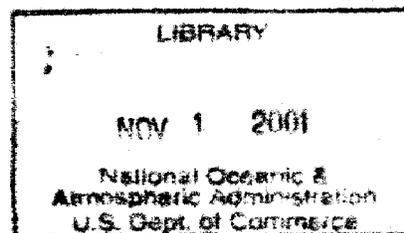


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**IMPERIAL  
DEPARTMENT OF AGRICULTURE  
FOR THE WEST INDIES.**



**REPORT**

ON THE

**AGRICULTURAL DEPARTMENT,**

**DOMINICA,**

**1916-17.**

BARBADOS :

ISSUED BY THE IMPERIAL COMMISSIONER OF AGRICULTURE

FOR THE WEST INDIES.

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## LETTER OF TRANSMITTAL

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

No. D. 1,884.

Barbados,

July 9, 1917.

Sir,

I have the honour to forward herewith the Report on the Agricultural Department, Dominica, for the year ended March 31, 1917.

2. The occurrence of a hurricane on August 28, the second within a period of thirteen months, interrupted the routine work in the Gardens and Experiment Stations. In connexion with this, a section of the report deals with the treatment of storm-damaged lime trees.

3. Owing to the uncertain position in regard to imported food supplies due to war conditions, attention has been given to the value of, and extended production of locally produced food plants.

4. In regard to progress in the chief industries, the results have been satisfactory considering the unfavourable weather conditions.

5. Work in the chemical laboratory has included useful investigations regarding lime juice and the composition and utilization of local foodstuffs and the lime requirements of Dominica soils.

6. Efforts are being made to improve the condition of peasant agriculturists and estate labourers. The suggested establishment of a co-operative lime juice factory is to be encouraged.

7. A new and useful feature in the present report is the section dealing with plant legislation at present in force in the Presidency.

8. At the end of the main body of the Report statements are given regarding the results of the manurial experiments with limes and with cacao. In the case of both crops, the great value of manuring with vegetable mulch and with complete mineral fertilizers is again demonstrated.

9. In connexion with the manurial experiments with cacao, attention should be directed to Mr. Jones's statement that these experiments were in progress two years before the crops from the different plots were first weighed. This fact considerably strengthens the dependability of the results.

10. The training of agricultural pupils continues to be carried on successfully: this form of instruction is now being appreciated by the pupils and their parents so that there is competition for admission when vacancies arise: the services of the trained pupils are also appreciated by their planter employers.

I have, etc.,

(Sgd.) FRANCIS WATTS,

Commissioner of Agriculture,  
for the West Indies.

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STAFF OF THE AGRICULTURAL DEPARTMENT, DOMINICA.

---

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#### ERRATA.

- Page 4, line 2 from bottom, *for Begger read Beggar.*  
" " line 9 from bottom, *for Mucana read Mucuna*  
" 9, foot-note, *for Beecher read Becher.*  
" 31, line 6 from top, *for Nicarguan read Nicaraguan.*  
" 59, line 17, *for aboard read abroad.*

# REPORT ON THE AGRICULTURAL DEPARTMENT, DOMINICA,

For the Year ended March 31, 1917.

## Work in the Gardens and Observations on Plants.

The occurrence of a hurricane on August 28, the second within a period of thirteen months, again interrupted the routine work in the Gardens and Experiment Stations. Consequently a good deal of time has been taken up during the year in repairing the resultant damage.

Fortunately the number of species lost was again small, and with one or two exceptions, these were mostly of common trees which are easy to replace. Generally speaking there is little at present to denote to visitors the ordeal through which the Gardens have passed during recent times.

The damage to the cacao plots in the Gardens and the lime plots at the Experiment Station was much more severe than during 1915. Of the first series of eight manurial plots in the Experiment Station, three—the control, mulch and complete manure plots—were completely destroyed. Two other plots were considerably damaged and three escaped without injury. The young cultivation was uninjured. In consequence of this damage, the plot experiments have been recast and will consist in future of three, possibly four series of five plots each, instead of two series of eight plots.

In January 1904, Sir Daniel Morris, then Imperial Commissioner of Agriculture, forwarded to Dominica seeds of three trees of Rhodesia, under their native names. One of these failed to grow. The two others thrived, and having recently reached the flowering stage, herbarium specimens were forwarded to Kew Gardens for identification. They were reported to be *Pel.ophorum africanum*, Lindl., and *Terminalia sericea*, Bunch. The first named is a fine flowering tree. Both are slow growers under the climatic conditions of Dominica.

Reference was also made to Kew in regard to the native trees known respectively as 'Bois Blanc' and 'Simaruba'. The first named is common everywhere in the wet districts, while Simaruba is a comparatively rare tree. It has now been decided that the botanical name for Bois Blanc is *Simaruba amara*, Aubl. It was not possible to send on flowers of the Simaruba, but the Kew authorities report that as far as can be made out from the leaves, the species is probably *Picroena excelsa*, Lindl., a tree not hitherto recorded in Dominica, though it is fairly common in Jamaica, in which place it is known as the Bitter Wood tree. The bitter cups in use in Dominica are made from the wood of the Simaruba.

