Dominica both on account of its appearance and for the well flavoured nut which it bears.

In the progress report for 1915—16, mention is made of the receipt from British Honduras, of seeds of a species of *Achras* said to yield the Chicle gum of commerce. A few plants placed out in the Gardens have made fair progress, but some years must elapse before they reach an age to be tapped. Now that communications with various Colonies are becoming normal again, it is hoped to obtain from British Honduras further supplies of seeds from trees which are known to yield the best quality gum.

Plot Experiments at the Botanic and Experiment Stations.

Trials with green dressings were very few during the year, the only one requiring notice being *Centrosema Plantieri*. This makes a fair ground cover, but there are so many of its class that are distinctly better, that it is hardly likely to become popular for this purpose in lime cultivations.

At the close of the year seeds of Sarawak bean (*Dalichos Hosei*) were received from the Agricultural Department, St. Lucia. This is said to afford a dense ground cover, which, when established, practically suppresses all weeds, with the further additional merit of being able to maintain that state of things over long periods.

Amongst other recent introductions are the Tagasaste (*Cytisus Palmensis*), Gacia (*Cytisus stenopetalus*), and Gacia blanca (*Cytisus pallidus*), all of which are used as forage and garden plants in the Canary Islands. Plants of each species have been secured from seed, and it will be interesting to observe if they can stand the wet conditions of Dominica.

Another interesting plant under trial is *Momortica cochinchinensis*. It is related to the local Coolie apple (*Momortica charantia*). The seeds of the former contain an oil similar to tung oil, which is furnished by species of *Aleurites*. The oil is remarkable for its drying properties, and may become commercially important in the future.

Small plots of good seedling canes are also kept for the purpose of supplying small growers with good types of cane. The varieties at present grown are D.109, B.6450, Ba.6032, B.H. 10 (12), B 376, B.6308, B.3859, A.2, and the Uba cane.

The plots referred to above are those of an annual character. In the Botanic Gardens there are plots of orchard cultivations such as nutmegs, cola nuts several species of Citrus, grafted and seedling cacao, coffee and vanilla, which form part of the permanent cultivation of the Department.

Notes on Economic Plants.

SHEA BUTTER TREE.

Mention is made in the Annual Report for 1913—14 of the fruiting of the Shea Butter tree which had been received from Kew fourteen years previously. The low rate of germination of these seeds, and the very slow growth of the seedlings were commented upon.

In the report for 1916—17 reference was made to the receipt of twenty-five seeds of this tree from the Agricultural Department, Northern Nigeria, the native country of this species. The seeds proved to be considerably larger than those borne by the

ECONOMIC PLANTS.

solitary specimen in the Botanic Gardens, and it was thought desirable to forward a sample of the seeds grown in Dominica to the Imperial Institute for comparison with the African product, and for examination and report. The information requested was kindly furnished by the Director, and is reproduced below.

It is necessary to point out that the Shea Butter tree in Dominica is growing under very different conditions from those of its habitat, which has a very dry climate. The rainfall of the Botanic Gardens, Dominica, is twice as heavy as those parts of Northern Nigeria in which the Shea Butter tree thrives.

The seven seedlings which are growing in the Experiment Station are healthy and promising, but in size they are very small for their age.

REPORT ON THE SHEA NUTS FROM DOMINICA.

The sample of Shea nuts which is the subject of this report was forwarded to the Imperial Institute by the Director, Royal Botanic Gardens, Kew, and is referred to in his letter dated September 25, 1918. It was stated that the nuts were the produce of a tree growing in the Botanic Gardens in Dominica, and it was desired to ascertain their quality and value.

DESCRIPTION OF SAMPLE.

The sample, which weighed 12 oz., consisted of nuts similar in appearance to Shea nuts from West Africa, and measuring from 1.2 to 1.4 inch in length, and from 0.7 to 0.9 inch in diameter. The nuts consisted of 76 per cent. kernel and 24 per cent. shell. The average weight of the nuts was 6.4 grams and that of the kernels 4.9 grams.

These nuts and kernels are not smaller or lighter in weight than some samples of Shea nuts and kernels from West Africa examined at the Imperial Institute, although larger nuts and kernels are frequently met with in commerce.

RESULTS OF EXAMINATION.

The kernels of the nuts were found to contain 5.2 per cent. of moisture and 41.8 per cent. of fat, equivalent to a yield of 44.1 per cent. of fat from the dry kernels. The fat was cream-coloured and solid, and had the usual appearance of Shea butter.

The percentage of fat in the kernels of these nuts from Dominica is somewhat low. Samples of Shea kernels from West Africa previously examined at the Imperial Institute have contained from 41.4 to 54.5 per cent., and the average yield of fat from commercial consignments from West Africa is 50 per cent.

COMMERCIAL VALUATION.

Under pre-war conditions Shea kernels usually realized from £11 to £13 per ton in the United Kingdom. A nominal price of £17 per ton was quoted for them in December 1917, but at present there is no market for Shea kernels in the United Kingdom owing to the plentiful supplies of palm kernels. It is consequently not possible to quote a current price.

REMARKS.

These Shea nuts from Dominica are similar to those obtained from West Africa, but the kernels contain a lower percentage of fat than commercial consignments from the latter source.

BAY OIL.

In the annual report for 1916-17 reference was made to the Bay oil tree (*Pimento acris*, Wight et Arn.), and its varieties, Bois d'Inde citronelle, and Bois d'Inde anise.

This led to a request from the Kew authorities for samples of oil of the two varieties. During 1918 it was possible, owing to the good offices of Mr. Augustus St. Hilaire of Bagatelle estate, to obtain oil of the Bois d'Inde citronelle, which in due course was despatched to the Director of Kew Gardens, along with a sample of the true Bay oil, Bois d'Inde. These were submitted, in turn, to the firm of Messrs. Wright, Layman & Umney, Ltd., for examination, who kindly furnished the following report:—

No. 3435.

No. 1. Marked 'Bois d'Inde, Dominica.'

Specific gravity	...	...	...	...	0.931
Refraction index (25°)	...	...	...	...	1.5020
Phenols	...	...	...	...	46 per cent.
Aldehydes absorbed by neutral sodium sulphite solution	...	...	...	...	8 per cent.

Solubility 1 in 1 volume of 90 per cent. alcohol, becoming opalescent with 10 volumes.

This is an oil of the type usually imported from the West Indies, although the specific gravity is a little below the average.

No. 2. Marked 'Bois d'Inde citronelle, Dominica.'

Specific gravity	...	...	...	...	0.932
Refractive index (25°)	...	...	...	...	1.4975
Phenols	...	...	...	...	28 per cent.
Aldehydes (citral) absorbed by neutral sodium sulphite solution	...	...	...	...	38 per cent.

Solubility in 90 per cent. alcohol 1 in 1 volume, becoming opalescent with 10 volumes.

This oil differs from the ordinary type of Bay oil in having a strong odour of citral, which is the chief constituent of Lemon grass oil. As a mixture of Bay oil and Lemon grass oil is frequently used in toilet preparations, it would probably have a commercial value of its own.

CAMPHOR.

Camphor plants were amongst the earliest introductions to the Botanic Gardens. A few years later, when trial distillations of the wood, twigs, and leaves were made, it was found that the variety introduced yielded oil only.

During 1911, a number of seedlings were obtained from the St. Joseph's nurseries, Trinidad, and at the same time a supply of seed was received from the Commissioner of Agriculture. These were successfully germinated. A plot of sixteen plants of the former was established at Morne Bruce, and one of eighteen plants of the latter kind at the Experiment Station. Recent distillations of leaves and twigs of both kinds have shown that these are true camphor trees. As soon as this was proved, another plot consisting of thirty trees was started at the Experiment Station, which brings the number of camphor trees under cultivation to sixty-four. There are also five specimens, of the kind which yields oil only, growing in the Botanic Gardens. All the trees thrive well under coast conditions, that is, in places in which the rainfall is about 100 inches per year. It is not yet known how the plants will grow under very wet conditions of climate.

A number of these trees have also been distributed to local planters and to Botanic Gardens abroad.

CAMPHOR DISTILLATIONS.

The following report by Mr. A. E. Collens, Acting Government Chemist and Superintendent of Agriculture, gives the results of the trial distillations of camphor tree prunings from Dominica:—

Three samples of camphor prunings were received, two of which conformed in appearance to the ordinary type of camphor leaves, the third being quite distinct in the appearance of the leaf, and also in odour, the leaf in the latter case being partly ovate in shape, and the smell terebinthine, suggestive of mango leaf. Previous experience in camphor distillation suggested that this type of leaf would yield oil only; this was confirmed by distillation.

A special condenser was designed for the distillation; this admitted of being readily taken apart at any stage of the distillation and the contents examined. Condensation was so complete that there was no loss of vapour even when the still was partly open. At the close of the distillation the still was disconnected, and the camphor readily removed with a rubber scraper. The apparatus proved both efficient and compact.

The following results were obtained on distillation:—

No. 1 sample from Experiment Plot, Morne Bruce (conforms to ordinary type of camphor in foliage).

Stage when examined.	Moisture, per cent.	On sample.		On sample dried at 100° C.	
		Camphor, per cent.	Oil, per cent.	Camphor, per cent.	Oil, per cent.
Prunings fresh (leaves and twigs)	50.4	0.8	0.11	1.6	0.2
" " " air-dried	3.5	1.25	0.12	1.28	0.123
Leaves only, air-dried ...	...	1.65	0.33	..	...
Twigs only, air-dried ...	...	0.55	...	...	...

No. 2 sample from Experiment Station plot (same as above).

Prunings fresh (leaves and twigs)	52.4	1.10	0.025	2.32	0.05
Prunings 2 days drying ...	38.0	1.14	0.09	1.84	0.14
Leaves only, air-dried ...	11.5	1.5	0.06	1.7	0.07
Twigs only, air-dried ...	6.0	0.65	...	0.7	...

No. 3 sample from Botanic Gardens.

Prunings fresh (leaves and twigs)	50.5	...	0.93	...	1.85
Prunings fresh	47.0	...	1.08	...	2.04
Prunings fresh	47.0	...	1.02	...	1.96
Leaves only	42.0	...	1.43	...	2.48
Twigs only... ..	43.0	...	0.32	...	0.56

THE LIME INDUSTRY.

The oil from the third sample was clear and limpid, and even on cooling to 15°C. and seeding (with a crystal of camphor) gave no deposit of camphor nor any appearance of turbidity. Its physical examination gave the following results:—

Refractive index	28° C.	1.4787
	28° C.	
Density	16.6° C.	0.9010
Rotation in angular degrees		- 17.5

The results of the physical examination of the oil recovered from the distillation of this third sample are in close agreement with a similar oil reported by Watts and Tempny (see *West Indian Bulletin*, Vol. IX, p. 275) as prepared from prunings from a camphor tree in the Botanic Gardens, Dominica. These authorities report yields of 0.52 per cent. and 1.93 per cent. of oil alone from leaves and twigs, the first yield being described as faulty. These oils gave the following constants:—

		27° C.	
	Specific gravity	16.6° C.	Optical rotation.
First distillation...	...	0.9024	- 18.4°
Second distillation	...	0.8986	- 19.0°

Progress in the Chief Industries.

LIME INDUSTRY.

GENERAL CONDITIONS.

The crop for 1918, calculated in barrels of a capacity of 4.55 cubic feet, amounted to 318,074 barrels of fruit. This is the smallest crop recorded for a period of nine years, and when compared with the output during 1917, shows a falling off of no less than 78,000 barrels of fruit. The bad position as shown by these figures is, however, alleviated to some extent if the question of carry over of crop is looked into. It is somewhat unfortunate that the position of the lime industry has to be considered according to the calendar year, when the actual position would be much more clearly shown by following the official year, which in this colony ends on March 31. There are always considerable shipments of lime products during the first quarter of the year, these being the last of the crop of the previous season. During the five-year period 1914-18, the amount of concentrated juice, raw juice, and citrate of lime shipped during January, February, and March of each year was equivalent to 43,616 barrels of limes.* During the first quarter of 1919, the shipments were equivalent to 72,276 barrels of fruit, showing an excess over the average for the previous five years of 28,660 barrels. If this is allowed for, it will be seen that the shortage of crop during 1918 was approximately 50,000 barrels of limes. The increased shipments during the first quarter of 1919 were due to the effects of the embargo of 1918, and lack of shipping facilities during the crop season of that year. This serious fall in production and consequent loss of wealth is due in part to the after effects of the disastrous hurricanes of 1915 and 1916, and to several other causes mentioned in previous reports, which have been brought into operation by the world war.

* Note.—Fifty gallons of concentrated juice represent 75 barrels of fruits: 7½ gallons of raw juice represent 1 barrel of lime fruits: 1 ton of citrate of lime is equivalent to 266 barrels of lime fruits.

THE LIME CROP.

The lime crop for the past five years, calculated in barrels of fruit, is recorded below :—

1914	...	388,000
1915	...	390,000
1916	...	384,000
1917	...	396,000
1918	...	318,000

The following table, calculated on the usual basis, shows the disposal of the crop under the various heads :—

Product	Barrels of fruit.	Approximate percentage of total crop.
Concentrated juice ...	222,958	70
Raw juice ...	76,798	24
Fresh limes ...	7,670	2
Citrate of lime ...	10,640	3

Comparison with the figures of last year's disposal of crop shows that the proportion shipped as concentrated juice rose from 56 to 70 per cent., this increase being largely due to the embargo on fresh limes, while raw juice experienced a slight fall of from 26 to 24 per cent. The effect of the embargo is clearly seen in the fresh lime trade, which declined from 10 to 2 per cent. Citrate of lime also fell from 6 to 3 per cent. No lime juice cordial was shipped during the year, and the business in pickled limes was confined to a single shipment of 8 barrels of that product.

On the whole, the weather conditions were generally favourable. On the Leeward Coast the rainfall was moderate and well distributed. On the Windward Coast, and in the inland districts, the rainfall was below the average, a condition which is held to be a good augury for crop prospects during the following season.

Though weather conditions were favourable, the year was a bad one for the lime industry. A short crop, an embargo on citrus products, and other difficulties caused by the war, created an unpleasant situation for the lime planter. While other West Indian islands in which sugar and cotton are the main products have benefited by high prices during recent years, Dominica has suffered in many ways. The coming of peace will, it is hoped, mean the dawn of a new era of prosperity for an island in which the economic situation has been strained and uncertain during recent times.

The outstanding event of 1918 was the action of the United States Government in placing an embargo on citrus products. This took effect in April, and although strong representations were made by the Government of Dominica, no relief was afforded until September, when the embargo was raised.

This stoppage of trade did not seriously affect the position as regards the moving of concentrated juice, as very little of this product is offering for shipment before September; but it limited the shipments of raw juice and put an end to the export of fresh limes at the beginning of the period during which the shipments are at the maximum. The loss of the green lime trade was a serious blow both to planters and small growers.

THE LIME CROP.

LIME JUICES.

CONCENTRATED JUICE.

The shipments during the past five years were as follows :—

1914	...	148,179	gallons
1915	...	153,292	„
1916	...	152,603	„
1917	...	149,775	„
1918	...	148,939	„

The bulk of the crop of the island is shipped as concentrated juice, in which condition it can be kept for a considerable time. Any reduction in the shipments of raw juice and citrate of lime, and any falling off in the trade in fresh limes would result, during a normal year, in an increase of the output of concentrated juice, and that this has not happened in a period in the course of which there has been a decrease in the shipments of the other three products mentioned, is, by itself, a clear indication of the very considerable shortage in the lime crop of 1918.

Efforts in the direction of substituting steam evaporators in the place of the open fire process of concentrating lime juice have been checked by the conditions existing during recent years. Now that improvement in this respect may be expected, it is to be hoped that the means for effecting this wished for improvement will be found, and that the will to carry out the work will be forthcoming in order to bring into more general use an improved system which will reduce by about 10 per cent. the considerable destruction of citric acid which now goes on under the old process.

A reference to the table of exports of concentrated juice for the past five years shows an average yearly shipment of 150,000 gallons. Allowing that one-third of that quantity is now prepared by steam concentration, there remains at least another third to which the improved method could be applied. Assuming an average test of this quantity of 112 oz. per gallon, the saving of 10 per cent. in the process of concentrating 50,000 gallons would amount to no less than 35,000lb. of citric acid.

There are a number of small estates on which it would not be possible to establish a steam plant for concentrating, but this class of producer could, as has already been shown, greatly reduce his present losses by exercising more care in the preparation of the raw juice for concentration.

The preventable losses in the process of concentration, though in course of being reduced, are still considerable, and when to these are added the losses caused by inefficient milling, the extraction by some mills being as low as 7 gallons per barrel of fruit when it should be at least 8 gallons, and, in particularly good work, $8\frac{1}{2}$ to 9 gallons, it will be seen that much still remains to be done before the industry is on a really sound basis, and capable of meeting on equal terms the active business-like and intelligent competition with which it is now threatened by lime growers in other West Indian islands and foreign countries.

RAW JUICE.

The business in this product has been on a very large scale during the four years, as the following table shows :—

1914	...	379,875	gallons
1915	...	777,064	„
1916	...	574,109	„
1917	...	778,133	„
1918	...	575,985	„

THE LIME CROP.

The increase in the exports since 1914, which are nearly double those of normal years has been due to special circumstances which end with the war. In the near future, shipments to the United Kingdom are likely to be on a much lower scale. It is said that the retail trade in this product has fallen off in England during the war; but a hot summer, and the higher standard of living now in existence may help to regain and improve the position in this respect.

It is generally thought that Canada and the United States offer the best possibilities for an increase of this business. The tendency towards prohibition in the former country, and a 'bone dry' United States would appear to lead to an increasing demand for lime juice as a popular beverage. At present the fresh fruit and the juice are largely used in both alcoholic and non-alcoholic drinks. Time alone will show whether a falling off in the use of the lime in alcoholic drinks, likely to be brought about by prohibition, will be followed by an increase in the use of lime juice in non-alcoholic beverages. On the whole, it would appear that the countries named offer the best opportunities for future development of the trade in lime juice.

CITRATE OF LIME.

The decline in production continues, and the output has now fallen to a low figure. Information as to shipments during recent years is given below:—

1914	...	5,191	cwt.
1915	...	1,102	..
1916	...	2,956	..
1917	...	1,960	..
1918	...	800	..

GREEN OR FRESH LIMES.

The effect of the United States embargo on fresh limes is clearly brought out in the following table, which shows the annual export of this fruit since 1914:—

1914	...	45,283	barrels.
1915	...	41,494	..
1916	...	38,916	..
1917	...	41,243	..
1918	...	7,670	..

Owing to the embargo, shipments of fruit were limited to the early and late months in the year, a period in which there is competition with other countries, and consequently a lower range of prices. In the spring and summer months at which time the business is profitable and the market controlled by the West Indian lines, no exports were possible.

Two years ago complaints were so numerous locally and also in New York regarding the shipments of immature fruit and the great wastage in a large proportion of the consignments that certain shippers asked for Government action in the form of legislation for the inspection of fruit. This was at once promised by His Honour the Administrator, but unanimity amongst shippers could not be reached, and the matter was dropped.

A year ago it was pointed out in the annual progress report that in some American islands in the West Indies, voluntary co-operative associations were in existence for the pur-

THE LIME CROP.

pose of maintaining a high standard in every detail connected with growing, handling, and shipping of citrus fruits, and it was suggested that this form of organization might be copied with advantage by persons interested in the green lime trade. To the present nothing has been done in this direction, and matters remain much as they were. Such improvements as are effected come slowly. Meanwhile much inferior fruit is still forwarded, and reports from New York continue to indicate very serious wastage in the majority of the brands shipped.

The trade in green limes is one of great importance to the community. When conducted on sound lines it is profitable, and it has the merit of affording a good deal of employment, especially to women and children, at a time that would otherwise be a slack period of the year. It is the more unfortunate that nothing in the way of co-operative effort with a view of placing this business on a sound and unassailable basis appears to be possible.

Collective action being practically unattainable, it is hoped that individual shippers will endeavour to bring about some improvements in their own interests. To effect this, the large amount of limes which are brought in a loose state to Roseau need to receive much better conditions for quailing and packing than are afforded at present. Better packing houses are required, and these should be kept in a thoroughly hygienic state. In some packing houses the rejected limes of one shipment are allowed to lie in heaps until the next lot of limes arrive for quailing and packing, or longer, with the result that millions of the germs which start decay are present, and it is probable that most carefully picked limes, quailed and packed under such conditions, would from this cause alone show a considerable percentage of wastage on arrival in New York.

Such slight improvements as the immediate removal of all rejected fruits, better ventilation, scrupulous cleanliness, the provision of shelves for quailing, and the spraying of the walls, ceilings, and floors with a weak solution of sulphate of copper after each shipment would bring down very considerably the high rate of wastage which now occurs in a large proportion of the shipments.

It is of course recognized that the first and chief cause of loss in green limes is due to the exceedingly rough handling which a large proportion of the fruit receives during picking, and in transport to the packing houses. This could be largely overcome by effective supervision in the field, and by improvements in the methods of transport. What is required is all-round efficiency. In many instances, improvements in the packing houses are just as necessary as the crying need for greater care in the picking and transportation of the fruit.

LIME OILS.

The export of these oils during a five-year period is as follows:—

Oils of limes,			Essential oil of limes,		
		lb.			lb.
1914	...	14,166	1914	..	34,860
1915	...	8,557	1915	...	35,945
1916	...	5,950	1916	...	48,160
1917	...	10,001	1917	...	45,141
1918	...	13,676	1918	...	25,096

The quantities exported are for the first time expressed in number of pounds weight instead of, as formerly, in number of gallons. This is due to the export duty being now payable by the pound instead of by the gallon. The ratio is $8\frac{3}{4}$ lb. to the gallon of oil.

THE LIME CROP.

The exports of lime products during 1918 are as follows:—

Product.	Quantity.	Value. £.
Concentrated lime juice	148,639 gallons	59,596
Raw lime juice	575,985 „	74,747
Green limes	7,670 barrels	11,904
Pickled limes... ..	8 „	8
Citrate of lime	800 cwt.	2,744
Essential oil of limes... ..	25,096 lb.	5,856
Otto of limes... ..	13,676 „	8,671
		£ 163,526

Compared with the previous year, there was a total decrease in values amounting to £41,373.