## PLANTS IN THE GARDENS.

Specimens of a native rough-barked tree fairly common on coast lands and known locally as 'Tendre à caillou' were also sent to Kew for determination. This proved to be *Piptadenia peregrina*, Benth.

From time to time there has been a good deal of reference in agricultural reports to *Pimenta acris*, Wight et Arn., the Bay Oil tree known in Dominica as 'Bois d'Inde', and the two varieties known respectively as Bois d'Inde anise and Bois d'Inde citronelle. The two varieties are useless for making Bay oil. Consequently the frequent appearance of leaves of these varieties amongst produce sold as Bois d'Inde leaves, is a matter of some concern to the distillers of Bay oil.

About fifteen years ago plants of what purported to be the three varieties were placed out in the Botanic Gardens. During the year under review herbarium specimens of the leaves and flowers of each were forwarded to Kew, but unfortunately, none of the trees bore fruit, so further investigation is suspended for a time.

The opinion is held by many that the trees are identical in appearance, and that the only means of determining the varieties is by sense of smell. This view is not supported by observations on the trees in the Botanic Gardens. The Bois d'Inde citronelle is possessed of a lax growing habit, which is quite distinct from the compact erect habit of Bois d'Inde anise. The appearance of Bois d'Inde approximates that of Bois d'Inde anise, but is less compact. The cymes of Bois d'Inde citronelle are larger than those of Bois d'Inde anise and several times larger than those produced by the Bois d'Inde.

It would be interesting if accurate observations were made on these points in all the islands in which *Pimenta acris* is native, and in which Bay oil is manufactured, with a view of clearing up these long-standing questions.

Reference was made in the Progress Report for 1915-16 of the receipt of herbarium specimens of eight forest trees of Dominica from Mr. W. C. Fishlock, of the Dominica Forest Company.

Six of these proved to be known botanically and appear in the published list of Dominica trees. The two undetermined trees were the Carapite and Bois Cotlette. The botanical name for the former is now given at Kew as *Amanoa caribaea*, Krug. et Urban, and that for Bois Cotlette, *Tappara latifolia*, Benth. The last named is another example of the confusion created by local names. The Bois Cotlette of the south district of Dominica is *Citharexylum quathangulare*, Jacq. It would appear, however, that another tree is also known by this name in the northern part of the island.

The following are amongst the interesting plants added to the collection during the year:—

Anacardium excelsum	Erythrina arborescens
Araucaria brasiliiana	Premna odorata
Azelia Caunzensis	Putranjiva Roxburghii
Brachychiton acerifolium	Parkia filicoidea
Chloroxylon Swistenia	Quebrachia Lorentzii
Cupressus glabra	Raphia longifolia.

## Work in the Nurseries and Distribution of Plants.

The nursery work was maintained on the usual scale, but the sales of plants were lower than for many years past.

Several causes have contributed to bring this about. The occurrence of hurricanes, a growing shortage of labour, and the absence of a number of estate proprietors have all operated to arrest development work.

## DISTRIBUTION OF PLANTS.

Field work on estates during the year has largely been in the direction of filling vacancies caused by wind and floods, and in dealing with storm-damaged trees. Circumstances have not allowed of any considerable increase of new cultivation.

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

Limes	...	...	...	48,847
Budded Washington Navel oranges	...	...	...	57
.. grape fruit	...	...	...	438
.. lemons	...	...	...	24
.. limes	...	...	...	175
.. tangerines	...	...	...	16
Grafted mangoes	...	...	...	16
Cacao	...	...	...	762
Coffee	...	...	...	1,000
Shade trees	...	...	...	2,030
Miscellaneous	...	...	...	275
			Total	53,640

The following quantities of seeds were sold :—

Vegetable	...	...	...	1,392 pkts.
-----------	-----	-----	-----	-------------

Considerable quantities of seeds of the useful green dressings, *Tephrosia candida* and *Canavalia ensiformis* were distributed to planters free of charge.

In order to assist peasant proprietors after the hurricane, His Honour the Administrator made arrangements to import a large number of cane tops.

In response to a published notice, applications for upwards of three quarters of a million plants were received.

At the end of the year about 200,000 cane tops had been landed and distributed.

These plants were received free of cost and transport charges owing to the generous action of the planters of Guadeloupe and Martinique.

## PLANT IMPORTATIONS.

Attempts to import plants of economic interest have been singularly unfortunate during the year. Seeds of the Longan (*Nephelium Longanum*) and the Rambutan (*N. lappaceum*), obtained from Ceylon, failed to germinate, as also did seeds of *Bassia longifolia*, from India. Proclamations in force against plant importations from certain countries have also prevented for the present the introduction of a number of interesting species.

Seeds of the Quebracho (*Quebrachia Lorentzii*) were received from the Director of the Royal Botanic Gardens, Kew, and a number of plants raised. This is a large forest tree, native of the Argentine, which furnishes a hard and durable timber, which in turn yields a valuable extract used for tanning.

The plants of the Jaboticaba (*Myrciaria cauliflora*), a fruit tree of Brazil, and of *Pouteria suavis*, a fruit tree of Uruguay, mentioned in the last progress report as being newly introduced, continue in a promising condition. A few of the latter were distributed to planters for trial.

A new batch of plants of the Brazil Nut (*Bertholetia excelsa*) were raised and specimens placed out. No success has attended the efforts to establish this tree in

## PLOT EXPERIMENTS.

the past. The seedlings now under trial are more promising in appearance than any of their predecessors.

Plants of *Aleurites Fordii*, the Tung Oil tree of China, raised from seeds received in July 1912, have not made much progress, the tallest being only 7 feet in height. A further supply of seeds was received during the year, and plants raised. Of these a few have been placed out for further trials. To the present it does not appear that this species will find a congenial climate in this island.

During September, twenty-five seeds of the Shea Butter tree (*Butyrospermum Parkii*) were received from the Agricultural Department, Northern Nigeria. None germinated, but their receipt was interesting as the seeds proved to be considerably larger than those borne by the tree already established in this island. In Nigeria the tree thrives in a very dry climate; in Dominica the single specimen is grown where the rainfall averages 80 inches per annum. The Dominica tree is however regarded by several persons who have experience of this species in Nigeria, as being a remarkably healthy specimen.

Reference has been made in past reports to the low rate of germination of the seeds produced in Dominica. This was thought to be due to certain birds which, being very fond of the fruit, attack it, causing the seed to drop prematurely. To settle this matter a number of fruits were enclosed in bags and allowed to ripen on the tree. In this particular instance the seeds picked up from the ground gave a better percentage of germination than those ripened in bags. During the past season nearly all the seed produced, grew. This improvement in germination is probably due to the increasing age of the tree.

The seedlings are very slow in growth, and unless carefully handled either in potting or planting in the field, are apt to die back; but they invariably break again from below the ground. Healthy young plants in the Experiment Station, now three years old, range from 12 inches to 18 inches in height, a rate of growth which accords with that of seedlings in Nigeria. Under natural conditions in the latter country this tree propagates itself largely by root suckers, which are stated to make a vigorous growth from the outset.

## Plot Experiments at the Botanic and Experiment Stations.

### GREEN DRESSING TRIALS.

In last year's progress report a list was given of sixteen species of green-dressing plants which have been experimented with in Dominica during the last ten years. During the present year seeds of the following new species were received through the Commissioner of Agriculture from Dr. Cramer of Buitenzorg:—

Mucana sp.  
*Indigofera Sumatrana*  
 " *longeracemosa*  
*Crotalaria Muysii*  
 " *incana*  
*Clitoria cajanifolia*

Mr. Andrew Green, whilst on a visit to Porto Rico, obtained seeds of the so-called Begger Weed which is much used as a green dressing in that country, and presented a quantity to the Gardens for trial.

## STORM-DAMAGED LIME TREES.

The seeds were all sown in carefully prepared nursery beds on July 11, 1916.

One seed of the *Mucuna* species germinated and developed into a strong vine, typical of the members of this genus. For the production of bulk of green material and to cover the ground rapidly this type of green dressing is excellent. In orchard cultivation however, care would have to be taken that this rank growth is not allowed to cover up the trees.

*Indigofera Sumatrana* and *I. longerracemosa*, like the common indigo, are upright-growing plants, and in three months attain a height of about 3 feet. *I. Sumatrana* is the taller of the two. *I. longerracemosa* has a more branching habit of growth and a thicker head. As a cover crop the latter is distinctly preferable. In March 1917 *Indigofera Sumatrana* was about 4 feet high, and both species were still green.

*Crotalaria incana* flowered in September when about two months old, when it had reached a height of just over 3 feet. The growth is thick and covers the ground satisfactorily. It eventually reached a height of 5 feet, and in March 1917 was starting to decline.

*Crotalaria Muysii* grew rather taller and did not flower for a month after *Crotalaria incana*. The growth was not quite so dense as the latter. It was 6 feet high in March 1917, and showed no signs of dying.

None of the seeds of *Clitoria cajanifolia* germinated.

The Beggar Weed (*Desmodium tortuosum*) germinated evenly and by the end of August was about 3 feet high and had commenced to flower. It did not grow much taller than this but continued flowering and producing seeds up to March, when it had dropped most of its leaves.

These experiments and those conducted in previous years show that there is no dearth of plants suitable for green dressing purposes, and though there is no general demand for seeds, it is satisfactory to note that during the year considerable quantities of seeds of green dressings were applied for and supplied to some half-dozen planters in various parts of the island. We cannot too often insist on the good results which are likely to follow the universal growing of leguminous green dressings in cultivations in Dominica.