CACAO.

The position as regards cacao showed some improvement as indicated in the table below:—

1914 ...	8,874
1915 ...	10,810
1916 ...	5,707
1917 ...	3,169
1918 ...	4,239

The yearly crop of cacao cannot be stated with any approach to accuracy, as it is well known that a considerable amount leaves the island surreptitiously. All that can be said on this matter is that production is considerably in excess of the amount shown by official figures.

There appears to be no increase of interest in this cultivation. Apparently the planting of new areas is not contemplated at present by either planter or peasant. Without development work, the output must inevitably decline in the course of years.

COCO-NUTS.

The falling off in the exports of this product during recent years makes gloomy reading. The position in 1918 may be due, in part, to the Proclamation issued in March last, prohibiting the export of coco-nuts, except under certain conditions. This was done in the interests of the food supply. It is generally held, however, that the reduced exports are mainly due to

MINOR PRODUCTS.

the effects of the hurricanes of 1915 and 1916. If this is correct—and it appears to be so—it is a striking example of the aftermath of these disturbances on tropical cultivation. At the close of the year there were signs of an increase of activity in this business, but it is doubtful if the position occupied in 1914 will be quickly regained. This falling off in production in practically all the leading exports during 1918 reveals a depressing situation, and one which requires careful consideration on the part of those concerned with the interests and well-being of the island.

The shipments for the period 1914-18 are given below :—

1914	...	554,549
1915	...	506,360
1916	...	408,007
1917	...	133,234
1918	...	89,676

MINOR PRODUCTS.

The quantities and values of minor products exported during 1918 are given below :—

Produce.	Quantities.	Values. £.
Oranges	1,226 barrels	809
Orange oil	153 lb.	49
Bay leaves	31 cwt.	33
Bay oil	1,627 lb.	770
Coffee	15 cwt.	81
Honey	675 gallons	405
Vanilla	796 lb.	159
Hardwood	213,550 feet	1,712
Hoops	1,517 bundles	500

Work Connected with Insect and Fungus Pests and their Control.

The insect, fungus, and parasitic enemies of the lime are fairly numerous, but up to the present time, with a single exception, no very great harm has resulted from their attacks in Dominica. The most serious set-back which the industry received was caused by the outbreak

of scale insects in 1902-3, and there is a strong belief locally that this was largely due to the heavy falls of dust which occurred at the time of great volcanic activity in the neighbouring islands of Martinique and St. Vincent. It is thought that the dust caused wholesale destruction of the parasites of scale insects, thus allowing the latter to increase to such an extent as seriously to injure the trees. And, in this connexion, the effect of a considerable layer of impalpable dust on the soil, seeing that it would not be speedily broken up and worked in, would tend in orchard cultivation, seriously to interfere with soil conditions, and thus weaken the trees, and render them more liable to the attacks of their enemies. As nothing like that outbreak of scale insects occurred before or since, it is rather difficult to dissociate the effect of the rather heavy falls of volcanic ash during the memorable year of 1902 from that outbreak.

The enemies of the lime tree in Dominica are well known, and these have been carefully studied by the officers of the Agricultural Department. It may be well to remind planters that there are also other enemies of lime cultivation without the gates. Although every precaution is being taken to prevent their entry, it is not improbable that sooner or later one or more of these pests, which in some countries have caused great damage to citrus cultivation, may be introduced by some means, and thus add to the already long list of difficulties which the planter has to fight against.

The more prominent diseases which are affecting citrus plants in other countries at this time, and which are not present in Dominica, are :—

- The Citrus Canker in the United States;
- The White Fly (*Aleurocanthus woglumi*);
- The Wither Tip of limes (*Gloeosporium limetticolum*).

The first named was introduced into America from Japan, and has caused, and still is causing great damage. The white fly pest originated in India, from which it has spread to many countries. It is present, and does a considerable amount of injury to orange trees in the Bahama Islands. The wither tip disease of limes became noticeable in Trinidad last year, where it is said to be now causing considerable damage on lime estates. This outbreak has been investigated by Mr. J. B. Rorer, Mycologist to the Board of Agriculture, Trinidad, and his report is reproduced below for the information of planters in this island. In the event of this disease reaching Dominica, it would be well for lime growers to remember that, in the matter of remedial measures, anything like effective spraying of lime plantations in this island is practically impossible.

THE WITHER TIP OF LIMES IN TRINIDAD.

During July and August 1918 there was a severe outbreak of a disease of lime trees throughout the colony, practically all districts being equally affected. Specimens were received from a large number of different estates, and all showed "wither-tip" in its characteristic form. This is one of the commonest and most destructive diseases of limes, though heretofore it has not been very prevalent in Trinidad. It is due to the fungus known as *Gloeosporium limetticolum*, Clausen. The fungus is able to attack the young growth of the lime trees of all ages; in fact, at the St. Clair Experiment Station it has caused the death of a great many nursery plants of from 6 inches to a foot high, during the past two years.*

The attacks of the fungus generally appear on the tips and edges of the very young leaves, but it occurs also on the leaf-stalk, at the point where the leaf joins the stem, or at any point in the very young shoots. The first sign of infection is indicated by a somewhat water-soaked appearance, until the young leaves and tip of the shoot are entirely destroyed. If the weather is not so damp, the water-soaked appearance is not so pronounced, but the attacked part is light green in colour at first, and then becomes brown. In all cases the affected shoots wither up, thus giving the popular name to the disease. When the larger young leaves are affected they often become curled and distorted, and the infected areas drop out or become cracked, so that the leaf is punctured with holes. Only young growing leaves

* This disease must not be confused with the 'Damping-off' disease which is very severe on seedlings when they are from one to 3 inches high, and which has already been described in the 'Proceedings of the Agricultural Society,' Vol. XV, 1915, pp. 14, 15. 'Wither tip' generally attacks the plants when they are a little older.

and the young shoots apparently can be attacked by the fungus; leaves and shoots that have hardened and matured are quite immune to the disease.

In addition to the leaves and the tender shoots, the flowers and young fruit are very susceptible to attack, and on this account the disease causes a great loss of fruit. If the flowers are attacked, they fall from the tree without setting fruit. When the young fruit is attacked, it shows a rough scabby appearance, and becomes cracked, and generally falls from the tree in two or three weeks.

After the fruits have become half-grown, they seem to be immune to further attack. Full-grown fruit, after having fallen to the ground, however, may be attacked through wounds, and the fungus in this way probably causes a good deal of rotting of the fruit from the time of gathering until it reaches the factory.

TREATMENT OF THE DISEASE.

As this disease has become epidemic this year (1918), it is quite probable that under favourable conditions it may do even more damage next year, and every one should be prepared to combat it. Fortunately, it is comparatively easy to treat. If possible, all the dead wood and diseased leaves should be collected and burned during the dry season, and as soon as the trees begin to make their new growth after the rains begin, they should be thoroughly sprayed with Bordeaux mixture 4-4-50, to every gallon of which should be added a sticker, made as follows:—

Resin	...	...	...	2 lb.
Washing soda (crystals)	...	...	...	1 ..
Water	...	...	...	1 gallon

Mix, and boil for about one hour, until the preparation is a clear brown. This will make the Bordeaux spread and stick to the glossy surface of the lime leaves. After the first application has been made, the trees should be watched very carefully as time goes on, to see whether or not the new growth is becoming infected. If infections are found, it would be advisable to make another application of Bordeaux mixture. The number of applications necessary can only be judged according to the climatic conditions throughout the growing period.

LIME TREE BARK BORER.

The following report by the Entomologist of the Imperial Department of Agriculture, which is based on observations of material forwarded from Dominica, will be of interest to planters, as it emphasizes the great need of removing all dead wood from lime fields. By careful sanitation of lime cultivation, much may be done to control the undesirable activities of the bark borer.

With reference to the sample of wood from a freshly killed lime tree sent to Mr. J. Jones in December last, and forwarded under cover of the Curator's letter No. 720 of December 30, 1918, I have obtained fifteen examples of the lime tree bark borer (*Leptostylus praeincurvus*) from these pieces of wood, the last of which was taken out of the cage alive early in this month. From this it will be seen that these insects have been able to complete their development in the dead wood, and this confirms the opinion often expressed by officers of this Department, that the bark borer lives in dead wood. The original attack is probably made in a dead patch of wood, and the feeding of several grubs in such a situation may hasten the process of dying of the whole tree.

For the control of this insect, the cleaning up of all dead patches, and the tarring of them to prevent reinfestation are recommended. The early removal of all dead trees and dead portions of trees which should be burned is also advisable, because, as the rearing records from these small pieces of wood show, large numbers of the beetles are able to mature in dead lime wood.

The careful sanitation of lime plantations will be of the greatest value in preventing attacks of this beetle, which, although exerting very little influence on healthy tissue, may yet hasten the death of a tree suffering from injury or disease.

Report on Agricultural Instruction at the Botanic and Experiment Stations.

In last year's report it was pointed out that the training of the agricultural pupils which had been in vogue for the past ten years, had to be suspended owing to want of assistance. During the latter part of the period under review, however, some temporary assistance was obtained, and the training of the pupils was resumed.

SELECTION OF PUPILS.

Seven pupils responded to the advertisement inviting candidates to present themselves to a competitive entrance examination which was held at the Botanic Station in January 1919.

At the entrance examination the pupils were examined in the elementary subjects of a seventh standard Public School, whereby some idea of the candidates' fitness to receive the agricultural course of training was fairly well ascertained. As a result of the examination, four boys failed to attain 50 per cent. of the marks awarded, and were considered below the standard required of pupils. The three remaining boys showed fairly good knowledge of the subjects in which they were examined, and were finally selected for a two years' course of training in the Department.

INSTRUCTION TO PUPILS.

On the admission of these three new pupils for training in January, the system of agricultural instruction given to them was similar to that in vogue in the Department since 1911, and detailed in the Annual Report of 1915-16.

The chief feature of this system of training is, that the practical work performed by the pupils, who are daily employed in the general routine work of the Botanic and Experiment Stations, is blended with a certain amount of theoretical agricultural teaching which they receive every Saturday morning in the class room from 8 a.m. to 12 noon.

In the course of this class work, knowledge is imparted to the pupil which will enable him to appreciate thoroughly the reasons for the adoption of any given agricultural procedure, and to read and understand the literature of the subject so that by the time his training expires, he is in such a position that he can further increase his knowledge by his own observations and efforts.

During their course of instruction in practical agricultural operations, the pupils are always under the supervision of an officer of the Department. This detailed supervision of the field work provides instruction to the boys to the necessity of neatness and correct ideas in all field operations, while the appreciation of the importance of careful observations and of the keeping of correct records is being inculcated.

During the first term of 1919, the following subjects comprised the pupils' training:—

CLASS WORK.

The Atmosphere and the gases composing it; Water and its properties; the Seed, germination, structure of the leaf, stem, root, flower and fruit; the theory of grafting and budding and other means of propagating plants, pollination and fertilization.