In many instances after fields have been hoed the additional cost of preparing the land for the reception of a green dressing crop would not be great. Where labour is not available for planting whole fields, a system which has given good results with young cultivation in the Lime Experiment Station attached to this Department consists in the cleaning up of a circle about 10 feet in diameter around the young plants, and planting this area thickly in green dressings, such as horse beans.

Seeds of several varieties of green dressings are available for distribution at the Botanic Gardens in season.

## Notes on Economic Plants.

### TREATMENT OF STORM-DAMAGED LIME TREES.

There is no subject of greater importance to lime planters than the treatment of storm-damaged lime trees. Sooner or later every planter is faced with this problem, and it may be correctly stated that during the quarter of a century in which lime cultivation has been the major industry of the island, no definite or general plan of action has been evolved for dealing with what is the most serious situation which the lime planter is called upon to meet.

## STORM-DAMAGED LIME TREES.

Before discussing the various methods advocated and in some cases adopted for dealing with this situation, it is desirable to consider what may be called the storm conditions of Dominica during the period in which lime cultivation has been the premier industry.

On the collapse of the sugar industry, planters, following the example of a few successful pioneers began to take up the cultivation of limes on a considerable scale during the late eighties and early nineties of the past century. These efforts had by the middle nineties resulted in a considerable area being placed under bearing lime cultivation. The weather conditions during that period were bad. From 1893 to 1899 though no hurricanes occurred, scarcely a year passed without storms of sufficient violence being experienced to blow over large numbers of bearing trees, which caused serious concern to those investing their capital in this cultivation.

From 1899 to 1902 there was a short respite, but in 1903 a severe storm struck the south end of the island. Reports received showed that several thousands of trees had been blown over. From 1903 to 1914 the weather conditions, from this point of view, were perfect. For eleven years the minds of planters were undisturbed by storms, and the much discussed question of the best way of treating storm-damaged trees was almost forgotten. The hurricane of August 10, 1915, followed by that of August 29, 1916, with the considerable resultant damage again brought this matter into prominence.

The lime industry of the nineties of the past century was on a small scale when compared with the present, but the problems were the same. Then, as now, there was a diversity of opinion as to the best means of dealing with fallen trees. Broadly speaking, there exist two main schools of opinion, one favouring the propping of trees in an upright position without delay, and the other believing that renewal of the top by means of suckers from the base of the fallen trunk is the sounder course to follow. Both methods may be modified in practice, according to the views of individual planters. Twenty years ago the majority of planters held the former view; only a few favoured the latter.

The methods practised in dealing with fallen trees may be described as follows:—

- No. 1. Propping the trees back in original position.
2. Removing the upper branches and propping the trees (a modification of No. 1).
3. Stumping the trees (now only practised on a small scale).
4. Renewal of top by means of suckers from the base of the trunk.

Before discussing the various ways of dealing with damaged trees, it may be pointed out that in the case of storms, the average percentage of deaths caused by the trees being blown over is remarkably low, probably not amounting, on the average, to more than 2 or 3 per cent., the loss naturally being higher on the dry coast lands and lowest in the wet forest districts, greatest amongst old cultivations and lowest amongst young cultivations.

With regard to the first method, it may be stated that it is invariably practised by young planters and others with little experience of this form of injury to plantations. It is considered the natural way of dealing with the situation. The dominant idea is to get the trees upright in order that the plantation may look much the same as before. The feeling exists that it is inherently wrong to attempt to follow any other course. On enquiry as to whether the soundest method is being followed, the answer is usually made that in countries with a temperate climate, orchard trees blown over would, unless of a very large size, be at once propped back in an upright position. It does not appear to have been considered that a method of dealing with deciduous plants in a northern climate, however successful, may not be a right one to apply in the case of evergreen bushes

## STORM-DAMAGED LIME TREES.

in the tropics. It is also important to add that nothing like a wholesale over-throwing, such as occurs on lime plantations in Dominica, can happen in orchard-temperate climates.

There would be little to be said against propping upright if planters could see into the future and assure themselves that the repetition of storms would not occur for at least three or four years. Under such conditions it could reasonably be expected that the trees would again attain a firm root hold in the soil and be capable of better holding their own against the violence of future storms. But it is clear that a period of one year is not long enough for the attainment of a good root hold. We may take the case of the hurricanes of August 1915 and August 1916. Many trees blown down on the first occasion were placed upright. In August 1916 all were blown down again. The position was then worse than in 1915. The year had been completely lost in so far as the restoration of the plantation and the planters' interests were concerned. Should the trees again be placed upright a similar disaster may be experienced in 1917 or 1918, for although it is hoped no hurricane will be experienced in Dominica for a long time, there may occur storms of sufficient violence accompanied by heavy rains (which reduce the holding power of the roots), to overturn lime trees, and especially those that have already suffered in this respect.

In connexion with this propping method it is only fair to state that there have been times when the supporters of the method would point to some measure of success. Such a time occurred in 1903. Trees propped on that occasion and carefully looked after proved successful because no storms were experienced for many years after. If hurricanes and storms only occurred occasionally and were always followed by long intervals of good weather, there would be something to be said in favour of this practice. Trees placed upright with care, moulded around when necessary with earth, and strengthened by an application of manure, continue to bear crops much as usual. There is no other way of restoring the plantation without a partial, and in some cases, a total loss of crop for two, perhaps in some instances, three years.

Whenever this treatment is followed it is very necessary that sound judgment should be exercised. In some cases the displacement of the roots is so considerable that no hope can be entertained of recovery. Such trees should be cut up for cordwood, or for providing props, and supplies put in their places. Propping upright should only be carried out when the condition of the roots justify the work. Herein very sound judgment is required.

When planters decide upon following this method, it is important to have the work done early. Should a considerable time elapse between the date of the storm and the propping operations, the roots tend to become 'set' in their new positions, and on raising, the plants receive another severe shock. To secure the best results the work should be carried out quickly, and while the soil is in a moist condition.

Whatever line of treatment is followed, it results in considerable expense to the planter. It is probable that the system of placing the trees upright is the most expensive of all, and yields the poorest results. A considerable amount of labour, under good supervision, is required to pull large numbers of trees upright, to carry out the subsidiary but necessary operations of trimming such roots as are displaced from the soil, and in mounding the base of the trunk with earth and pressing it firm. In order to keep the trees upright, large quantities of props have to be cut for this purpose from the nearest woodland. None of the props last long, and many decay in two or three months. Constant supervision and replacement are required. Failure to attend to these matters results in the undoing of the initial and expensive stages of this work.

The second method, that of removing the top, is being tried on a small scale for the first time. The removal of the upper branches makes it a much easier matter to raise and to support the trees, but it results in a loss of crop for a couple of years. In the case of old healthy specimens, that is, those not infected with the bracket-shaped fungus which is now becoming so common and hurtful on old

## STORM-DAMAGED LIME TREES.

plantations, this course will furnish a new and vigorous top in place of a worn-out one, a proceeding which tends to rejuvenate the trees, to increase their productivity, and in the long run, if weather conditions allow, recoup the planters for the period during which the crop was lost.

While trees treated in this way are not so likely to be blown over by storms during the following year owing to their smaller tops, still it is evident, as the tops increase in size, that success is largely dependent upon the weather conditions during the two or three years following. If these are bad, the majority are likely to be blown over again with the inevitable loss of time and effort. Like No. 1 method, succeeding good weather for a few years is likely to bring a fair measure of success, succeeding bad weather a large percentage of failures.

It is hoped, however, that this method will be given a fair trial and the results carefully noted. Now that so many thousands of trees are storm-damaged, the present would appear to be essentially a time for experiment with a view of eliminating faulty measures, and of bringing about a common line of treatment in the future.

The third method, that of stumping, is too severe a measure to be recommended, but there are occasions when it is necessary to apply it.

Stumping consists of cutting back all the branches to within 2 or 3 feet of the ground. If this is done soon after the trees have fallen, the stumps after being relieved of the weight of the branches, naturally go back to a perpendicular position. All that then remains to be done is to top dress the loosened area with earth, and press the soil firmly around the base of the trunk.