FIELD WORK.

Pruning lime trees, dressing wounds, mixing and applying insecticides and fungicides; sowing green dressing seeds, budding limes, and the applying of manures, etc.

The progress made by the pupils so far, may be considered as fair. Much energy and keenness to learn were evinced by them in all sections of their duties. It is hoped that the usual half-yearly examination conducted by the Imperial Department of Agriculture will again be resumed in July next.

PLANT LEGISLATION IN DOMINICA.

The first step in the direction of plant protection was taken in 1898, when Act No. 3 was passed to provide against the importation of articles likely to introduce diseases among plants. Under the authority of this Act, a Proclamation dated August 27, 1898, prohibited the importation from Ceylon of plants, seeds, berries, earth, and soil. This Act was suspended by Law No. 9 of 1904, in which provision is made for the fumigation and disinfection of imported plants, cuttings, buds, grafts, bulbs, roots, and seeds, and their packages; also fruit and vegetables intended for propagation, and not for consumption as food.

Under Law No. 6 of 1907, power is conferred to prohibit by proclamation the importation of plants, cuttings, bulbs, roots, seeds, or berries, or any earth or soil, or any articles packed therein, or any packages, or other articles or things likely to be the means of introducing any plant disease.

A Proclamation dated February 5, 1909, under No. 6 of 1907, prohibits the importation into Dominica of all plants from Dutch Guiana which are likely to be a means of introducing disease from that country.

A Proclamation dated October 26, 1910, prohibits the importation of banana plants and suckers from all countries of Central or South America, and from the island of Trinidad, also of coco-nuts in husk and all growing plants or parts of plants of coco-nuts, from Cuba, Jamaica, Trinidad, and all countries of Central or South America.

A Proclamation dated August 7, 1915, prohibits the importation of citrus plants and citrus budwood from the United States of America. This is superseded by a Proclamation dated October 9, 1916, which applies to citrus plants, citrus budwood, or citrus fruit, or any parts of such plants, from the United States of America, Cuba, Jamaica, Haiti, San Domingo, and Porto Rico.

A second Proclamation of the same date restricts, under certain conditions the entry of rooted plants from the countries named in the above Proclamation.

A Proclamation dated October 29, 1917, prohibits the importation of seed-cotton or cotton seed from all countries or places outside the Colony of the Leeward Islands, save and except from some other Presidency of the Colony or from the Colony, of Trinidad and Tobago and its dependencies, or from the Colonies of Grenada, St. Vincent, and St. Lucia, provided, however, that small quantities of cotton seed for experimental purposes may be imported into the Presidency of Dominica, on the written permission of the Superintendent of Agriculture, on such terms and conditions as he may prescribe.

A Proclamation dated March 8, 1919, prohibits the importation from any country, save and except the island of Montserrat, St. Lucia and Grenada, of any Citrus plants, or parts thereof, including the fruits thereof, as these are likely to be a means of introducing the plant disease known as 'Blossom Blight' and 'Wither Tip Disease.' It is, however, allowed that the Curator or Agricultural Officers shall have the power to import for scientific purposes anything thus prohibited, on his making a report of such importation for the information of the Governor.

A Proclamation dated March 8, 1919, prohibits the importation from the islands of Trinidad and Grenada of growing and sprouting coco-nuts, as likely to be a means of introducing the plant disease known hitherto as 'Root disease of coco-nuts' but to be called in future the 'Red Ring disease of coco-nuts.'

With regard to the export of plants, it is only necessary to state that such cannot be admitted into the United States unless accompanied by a certificate showing that they have been inspected by a duly authorized official, and found free from injurious plant diseases or insect pests.

Persons wishing to export plants to the United States from Dominica should notify the Curator of the Botanical Gardens, who will arrange for the inspection, and the issue of the necessary certificates.

The importation of nursery stock into the United States by mail is prohibited.

Plot Experiments With Orchard Cultivation.

CACAO.

A number of manurial plots in cacao cultivation have been carried on at the Dominica Botanic Gardens for the past nineteen years. These have proved highly interesting, and though by necessity the area under these trials is limited, the results, in spite of defects incidental to this class of experiment, have afforded to planters and scientists broad general indications of the main requirements of cacao cultivation in this island.

In discussing the subject of plot experiments, it may be stated at the outset, that accurate results such as are supposed to be attainable in sugar-cane cultivation, and with other annual crops such as cotton, etc., are, under present conditions, unattainable in the case of orchard cultivations.

In the matter of cane experiments, a single cutting of the ripe canes, their weighing, and the subsequent examination of the juice, complete the investigation. In regard to cotton, a few pickings and weighings within a limited time close the work, and in the case of root crops, the lifting and recording of the weight of the rhizomes or tubers are quickly and easily carried out. That is, persons connected with the plots may be very busy during the ripening period of the product under investigation, but all the work can be carried out within a few weeks, and in some instances, within a few days.

Very different is the work of recording the yields in orchard cultivation. In these cases the crops are coming in practically all the year round, and unless the persons carrying them on are keenly interested, the routine is apt to become monotonous, which may lead to indifference and the making of mistakes on the part of those entrusted with the work of recording the yields.

In the early years of the Imperial Department of Agriculture, several attempts were made to obtain information by co-operating with planters in carrying on manurial experiments on estates, but in every instance these failed, owing to the difficulty of keeping records, which in cacao cultivation amounts to twelve or fourteen pickings a year, and in limes, to sixty or more collections during the same period. The close supervision required over labour engaged on the plots, and the measuring and recording of crops are such that no manager of an estate can be expected to undertake them in addition to his usual manifold duties.

On the starting of the manurial plots in Dominica in 1910, it was pointed out that fields of cacao were usually made up of various strains, some of which were good and others indifferent bearers. This was done with the object of advising the planters always to select seed for sowing from the prolific strains. The full significance of this variation in yield of individual trees, and its effect on manurial experiments were not comprehended for some years later, indeed, not until the remarkable set of experiments with cacao were undertaken by the Agricultural Department of Trinidad, when it was found that what is termed the natural yield of individual trees could very seriously disturb the manurial experiments, that is, the accidental grouping of high yielding trees within the area of a plot or plots would give misleading results as to the particular value of the manure or manures used, and vice versa in the case of low yielding trees.

In order to correct this error it was suggested that the yield of the plots should be known for some time before the manures were applied, and the practice of recording the yields for three or four years before the manurial plots are started, appears to be now followed in Trinidad. No doubt this practice, preparatory to the carrying on of manurial experiments, will do something to smooth out errors, and assist in the production of more reliable information, though far from exact, than any hitherto recorded.

In the attempt to obtain even approximate results it is necessary to repeat the series of experiments several times, also to carry them on for a considerable number of years. Short term manurial plots in orchard cultivation may be very misleading.

As far as crop returns are concerned, short term plots to which mineral nitrogenous manures have been applied, will give the highest results, but a few years of this treatment

will leave the soil and the trees in a poor and unbalanced condition. In this connexion it should be remembered that it is as easy for a manager of a tropical estate, by following an unsound system of manuring, practically to ruin a soil and to make things impossible for his successor, as in bygone days the English farmer, for the same reason, could prevent his successor in the tenancy from making a living out of the land.

This question of natural yield of cacao trees is one that would require very careful examination in Dominica. As is well known, the climate of this island is only a second class one for the higher types of cacao, such as the Criollo variety. It is only the Calabash and hardy strains of the Forastero variety that succeed. The Criollo variety, and the best strains of the Forastero are more prone to disease than the former. Generally speaking, in cases of attack by canker (*Phytophthora fabei*), many trees are usually abnormal bearers for the longer or shorter term of their diseased existence. Unless very carefully examined, it might follow that the natural yield in a number of cases might be affected by the abnormal bearing of a number of diseased and dying trees. It is possible, unless great care is exercised, that the so-called 'natural yield' of cacao trees might lead to greater errors in manual experiments than the general acceptance for plot purposes that all trees are average bearers. It will be seen that the prevalence of canker is likely to prove a disturbing element in all cacao experiments, both in regard to the determination of the natural yield, and again in the manual experiments.

The presence of canker would also operate in another direction. In some circumstances considerable numbers of full-grown, or nearly full-grown, pods are attacked and destroyed by it. In Dominica the proportion of pods so destroyed is always larger, in fact it may be said to be chiefly confined to varieties which yield high grade cacao. The accidental grouping of such kinds in a field devoted to plot experiments would introduce another disturbing element. It may of course be argued that, if canker of the trees produces abnormal bearing, especially in the Criollo variety, and if the same canker also destroys a large number of pods of the same kind, that one balances the other. Even if this could be proved to be near the truth, it would be difficult to accept such a solution in any well regulated experiments. And there is another disease at work known as brown rot, which takes a toll of cacao pods, the attacks of which may be very unequally distributed in a plantation.

Another disturbing element in cacao experiments is the presence of rats. In spite of efforts to keep them down, they usually succeed in exacting a considerable toll. And again, the attacks are often unequal, that is, the rodents may exhibit a preference for individual trees, or for groups of trees in certain parts of the field. To some extent the losses under this head could be followed up by collecting the attacked pods and calculating the amount of beans lost. But it is doubtful if this is done in any of the experiments of the present day. The yields given are those of cacao actually collected and sold, and it would probably be unwise to introduce any form of calculating crops in addition to the actual crop gathered.

During the progress of experiments, losses may also be due to pilfering, which is so common in the West Indies. It is clear that the plots which suffer most in this respect are those which are so situated as to offer opportunities with the least likelihood of detection.

Though the losses from various causes are common on estates throughout the West Indies, it is clear that the effect of a single cause might affect plot experiments, especially in the case of a single series, and that a possible collective effect would make this work very misleading.

Much might be done to control canker in plantations by spraying. Information on this matter may be found on referring to the spraying experiments in Trinidad, which show the heavy losses caused by canker, and their possible effect on plots. Also the variation in yield of seedling trees might be overcome to some extent by making experiments with budded or grafted cacao, that is, with a single variety instead of many varieties as at present. It is understood that this is being done on some scale in Trinidad.

LIMES.

Plot experiments with lime cultivation also presents difficulties, though these are fewer than in cacao cultivation. The lime is a hardier plant than the cacao, and a free bearer

under sound cultivation. Further, the lime shows very little variation from type. The great heaps of fruit which may be seen on large estates during the height of the crop are remarkable for uniformity in shape and size.

But even hardy and uniform lime trees, when grown within the small space of 2 acres, do not behave alike, as a reference to the published records will show. The eight plots were planted on the same day, and received the same treatment for three years. During the past two years manures have been applied, but, as seen in the early stages, equal manurial treatment does not produce equal results. A reference to the two control plots which receive no manure, shows in the second year of bearing a difference of 50 per cent. The complete manure plots also show the same wide differences, which continue in a slightly less degree throughout the series. Even with young cultivation there is no definite or equal starting point.

For experimental purposes, it may be said that these differences can be calculated and allowed for; but, even so, who shall say that the influences now operating will be continuously felt throughout the experiments which may be carried on for twenty or thirty years?

To what cause or causes are these variations in yield due? Soil conditions appear to be equal, but the special examination of the soil of each plot, though intended, has not yet been possible. In the matter of exposure to wind, the low yielding plots appear to be best protected, as they are to some extent inside plots, as far as the direction of the prevailing wind is concerned. And this matter of exposure will not be continuous. It is being mitigated yearly as the wind-belts develop.

A close examination of the field does something to reveal the cause or causes of the discrepancies in yields. The plots in their third year were badly attacked by scale insects. This is usual amongst young cultivations under the conditions of the Leeward Coast, and is termed the critical stage in the life of young lime trees. Remedial measures were applied, and the trees recovered. But the low yielding plots of to-day are those on which growth has been the poorest, and amongst which scale insects and the resulting black blight still linger, though gradually being overcome. It is evident that the decrease in yield is due in part to the attacks of scale insects, and that these attacks are again due to unfavourable soil conditions. To put the matter briefly, one-third of the soil of the 2 acres of experimental cultivation shows considerable variation from the rest. To the present this variation has operated against the well-being of the trees. It will be interesting to watch the plots carefully, and to observe the effects of good cultural measures, and the application of manures on what appear to be deficient soils.

Another difficulty and cause of loss in lime fields is the effect of torrential rains in a wet country like Dominica. When these occur at the height of the crop, large numbers of fruits are swept away, first to the drains, then to the streams and river, and finally to the sea. There is room for ingenuity on the part of planters to devise methods for preventing this loss, or part of it. At present most attempts fail, as the arrangements at outlets of drains to collect the fruit are speedily blocked by the debris of the fields, and are either carried away, or if not, the water rushes over the obstacles and floats away the limes with it. The annual loss of fruit in Dominica during a wet season is very considerable. Losses from this cause may possibly affect the results of manurial experiments, as it is probable that the heavy bearing plots would lose the most fruit.

The pilfering of limes, both ripe and green, is also another serious difficulty. With green limes selling at 20s. to 25s. per barrel, the incentive to steal is very great, a third of a barrel, obtained sometimes with ease, giving the same results in money as a week's work. At the Experiment Station it was hoped to gather all the crop as ripe limes. Owing to theft, this was found impossible. As a measure of defence the green limes have now to be picked for sale. It will again be seen that the crop results of plots which offer the best opportunities for theft may be considerably confused by pilfering.

There are other minor pests and diseases which take toll of orchard cultivation, and there is also the experimental error which can be calculated, and the human error which can not. Liability to mistakes in recording and measuring crops is much greater in orchard experiments than with annual crops. In lime cultivation, from sixty to seventy pickings have to be made during a season, and recorded, and the work has often to be carried out under the most miserable conditions of weather. In the case of the twenty-one plots of

MANURIAL EXPERIMENTS.

lime cultivation at the Experiment Station, this means from 1,260 to 1,470 separate measurements and records in the course of a year.

There are undoubtedly considerable difficulties to face in carrying on orchard experiments in the tropics. This work calls for close and sustained interest on the part of those responsible for it, in fact, interest in it should grow with the years. These experiments do not fall into the same category as those with annual crops; neither are the difficulties in connexion with orchard plots so readily overcome as in the case of sugar-cane and root crops. In spite of the present day defects, these investigations should be extended, and at the same time every effort possible should be made to overcome present inequalities with a view of adding to the reliability of the results.

MANURIAL EXPERIMENTS.

Consideration having been given in the above notes to some of the difficulties experienced in carrying on orchard experiments in the West Indies, it may not be out of place also to refer to the manurial treatment, and to enquire as to the object and aims of those experiments.

It is very evident that when manurial plots are to be carried on for a number of years, possibly for a generation, great care and thought are necessary in laying down the treatment, and it would appear that to the present this has not been always the case, with the result that some of the experiments do not seem to be directed towards the attainment of any definite or useful end.

It would appear that experiments in orchard cultivations in the West Indies could be considerably advanced by following the methods of citrus growers in the United States, and in islands like Cuba and Porto Rico, who act, and no doubt correctly so, on the basis that all soils which are expected to yield heavy crops over a long period of years, as in citrus growing, require a complete manure annually, of nitrogen, phosphates, and potash.

The acceptance of this sound policy of manuring would revolutionize plot methods in the West Indies, in which place considerable and altogether undue importance is attached to experiments in which one or two of the three primary plant foods are left out. In the light of our present day knowledge of the soil and plants, it is difficult to account for these methods, and it is far from clear as to what is the ultimate aim in carrying on manurial plots of this character.

Too much stress cannot be laid upon the fact that, in orchard cultivations, the same plots will be in continuous use, may be for thirty or forty years or more. In experiments with annual crops this is not the case. These can, and probably are, moved to new grounds from time to time. The maintenance of the fertility of the soil, and the well-being of the plants being of highest importance, it is disappointing to find that 50 per cent. of the experiments as laid down must result, in the course of years, in semi-starvation of the trees.

A reference to the manurial experiments as carried on in the several West Indian colonies will show an extraordinary variety and range of treatment, so great in fact that instead of interesting the planter, the supposed beneficiary of the investigations, the work is by far more likely to result in his unconcern, or, if he studies the matter, possibly his bewilderment.

It may be interesting in this connexion to refer to the series of plot experiments as carried on at the Dominica Experiment Station. When compared with work of this kind in other colonies, they are comparatively clear and simple, but even in this limited range, there appears to be a number of defects incidental to the present trend of thought on the part of those who are responsible for laying out this class of work in the West Indies.

First on the list is the complete manure plot of organic nitrogen, Thomas' phosphate, and sulphate of potash, a very necessary experiment in any series. But even in this case the question arises, whether the fertility of the soil can be maintained by this treatment at a sufficiently high standard to grow healthy trees and to yield good crops over the lifetime of a lime plantation, that is, possibly fifty or sixty years. The humus question cannot be overlooked. As the trees cover in, there will be a lessened growth of weeds. Will these prove sufficient, in conjunction with the small amount of organic matter applied yearly, to maintain the humus content of the soil without which we are told a high state of fertility

MANURIAL EXPERIMENTS.

cannot be expected? That the above treatment will keep up the fertility of the soil for a few years may be accepted as proved, but whether under the conditions of a lime plantation it will do so indefinitely, has not yet been shown.

To the practical man the existence of the doubt expressed above at once suggests an alternative experiment, that is, a complete manure as stated, one year, and an application of pen manure or mulch at the rate of from 5 to 10 tons per acre, the second year. There appears to be no sound reason for the present rigid adherence to annual and often inadequate applications of certain fertilizers, when the extension in some cases to bi-yearly treatment would add to the interest and value of the experiments.

The next plot on the list is the control or no-manure plot. It exists in all series of orchard and other experiments, apparently with a view of sustaining our interest in the value of fertilizers. As the years pass, the widening difference in crop returns between the treated and untreated sections is held to be indisputable proof of the efficacy of manures, and to be the chief means of convincing those of little faith in this respect, that it pays to apply them.

While control plots may be necessary, and even harmless in annual or other short term experiments, their presence in a series of orchard and long term plots is not so easily defended. In time, these will be starved cultivations in the midst of more or less healthy cultivation. They may become centres of disease from which the healthy plots will be constantly menaced. Their presence will be the negation of everything that has been written and said in favour of intensive cultivation, and there is so much starved lime cultivation to be seen in this island that one wonders if it is necessary, for the sake of convincing planters, to reproduce those conditions in a series of manurial plots. Would it not be better to seek justification, if needed, for applying manure and carrying on sound cultural measures in a fertile soil, in healthy trees, and in good returns per acre? Conviction that manures are useful might be sought for in good results alone, rather than in measuring the difference in crop yields between good and poor cultivations. To the present, plot experiments with trees appear to have suffered by being based upon what has been found necessary and useful in carrying on this line of work with annual crops. The difference between arable and orchard cultivation does not appear to have been sufficiently noted. Experiments with the former are transient, and end with the season, and can be repeated at will on the old or new ground; the latter are permanent, and the treatment once embarked upon cannot be changed without creating many difficulties, and leaving a number of residual effects in operation. To put the matter briefly, it appears to be a pity that control plots are still considered necessary in every series of experiments. In orchard plots at least, there are other ways of showing the value of manures instead of by comparison with control cultivation.

The third plot of the series receives mulch at the rate of 5 tons per acre. In the cacao experiments mulch has proved of high value, and it will be interesting to watch if this is confirmed in the lime plot experiments. Planters have long been advised to utilize every form of mulching in their cultivations, as a safe and certain means of keeping up the fertility of the soil.

Plots Nos. 4 and 5 are treated respectively with nitrogen and phosphates, and nitrogen and potash. In neither case does there appear to be any particular object in view. The natural and probably correct inference is, that the application of nitrogen and phosphates will develop considerable energy in the plant, and thereby create a greater demand for potash than the natural resources of the soil are able to furnish. Theoretically there may be sufficient potash in the land, but in practice, the amount available for plants is small. Consequently, in these sections there will be a sufficiency of certain kinds of plant food on the one hand, and a deficiency on the other. Under such treatment, the soil and the plant may become unbalanced, as they are known to do when large applications of nitrogen from mineral sources are given over a period of several years, and potash and phosphates withheld. This is clearly seen in the potash and phosphates manurial plot of cacao in the Botanic Gardens. Owing to lack of nitrogen, it is a starved plot. Similarly with the nitrogen plot of cacao, the yield is below the complete manure plot, owing to lack of potash and phosphates. It is probable that plants growing under these conditions are more truly starved plants than those which are unmanured and depend upon the natural resources of the soil only.

Under present conditions, a considerable area is taken up with manurial plots in order to show what competent planters already understand, that is, that partial treatment with

EXPERIMENT STATION.

fertilizers will in the long run result in reduced crops when compared with the returns of plots which receive complete manures. And the effect of a lack of plant food could, if considered necessary, be amply and impressively demonstrated by a series of pot or box cultures with plants. If the object of these experiments is to find out the best means of maintaining the fertility of the soil over long periods, to grow healthy trees, and to produce good crops, anything short of the application of a complete fertilizer annually is a waste of time. A sound system of treatment which will produce 300 barrels of limes per acre per year, and maintain the soil and trees in a proper condition, will convince those planters who are interested. Therefore, the furnishing of a table showing gradations in yield from the control, through the semi-starved, to the fully manured plots, would not appear to be required in these days.

The adoption of the formula of American citrus growers would put an end to these indefinite and fragmentary experiments, and allow of the admission that all soils which are expected to yield heavy crops should receive a complete manure annually. Experiments with a view of finding the best form of furnishing the different manures, together with greater attention to the humus question, and the adoption in some cases of bi-yearly methods of treatment, would appear likely to lead to more practical results than any that can be expected from manurial plots in their present form.

Experiment Station.

This Station was started in April 1913, and the first planting of limes was made in June of the same year. A statement showing the expenditure and receipts during the six-year period is given below :—

	Expenditure.			Receipts.		
	£	s.	d.	£	s.	d.
1913-14	50	0	0	17	9	7
1914-15	70	0	0	61	1	5
1915-16	120	0	0	86	9	10
1916-17	175	0	0	121	2	11
1917-18	175	0	0	180	12	2
1918-19	200	0	0	233	12	8
Cost of manures to date	60	0	0			
Grant for draining from Special						
Services	48	3	0			
Head labourer's house	60	0	0			
Shed for housing mill, etc.	100	0	0			
	£1,058	3	0	£ 700	8	7

Supervision, always a considerable charge, has cost nothing in this instance, the work having been done by the agricultural officers. A fair amount of assistance has also been given by the two or three agricultural pupils who have been under training during recent years. These were from time to time engaged in sowing green dressings, in applying manures, pruning trees, and other work of a light character.