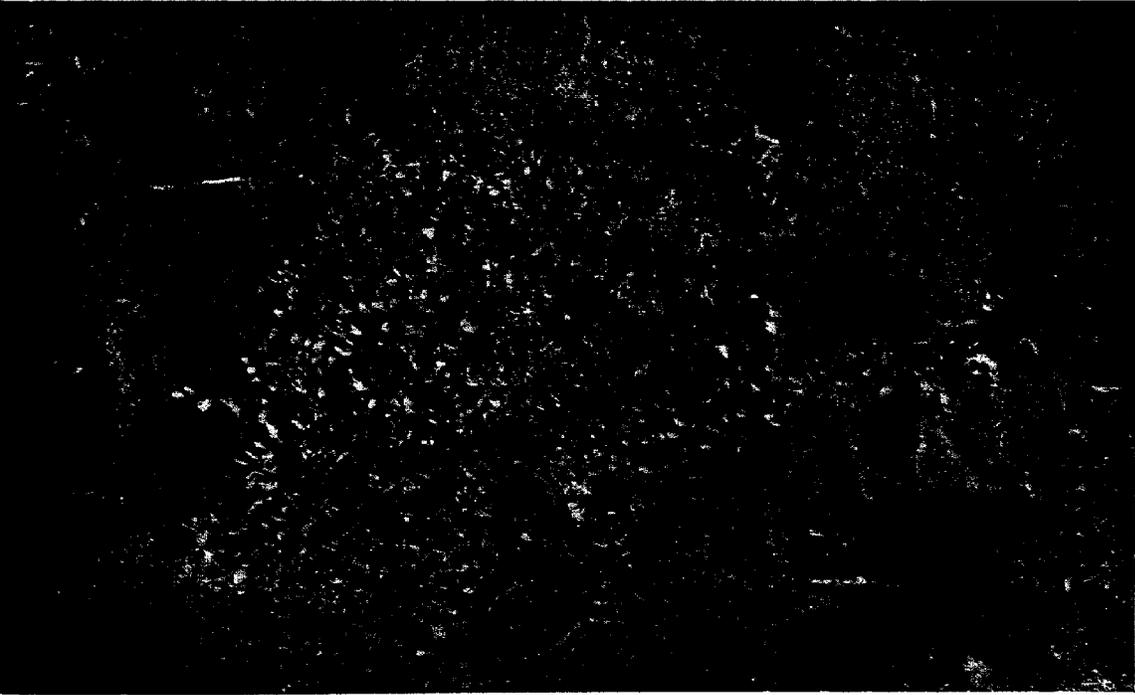
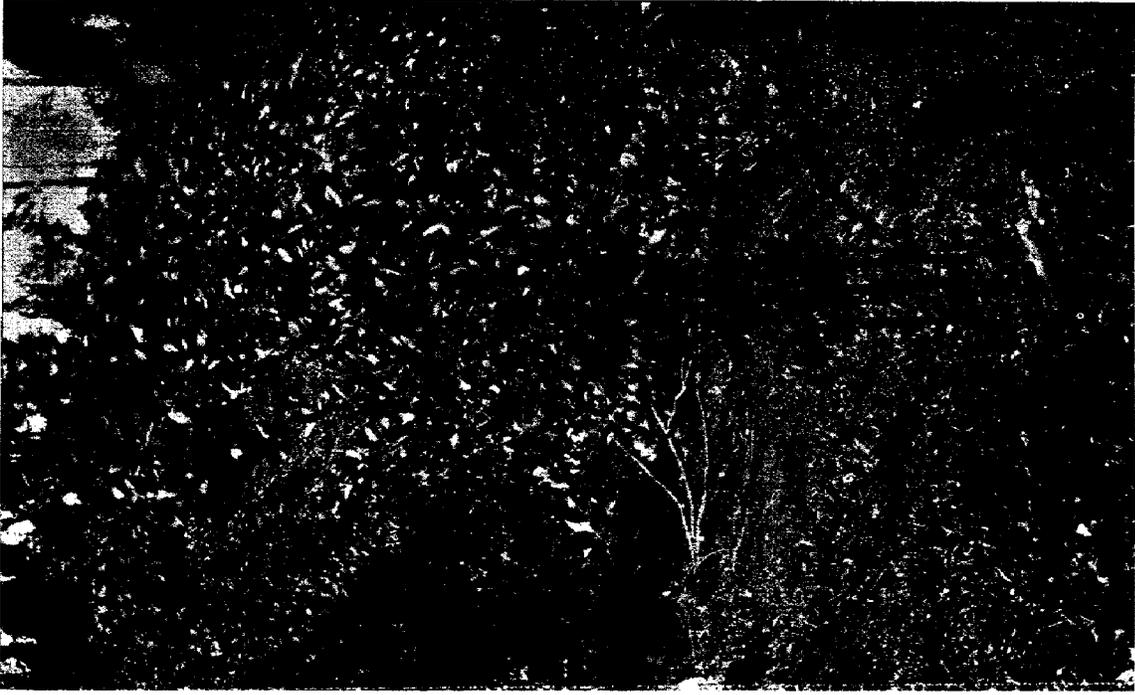
In some cases, and especially when the trees have lain on the ground for a considerable time before cutting the branches, the stumps will still continue to lean over after being relieved of the weight of the branches. It remains to be found out by experiment whether in cases of this kind, the trunks should be allowed to remain leaning or whether they should be brought back to an upright position. Local experience favours renewal from stumps lying at an angle, as such are seldom again affected by storms, that is, as far as the roots are concerned. The tops may be broken by the force of the wind, but the roots generally remain firm. This is a point of great importance. Trees grown from stumps placed upright are regarded as being just as liable to overturning as the original seedlings.

In the case of young and vigorous trees, a growth of suckers will follow this operation, but the older the individuals, generally speaking, the less vigorous the growth. A large proportion of old trees and those infected with the bracket-shaped fungus are likely to die under the shock. Owing to weak growth made by old stumps, and the poor results obtained, it would be better to attempt other methods of restoring the plantation.