LIME EXPERIMENT STATION.

A grant of £48 3s. having been made by the Commissioner of Agriculture to effect cultural improvements, it was possible to dig a length of many thousands of feet of drains in the lime and coco-nut plots, and also to drain and prepare a further 2½ acres of land for planting in limes with the rains. This grant was a useful and timely one. It has served to put the bulk of the cultivation on a sound basis at once, instead of by gradual work extending over a number of years.

The building of a shed to house a mill, etc., also marks the first step towards the provision of a small factory for dealing with the crop of limes. When this is done, it will be possible to train the agricultural pupils and cadets, and if desired, also other young men who may arrive in the island for the purpose of acquiring land to grow limes, in the work of cultivating limes, and preparing the products for market. Given a small factory, the Agricultural Department would be in a position to offer a course of practical instruction to young men, commencing with the sowing of the seed, and ending in the manufacture and shipping of the products of the lime. It is essential that young men should be taught the great need of efficiency in the field and in the factory. Under present conditions, pupils sometimes receive their initial training on estates on which there is a low standard of cultivation coupled with old-fashioned methods of dealing with the crop. A young planter will certainly improve his chances of success if he is soundly trained in the best methods of growing limes, and of preparing the products for market.

During the six years of its existence, the Experiment Station, as far as the disposal of the crop is concerned, has been in the position of a small grower, that is, the ripe limes have had to be sold in the open market at the current ruling prices. For purposes of record, a table has been prepared which shows the local market rates for ripe limes per barrel of fruit since 1914-15 :—

Year.	No. of barrels of fruit.	Amount received.			Rate per barrel.	
		£	s.	d.	s.	d.
1914-15	222	61	1	5	5	6
1915-16	315	86	9	10	5	6
1916-17	541	121	1	1	4	5½
1917-18	649	180	12	2	5	6½
1918-19	1,070	221	2	8	4	1½

At the end of 1918-19, 10 barrels of green limes were sold, and these account for the difference in the number of barrels and the total sum received, which is given on another page.

As time goes on it should be possible for the Experiment Station to sell a fair proportion of the crop as green limes, either locally or by direct shipment to New York. A good deal has still to be learned in regard to the handling and packing of limes, and a carefully directed investigation by the Department should, in due course, yield much valuable information on this important matter.

MANURIAL EXPERIMENTS WITH LIMES.

The main manurial experiments now carried on consist of five plots, three times repeated, two series with young limes, and one series with old limes. They are as follows :—

- A—Complete manure of nitrogen, phosphates and potash.
- B—Control. No manure.
- C—Mulch of grass, 5 tons per acre.
- D—Nitrogen and phosphates.
- E—Nitrogen and potash.

MANURIAL EXPERIMENTS WITH LIMES.

The yields of these plots, in barrels of fruit, during 1917-18 and 1918-19, are given below :—

TWO YEARS' RESULTS OF MANURIAL EXPERIMENTS WITH LIMES.

ORIGINAL SERIES.

Trees planted July 1913.

Year.	Size of plots.	A. Complete manure,		B. Control,		C. Mulch,		D. Nitrogen and phosphates,		E. Nitrogen and potash,	
		per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.
1917-18	$\frac{1}{4}$ acre.	15 $\frac{1}{4}$	63	14	56	23 $\frac{3}{4}$	95	24	96	7 $\frac{1}{4}$	31
1918-19	$\frac{1}{4}$ acre.	59	236	46	184	68 $\frac{1}{2}$	274	58 $\frac{3}{4}$	235	34 $\frac{1}{4}$	137

DUPLICATE SERIES.

Trees planted July 1913.

Year.	Size of plots.	A. Complete manure,		B. Control,		C. Mulch,		D. Nitrogen and phosphates,		E. Nitrogen and potash,	
		per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.
1917-18	$\frac{1}{4}$ acre.	6 $\frac{3}{4}$	27	10 $\frac{1}{4}$	41	18	72	6 $\frac{3}{4}$	27	10 $\frac{3}{4}$	43
1918-19	$\frac{1}{4}$ acre.	35	140	22 $\frac{1}{4}$	89	42 $\frac{1}{2}$	170	30	120	38 $\frac{1}{2}$	154

TRIPLICATE SERIES.

Old Trees planted 1893.

Year.	Size of plots.	A. Complete manure,		B. Control,		C. Mulch,		D. Nitrogen and phosphates,		E. Nitrogen and potash,	
		per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.	per plot.	per acre.
1917-18	$\frac{1}{4}$ acre.	45	180	30	120	25 $\frac{3}{4}$	103	27 $\frac{1}{2}$	110	23	92
1918-19	$\frac{1}{4}$ acre.	60	240	32 $\frac{1}{4}$	129	23	92	52 $\frac{1}{2}$	210	34	136

BUDDED LIMES.

It would be unwise to attempt to draw any conclusions in orchard cultivations from the results of a series of plots on a two-years' term of manurial experiments, but this need not prevent consideration of the yields of the plots collectively. The ten plots of young limes, which cover an area of $2\frac{1}{2}$ acres, were planted in July 1913, and are therefore, at the end of March 1919, five years and nine months old from the time of being placed out in the field. The crop returns during this period are as follows:—

1917-18	...	$137\frac{1}{2}$ barrels or	55 barrels per acre
1918-19	...	$434\frac{1}{2}$ " " 174 " " "	" " "

These returns are very high from trees which, during their third year, suffered severely from attacks of scale insects, which led to the growth being retarded over a period of some months.

This experiment, reviewed from a collective standpoint, shows that lime cultivation can be established on coast lands within six years, and more than average returns obtained. Many of the lime fields in Dominica take from ten to twelve years to become established. The cost of establishing an acre varies somewhat, but if £50 is taken as an average figure, it would appear far better business to spend £10 per acre per year over five years, than to expend £5 per acre per year, the usual course, over a period of ten years. The reply to this suggestion is that many planters have not the money to allow of the best course being followed, but those who can spend the necessary amount may in future overcome the long period of waiting by adopting intensive methods of cultivation.

Experiments with budded limes are also in progress. In this section there are two plots, each $\frac{1}{4}$ acre, of common limes budded on Sour Orange stocks, and one plot of the same area of spineless limes on the same kind of stock. Adjoining this is a plot of ordinary seedling limes for comparison. During the past two years the trees in each section have received a small dressing of organic nitrogen at the rate of 4 cwt. per acre. One of the budded plots was grown with Tephrosia as a green dressing, the other in the usual way with weeds and grass, which was weeded occasionally; the spineless limes had a green dressing of horse beans, and the seedling limes were clean-weeded. Now that the trees are closing in, it is proposed to discard the green dressing and apply a complete manure annually. The crop yields of the plots for two years are as follows:—

TWO YEARS' RESULTS OF EXPERIMENTS CONDUCTED WITH SPINELESS AND COMMON LIMES,
BUDDED ON SOUR ORANGE STOCKS, AND WITH COMMON SEEDLING LIMES

PLANTED JULY 1914.

SPINELESS LIMES BUDDED ON SOUR ORANGE STOCKS, GROWN WITH HORSE BEANS.

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre.
1917-18 ...	$\frac{1}{4}$ acre	$8\frac{1}{2}$	34
1918-19 ...	$\frac{1}{4}$ acre	18	72

COMMON LIMES BUDDED ON SOUR ORANGE STOCKS, GROWN WITH TEPHROSIA.

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre.
1917-18 ...	$\frac{1}{4}$ acre	$8\frac{1}{2}$	33
1918-19 ...	$\frac{1}{4}$ acre	$34\frac{1}{2}$	139

BUDED LIMES.

COMMON LIMES BUDED ON SOUR ORANGE STOCKS, GROWN WITHOUT GREEN DRESSINGS.

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre.
1917-18 ...	$\frac{1}{4}$ acre	6	24
1918-19 ...	$\frac{1}{4}$ acre	13 $\frac{1}{2}$	54

COMMON SEEDLING LIMES CLEAN-WEDED.

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre.
1917-18 ...	$\frac{1}{4}$ acre	Nil	Nil
1918-19 ...	$\frac{1}{4}$ acre	16 $\frac{1}{2}$	67

The results show clearly the tendency to early bearing which is characteristic of budded and grafted plants; but whether this is an advantage in the case of limes remains to be shown. Early bearing in this case tends to arrest growth, stunts the trees, and may bring about a state of ill health unless the trees are highly manured. Generally speaking, it may be said that budding is the first step in the direction of intensive cultivation, and full advantage of its application will not be obtained unless intensive methods are applied throughout the lifetime of the plants.

The second point brought out is that a green dressing like Tephrosia, which affords a good ground cover as well as lateral protection over a period of two years or more, is very helpful to limes in their early stages.

The crop returns from the three plots of budded limes placed out in July 1914 were, in 1917-18, when between two years and nine months, and three years and nine months after planting in the field, at the rate of a little over 30 barrels of fruit per acre. The following year, 1918-19, the three plots of budded trees and plot of seedling limes, making in all 1 acre in extent, yielded 84 $\frac{1}{2}$ barrels of fruit. These are remarkable instances of early bearing.

RECEIPTS AND EXPENDITURE.

Details of Administration.

EXPENDITURE, RECEIPTS, ETC.

EXPENDITURE.

The Votes for the Agricultural Department for the year were as follows :—

	£	s.	d.
Salaries, Curator, Assistant Curator and Foreman ...	477	0	0
Travelling expenses	50	0	0
Maintenance, Botanic Gardens	280	0	0
Cultivation of saleable products	260	0	0
Fumigation of imported plants	5	0	0
Maintenance, Public Gardens	15	0	0
Purchase of special manures	50	0	0
Printing reports, etc.	40	0	0
Cacao Prize Holdings Competition	25	0	0
Experiment Station	200	0	0
Purchase of vegetable seeds	35	0	0
Trial shipments of fruit	20	0	0
Field experiments	20	0	0
Chemicals and apparatus	55	0	0
Telephone rental	8	0	0
Contingencies	10	0	0
Total	£1,550	0	0

The actual expenditure during the year under the above heads was £1,313 17s. 11d. The grant to meet the cost of training agricultural pupils was £199, of which £80 1s. 7d. was expended. The total gross expenditure was therefore £1,393 19s. 6d.

RECEIPTS.

The receipts under the various heads were as follows :—

	£	s.	d.
Cacao	292	5	2
Nutmegs	70	14	10
Plants	79	19	9
Fruit	24	7	9
Limes	233	12	8
Kola nuts	19	18	0
Vegetable seeds	20	2	9
Miscellaneous	6	10	8
Total	£747	11	7

ADMINISTRATIVE.

The total cost of the Agricultural Department during 1918-19, was therefore £646 7s. 11d.

The sum of £48 3s., the last of the Special Grant from the British Government for Agricultural Services, was, by permission of the Imperial Commissioner of Agriculture, expended in effecting cultural improvements in the Experiment Station.

STAFF CHANGES.

Mr. G. A. Jones, Assistant Curator and Chemist, severed his connexion with the Colonial Service in December, after ten years employment in the Agricultural Department of Dominica. At the end of the year no permanent appointment to the post had been made. Under present conditions it is being found very difficult to obtain trained men in England for filling agricultural positions in the tropics.

At the end of November, Mr. C. A. Gomez, Manager of the island of Barbuda, was appointed Acting Assistant Curator.

B. J. Paul, overseer in connexion with agricultural instruction, left in March in order to take up a position in the Agricultural Department, St. Lucia, and J. Le Blanc, senior agricultural pupil, was selected to fill the vacancy.

CORRESPONDENCE AND DISTRIBUTION OF INFORMATION ON AGRICULTURAL MATTERS.

During the year, 726 communications were despatched from the office of the Department, and seventy-nine minute papers were dealt with. Sixty two copies of the various issues of the *West Indian Bulletin*, and 160 of the Annual Report on the Agricultural Department for 1917-18, were distributed free of charge to leading planters, officials, and others in the island.

A considerable number of planters and others desiring information on agricultural matters called at the Gardens during the year.

A number of new books were added to the Library during the year, and the publications of a number of Tropical Agricultural Departments were duly received and bound. The opportunity is again taken of thanking those Departments who kindly forward their publications.

PLANT AND SEED EXCHANGES, FOREIGN AND LOCAL.

Contributions of seeds and plants were received from the following: the Imperial Commissioner of Agriculture; United States Department of Agriculture; Botanic Gardens, Buitenzorg, Java; Botanic Gardens, Calcutta; Ministry of Agriculture, Cairo, Egypt; the Agricultural Departments of Trinidad, Grenada, St. Lucia, Montserrat, Antigua and St. Kitts; and from the Hon. Dr. Nicholls, C.M.G.

Seeds and plants were sent to the Imperial Commissioner of Agriculture; Royal Gardens, Kew; United States Department of Agriculture; Botanic Gardens, Buitenzorg, Java; Ministry of Agriculture, Cairo, Egypt; Station Agronomique, Guadeloupe; and the Agricultural Departments of Trinidad, Jamaica, Grenada, St. Vincent, Montserrat, Antigua, St. Kitts and Tortola.

VISITS BY OFFICIALS OF THE DEPARTMENT.

Sir Francis Watts, K.C.M.G., Imperial Commissioner of Agriculture for the West Indies, paid a visit to the Gardens on November 28, while on his way from Antigua to Barbados.

Mr. H. A. Ballou, Entomologist on the staff of the Imperial Department of Agriculture, paid a brief visit to the Experiment Station in March, while on his way to the Northern Islands.

Mr. W. Nowell, Mycologist on the staff of the Imperial Department of Agriculture, paid a visit to Dominica in September. He arrived on September 8, and left on September 10 for Antigua. He again visited the Gardens on September 25, while on his return voyage to Barbados.

Other visitors during the year were: Mr. S. C. Harland, B.Sc., Assistant for Cotton Research on the staff of the Imperial Department of Agriculture, and Mr. J. Sydney Dash, Director of the Station Agronomique, Guadeloupe.

METEOROLOGICAL RETURNS.

RAINFALL.

The rainfall at the Botanic Gardens for 1918 amounted to 71.64 inches, or 9.16 less than the previous year, and 6.73 inches less than the average annual precipitation for the last twenty-six years, which is 78.37 inches.

The following table shows the mean monthly and annual rainfall at the Botanic Station from 1893 to 1918, a period of twenty-six years, and the accompanying chart shows at a glance the fluctuations from year to year.

METEOROLOGICAL.

RAINFALL AT THE BOTANIC STATION, DOMINICA, 1893-1918.

Month.	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	Mean monthly rainfall.
January ...	3.62	10.20	4.08	5.52	2.60	3.00	6.78	2.25	4.52	2.01	3.10	7.92	3.86	3.74	4.48	1.56	2.30	5.20	11.46	8.21	7.48	3.22	1.76	10.79	5.00	6.02	5.02
February ...	7.65	4.99	1.09	1.23	3.21	2.11	3.00	1.15	0.88	0.43	5.01	5.58	2.56	2.04	3.82	1.16	5.02	11.42	4.00	1.32	2.32	5.56	1.04	1.90	4.10	8.73	3.51
March ...	2.97	4.39	5.35	2.73	3.36	1.53	1.32	3.56	3.27	2.69	2.44	2.16	4.38	0.90	1.96	3.68	2.08	1.16	3.11	4.66	7.29	2.23	0.84	4.52	6.74	3.32	3.18
April ...	4.71	2.33	2.92	1.27	1.39	0.75	0.60	1.29	0.25	2.80	0.57	1.64	1.90	3.18	2.66	3.08	8.12	2.86	5.00	3.38	1.57	6.45	15.75	1.22	0.47	1.86	2.99
May ...	5.45	3.09	10.08	6.12	12.75	1.19	1.76	7.62	3.05	6.86	2.44	1.58	4.32	3.78	1.64	2.24	1.92	7.30	11.16	1.56	3.45	2.58	3.65	2.05	2.94	5.90	4.44
June ..	16.12	8.22	3.19	8.23	6.50	11.78	7.23	5.59	12.18	12.89	9.02	6.00	5.54	9.46	5.54	6.16	9.00	14.26	6.54	5.44	3.49	7.27	9.17	4.82	15.34	6.04	8.26
July ...	13.67	8.52	7.13	14.88	8.80	14.75	10.08	10.50	22.96	9.74	8.91	10.38	6.10	10.10	8.00	9.22	9.86	12.60	8.08	5.83	7.57	11.83	14.84	8.23	13.70	11.28	10.67
August ...	11.86	5.84	9.67	7.07	8.87	16.35	6.32	7.34	13.53	7.41	18.41	7.69	14.18	7.30	7.40	9.41	13.12	10.22	11.43	4.88	10.93	3.98	14.74	16.58	8.53	8.46	10.02
September	11.15	8.22	17.42	6.47	4.51	7.89	7.04	5.28	5.86	8.62	9.69	11.32	8.92	10.88	11.60	7.52	6.44	8.90	15.34	3.32	8.39	7.71	11.36	6.20	15.02	4.14	9.19
October ...	8.94	14.41	11.32	3.93	8.42	7.97	1.81	6.60	4.84	5.75	12.73	10.21	9.10	8.12	7.80	5.12	13.10	3.82	7.06	7.26	10.40	5.13	8.41	10.06	2.46	6.67	7.73
November	3.18	6.14	11.21	16.81	7.81	6.55	5.02	3.49	6.43	11.20	4.17	3.13	5.48	9.58	5.98	1.96	4.36	5.40	6.94	11.20	4.28	9.44	10.05	14.28	1.92	3.36	6.86
December...	10.61	4.99	5.66	6.60	10.55	5.86	2.19	3.68	4.32	7.16	14.23	4.84	5.72	2.94	8.42	7.80	5.82	7.50	7.14	6.66	2.72	9.70	8.40	3.77	4.58	5.86	6.48
Total ...	98.93	81.44	89.07	80.86	78.77	79.73	53.15	57.75	81.09	77.46	90.72	72.45	72.06	72.02	69.30	59.91	81.14	90.64	97.26	83.75	69.90	75.10	100.01	84.42	80.80	71.64	78.37

METEOROLOGICAL.

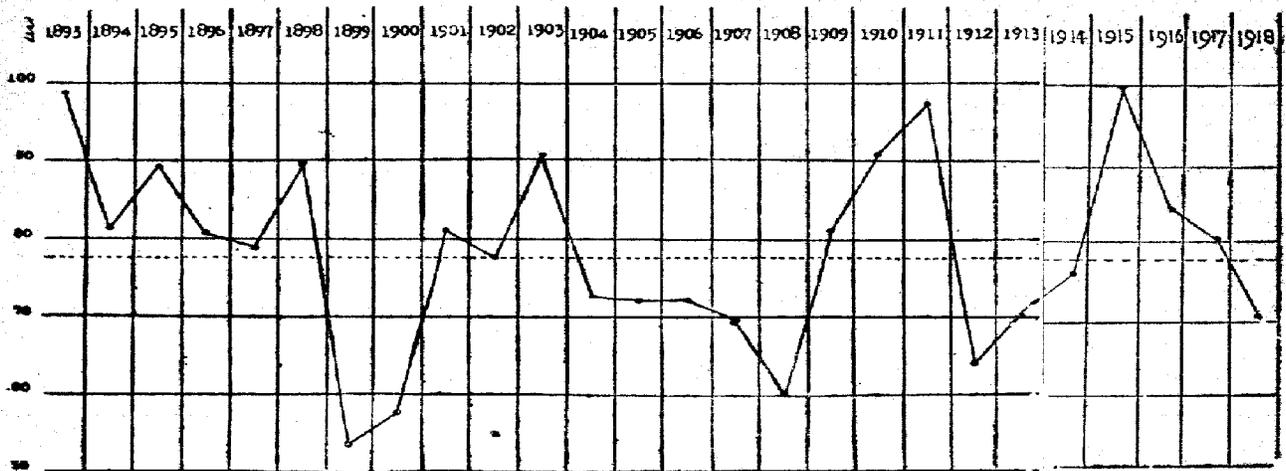


Diagram showing annual rainfall, in the Botanic Gardens, Dominica, 1893-1918. The average for this period—78.37 inches—is shown by the dotted line.

Another chart shows the mean monthly rainfall over the same period. From this it will be observed that the months of February, March and April are the dry months, with a mean rainfall of about 3 inches, and that July and August are the wettest months, with a precipitation of over 10 inches.

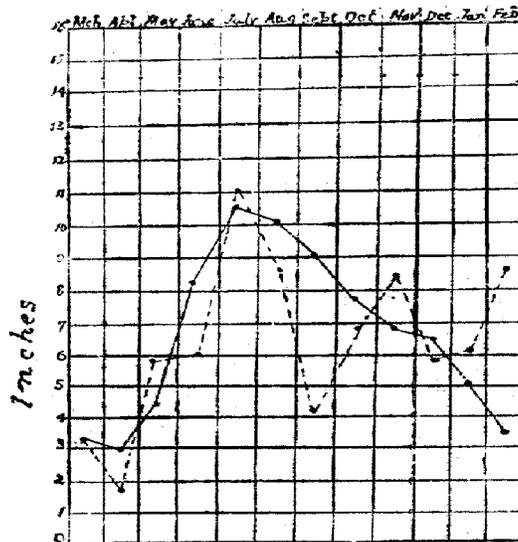


Diagram showing mean monthly rainfall, Botanic Gardens, Dominica, for twenty-six years 1893-1918. The monthly rainfall for the year under report is shown by the dotted line.

Following the above will be seen the monthly rainfall at the twenty-seven recording stations located in different parts of the island. The thanks of the Department are due to those planters who furnish the information from year to year.