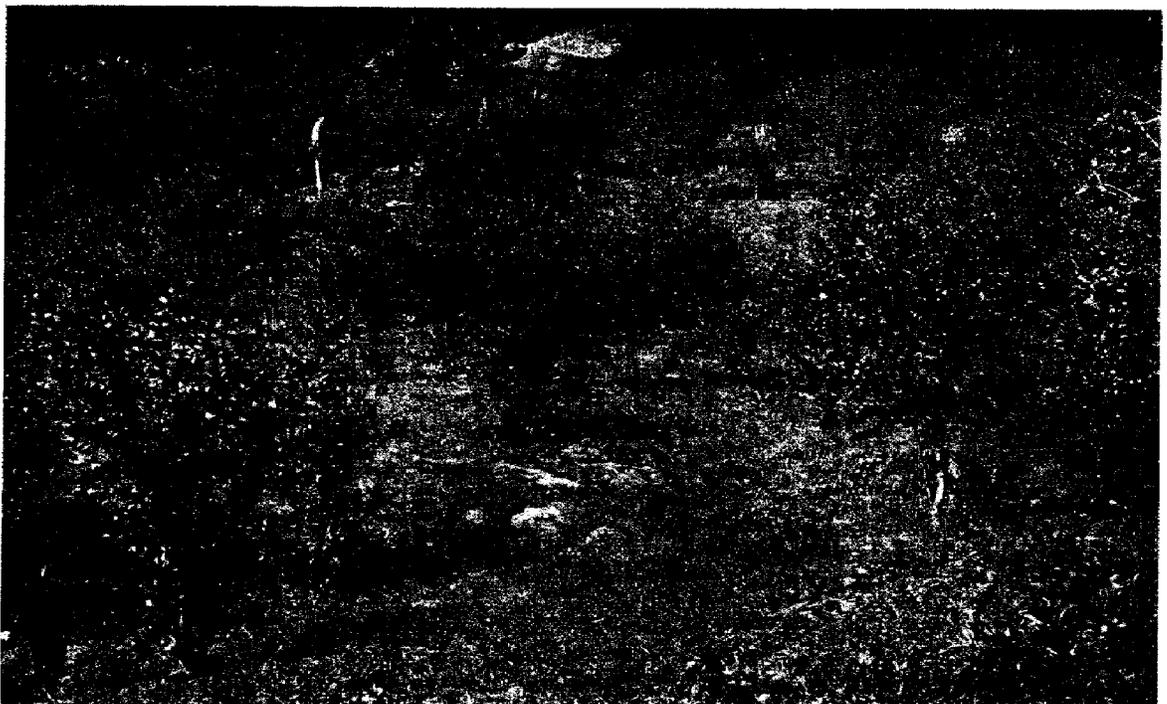
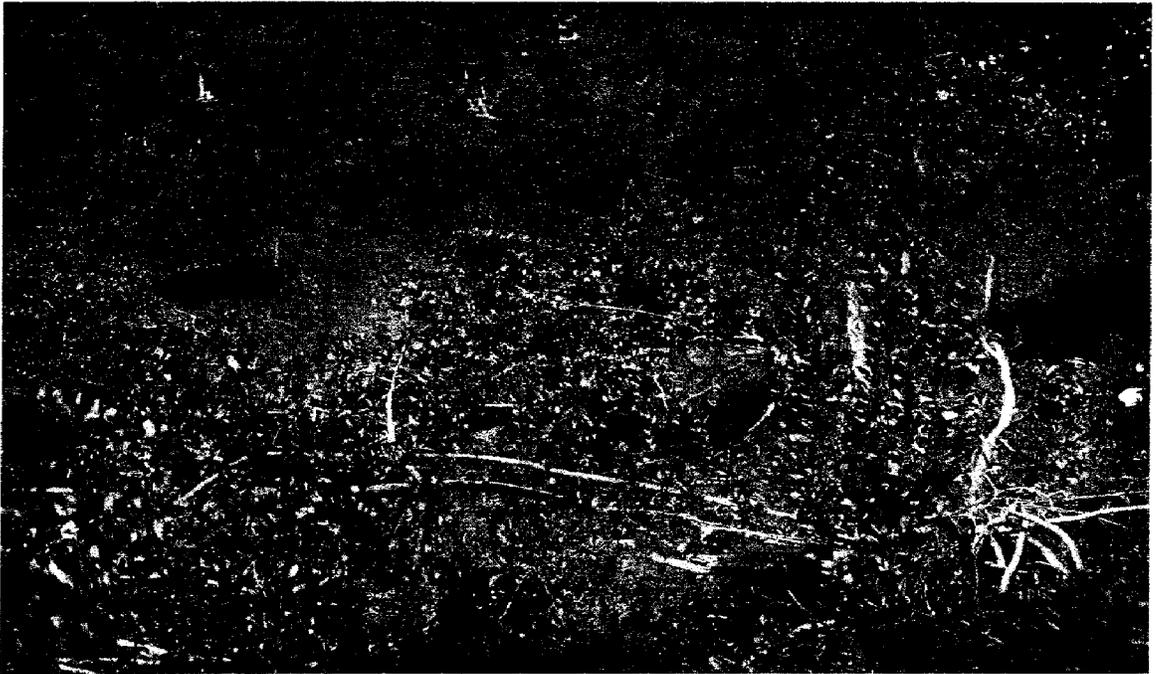
The application of this drastic measure may be justifiable in the case of entire fields being overthrown. When this happens the planter is faced with a tangled mass of armed vegetation which cannot be entered either for the purpose of collecting such fruit as may be on the ground or left on the branches, and to which nothing can be done in the way of weeding and cultivating. Left for a few weeks the trees would be entirely covered with climbing weeds. Probably the best, quickest, and cheapest way of dealing with such a situation is by stumping alternate rows, in order to allow sufficient working room for the application to the remaining rows of the course of treatment, other than stumping, most in favour with the individual planter.