From this table it will be observed that the mean rainfall for the twenty-seven stations is 100.80 inches. By taking the island in districts, we obtain the following returns: The fifteen Leeward Coast stations registered a mean of 78.85 inches; the two Windward Coast stations averaged 134.34 inches; two Inland stations 160.73 inches, and eight Lasoye stations 118.56 inches.

RAINFALL RETURNS, DOMINICA, 1918.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Batale	3.07.	3.48	2.2	7.0	2.51	3.29	6.70	4.70	2.22	5.60	1.86	2.35	36.70
Bagatelle, Soufriere	3.75	6.81	3.66	2.73	8.66	6.40	8.75	7.12	3.98	8.01	6.17	4.12	70.16
Bellevue	9.84	14.73	10.81	7.69	11.96	17.59	14.90	11.37	10.76	17.46	12.67	13.76	153.54
Bleuherm	8.34	6.31	6.42	8.04	30.85	10.23	8.89	8.53	6.68	17.38	6.91	6.25	124.85
Botanical Gardens	6.02	8.73	3.32	1.86	5.90	6.04	11.28	8.46	4.14	6.67	3.36	5.86	71.24
Canefield	4.09	8.31	2.97	2.27	4.57	7.27	12.23	8.37	4.31	6.77	3.69	5.67	70.52
Castle Bruce							7.65	7.45	10.19	25.51	10.89	11.39	
Everton	5.13	9.29	5.72	1.47	6.46	11.12	18.84	10.40	6.49	8.69	5.36	5.82	94.79
Goodwill	5.64	10.38	3.86	2.37	6.03	5.81	11.28	8.46	4.14	5.64	2.38	5.57	71.56
Governor	10.01	8.73	13.85	9.79	25.12	17.70	1.65	8.44	13.82	26.95	19.95	20.99	186.03
Hampstead	5.90	3.72	5.61	5.58	17.69	8.52	6.15	8.97	9.83	13.34	8.38	5.82	99.51
Hatton Garden	6.51	5.71	6.07	6.03	19.41	12.53	7.27	6.78	10.86	20.76	10.50	8.02	120.45
Hillsborough	5.27	7.30	3.31	1.44	6.65	8.65	14.38	12.32	5.06	7.93	4.11	6.62	89.04
Indian River	5.61	9.73	5.49	5.17	10.73	7.53	10.70	7.38	5.83	12.53	3.76	5.80	90.26
La Haut	1.97	10.70	6.12	3.02	5.62	10.15	14.80	9.48	6.02	6.78	6.67	6.97	88.30
Londonderry	4.34	5.69	5.34	6.75	18.72	8.03	10.55	11.86	10.60	24.77	12.28	7.90	127.03
Long Ditton					12.20	31.80	29.09	19.44	13.09	26.82	19.58	20.59	
Melville Hall	3.90	6.16	4.63	6.32	15.28	9.99	6.91	8.36	9.98	11.17	8.94	6.93	98.60
Monne Park	7.85	6.11	6.91	6.42	24.71	10.44	9.09	7.07	5.15	13.15	5.24	7.28	109.42
Monne Bruce	8.31	9.64	4.69	2.60	6.20	4.37	10.37	10.08	3.53	9.06	3.98	7.03	79.86
Picard	7.63	10.51	4.22	3.00	10.19	7.01	11.07	6.00	5.97	11.20	4.05	3.71	84.56
Pte. Molâtre	6.94	7.25	4.76	9.83	15.78	8.58	10.31	5.75	13.73	26.28	8.05	10.42	127.68
Rosalie	3.10	14.81	6.16	7.98	19.76	12.05	8.95	8.68	11.92	25.96	12.92	7.70	140.99
Shawford	9.55	18.35	12.14	7.26	12.85	18.82	24.87	15.03	7.53	16.56	10.90	14.07	167.93
Sung Corner	7.20	12.20	7.80	3.90	6.80	13.80	10.70	10.50	6.39	11.80	8.40	10.30	115.70
Soufriere	2.42	2.50	1.23	1.05	5.80	6.17	10.20	11.05	5.75	5.70	13.04	3.95	61.17
Spring Hill					11.27	18.13	16.58	13.04	6.79	17.31	5.35	12.65	
St. Arment	6.67	13.02	5.6	3.07	5.05	9.18	15.40	9.94	4.29	8.59	4.76	7.78	83.31
Wall House	3.81	5.60	4.48	2.08	4.45	8.40	10.92	9.72	5.80	10.10	2.85	8.10	76.31
Woodford Hill	4.15	3.25	3.96	3.55	13.04	8.05	4.91	5.61	5.98	16.37	5.43	8.37	82.67

Mean Rainfall, 27 Stations 100.80

" " 15 Leeward Coast Stations 78.85

" " 2 Windward " 134.33

" " 2 Inland Stations 160.73

" " 8 Lasoye " 118.56

93.5 73.5 14.0 7.5 8.9 27.6 100.

44
78
53.0
4

GRAFTED CACAO YIELDS.

Cacao.

GRAFTED CACAO

A note on the three plots of grafted cacao trees and their yields appeared in the Report for 1915-16. As these are probably the first experiments with grafted cacao, the yields, which have been carefully recorded, are now brought up to date.

The following table gives the results of the observations to June 30, 1919: —

Date of planting.	No. of trees planted.	Last date of picking.	No. of bearing trees.	Total annual yield in pods.	Yield per tree in pods.
Plot No. 1.					
July 1906	14	June 30, 1908	14	12	0·8
„ 1907	14	„ „ 1909	14	237	16·9
		„ „ 1910	28	860	30·7
		„ „ 1911	28	1,382	49·3
		„ „ 1912	28	1,365	48·7
		„ „ 1913	28	1,274	45·5
		„ „ 1914	28	2,360	84·3
		„ „ 1915	28	3,528	126·0
		„ „ 1916	28	2,702	96·5
		„ „ 1917	28	3,308	118·1
		„ „ 1918	28	3,265	116·6
		„ „ 1919	28	3,138	112·0
Plot No. 2.					
July 1907	53	„ „ 1910	35	191	5·4
„ 1908	17	„ „ 1911	52	893	17·1
		„ „ 1912	52	3,466	66·6
		„ „ 1913	52	6,466	124·3
		„ „ 1914	52	7,782	149·6
		„ „ 1915	42	3,579	85·2
		„ „ 1916	42	4,038	96·1
		„ „ 1917	42	4,774	113·6
		„ „ 1918	50	5,053	101·0
		„ „ 1919	50	5,965	119·3

YIELD OF GRAFTED CACAO.

Date of planting.	No. of trees planted.	Last date of picking	No. of bearing trees.	Total annual yield in pods.	Yield per tree in pods.
Plot No. 3.					
July 1910	30	June 30, 1914	30	713	23.7
		" " 1915	30	1,239	41.3
		" " 1916	30	1,763	58.7
		" " 1917	30	2,609	86.9
		" " 1918	30	2,702	90.0
		" " 1919	30	2,857	95.2

The twenty-eight trees in plot No. 1, fourteen of which are of a Criollo variety, and fourteen of a Forastero type, were originally planted amongst orange trees. Under these conditions the maximum crop was reached during 1911. In 1912-13 the yield began to fall off. The orange trees were thinned during 1912, and all were removed during 1913. The two succeeding years showed a considerable increase of crop. During 1916, owing probably to the excessive rains and high winds, there was a falling off in the yield. Since that time some recovery is noticeable.

The Forastero trees in plot No. 2, planted at distances of 12 feet \times 12 feet, were severely attacked by root grubs during 1914, and several trees were killed outright. These were replaced and the number of bearing trees is now fifty. This plot suffered considerably during the hurricanes of 1915 and 1916.

Plot No. 3 consists of thirty trees of a Forastero variety, planted at 20 feet \times 20 feet amongst seedling orange trees. The comparatively low yield of this plot is due to the orange trees. These are being gradually removed.

Plots Nos. 1 and 3 have received an annual dressing of pen manure. Plot No. 2 has not been systematically manured; had this been done, the unfortunate attack of root grubs during 1914 might not have occurred. Planters would do well to remember that any efforts to increase the yield per acre by selecting and grafting good bearing varieties, or rather varieties that are willing to bear if they receive adequate supplies of plant food, must be followed up by sound system of manuring and by good cultural operations. If these are lacking, the trees as in the above instance are likely to overbear themselves, and then being in a weakened state, fall a prey to the attacks of their insect or fungus enemies. The act of selecting and grafting is the first step in the direction of increasing the yield per acre, but it is doubtful if this object will be attained over a series of years, unless intensive methods of cultivation are applied. From now onwards it is intended that plot No. 2 shall receive a liberal application of nitrogen, phosphates and potash each year.

Onion Growing.

The experiments in onion growing have been continued at the Spring Hill estate, and notes on the progress made have been published in the *Agricultural News* from time to time.

These experiments have shown that in Dominica it is desirable to use a considerable proportion of the seed, which is received from Teneriffe about September-October of each

CROP YIELDS IN THE GARDENS.

year, for the production of sets which can be grown and stored and then used for successive monthly plantings from May until about October. Onions grown directly from seed sown in October would mature during the following March and April, and if sets are planted with the rains early in May, these would mature three months later. By successive plantings of sets from May onwards, onions could be reaped from August until the following January.

Now that these points have been made clear, and the suitability demonstrated of certain parts of the Leeward Coast for growing onions, it is hoped that sufficient interest will be taken in this subject to follow up the lead given by Mr Seignoret, and that within a short time sufficient onions will be produced to supply local requirements. As an aid to this end, the Agricultural Department has raised and distributed during the season a large number of sets and seedlings to interested persons.

The question of seed production is also being considered, and the results so far are promising. It was found that while sets planted in May and the following months showed no tendency to seed, a proportion of those planted towards the end of the season, when the sets had passed into their second year, did so. Experiments with this locally produced seed will shortly be made and reported upon. It is probable that seed production in the West Indies is a matter of age of the bulb and season. Once these have been determined it may be possible to raise seed locally, instead of, as now, being entirely dependent on other countries for supplies.

It is hoped that close attention will be given by a few interested persons to this cultivation. In an island which practically depends upon orchard cultivation, the establishment of even a small industry, the crop of which would bring in ready money after about five or six months, is desirable, and would prove very helpful, especially to small growers. There is nothing very difficult to learn about the cultivation: the trouble would be to secure that attention to detail and the carrying out of the work at the right time by persons who for a long time have been used to orchard cultivation, which, generally speaking, is carried on in Dominica in a manner by no means exacting in regard to seasonal requirements and to methods of work.

CROP YIELDS AT THE GARDENS.

The cacao crop for the year ended June 30, 1919, was 74½ cwt., this being an increase of 9 cwt. over the crop of the previous year. The low yields of the past two years are mainly due to the hurricane of 1915 and 1916.

Three bags of Kola nuts of a total weight of 651 lb and three bags of nutmegs of a total weight of 667 lb were also shipped to London. The latter brought in the very considerable sum of £70 14s. 10d.

There were also sold locally 1,070 barrels of ripe limes and 10 barrels of green limes, as well as considerable quantities of mangoes and citrus fruits.

The rainfall for the year ended June 30, 1919, was 55.24 inches, or 23.70 inches below the average fall for the past sixteen years.