The fourth method, that of renewing by suckers from the base of the trunk is now becoming more generally adopted.

The procedure is as follows. In nearly all cases the branches are resting on the ground. It is necessary to cut away these lower branches, generally sacrificing about one-third to one-half of the top, in order to give a clear space between the



PHOTOGRAPH- ILLUSTRATING THE RENEWAL OF STORM-DAMAGED LIME TREES BY SUCKERS.



PHOTOGRAPHS ILLUSTRATING THE RENEWAL OF STORM-DAMAGED LIME TREES BY SUCKERS.

## STORM-DAMAGED LIME TREES.

ground and those which remain. This is done in order to keep the ground free of weeds and to allow such fruit as is on the tree or is borne while the top remains to be picked up when ripe. Short props, usually furnished by the branches which are lopped off, are necessary to support the top and to prevent its being rocked about by the wind. Such roots as project from the soil should then be cut away and sufficient earth thrown around the trunk to fill in the depression caused by uprooting. The soil should then be firmly pressed with the feet. These operations assist in keeping the tree firmly in position, and provide good facilities for making fresh roots.

In the case of healthy trees suckers will be produced in abundance in a few weeks. In the course of a year or fifteen months these will be sufficiently advanced to allow of the remaining portion of the original top to be cut away. The chief object in retaining the old branches has been to keep the vital processes going without a check—a proceeding which greatly assists the development of the young suckers.

Old lime trees and those attacked by fungoid diseases when treated in the above manner will often fail to produce suckers. Such are better destroyed and supplies put in their places. Occasionally young specimens may fail to produce suckers where they are required, that is, at the base of the trunk. To induce suckering a narrow slit of bark may be taken out half-way around the trunk at about a foot from the ground, which should have the effect of causing the dormant buds to develop.

In some cases it is probable that the sudden exposure of the trunk to the rays of the sun from which it has more or less been shaded for many years has the effect of hardening the bark and preventing the development of growth. When this occurs, a light shading of the trunk and the removal of a thin piece of bark should have the desired effect.

The chief advantage claimed for this method is that the majority of the trees are not again likely to be uprooted by the wind. Trees blown over many years ago and treated in this way have since held firm. Renewal by these means also gives a new and vigorous top which possesses, under good treatment, greater productive power than the old branches.

The accompanying photographs \* show a single specimen and also a field of trees restored by suckers after the hurricane of August 1915. The old tops were cut away nine months later. On the occasion of the second hurricane in August 1916, the new growths then 6 feet to 8 feet high were uninjured. This field is expected to yield a small crop of fruit by the end of 1917. The photographs were taken in January 1917, or seventeen months after the date on which the damage was caused.

In the photograph showing the single specimen renewed by suckers, it will be observed that the overturned trunk lies near to the surface of the ground. Experiments are needed to find out whether if the earth were banked up to the trunk roots would be formed, and the tree given a greater hold on the soil. It is probable that in wet districts roots would be freely emitted, a proceeding which would benefit and further secure the tree in the ground. Planters interested might make experiments in this direction.

It will be seen that in the short period of seventeen months great progress has been made in restoring the plantation by means of suckers. Under such conditions the planter has every reason for confidence in the future. Contrast this with those estates on which the trees have been propped upright. In the latter case the planter has fields of trees weakened by being overturned twice, in some instances, three times in eighteen months, for it is reported that the boisterous weather experienced early in January 1917, again brought down large numbers that had been set upright in August 1915, and August 1916. And it should be understood that the percentage of deaths though low in the first instance, rises rapidly in the

\* Photographs taken at Sherwood Estate, the property of Major Beecher.

SOUR ORANGE STOCK FOR LIMES.

case of successive overturnings. Consequently the position is now worse than on the occurrence of the first hurricane. Time has been lost and money spent to little purpose, owing to insistence on a course of action which past experience has shown yields but meagre results, and those only under special circumstances of weather which may only recur at very long intervals.

From careful observation of field experiments in treating storm-damaged trees, it is apparent that the method of renewal by suckers gives the best results. The planter who adopts this course is undoubtedly taking the long view of the situation and insuring, as far as possible, against adverse weather conditions of the future.

In dealing with injuries caused by the wind, efforts should be made to give the disturbed root system that early attention which is essential to bring about the sound conditions necessary to effect early recovery. The recommendations made in the above notes on this point should be carefully followed. Hitherto but little attention has been paid to this important matter. Failure to do so has caused the loss of many trees and unduly prolonged the recovery of others.

Whatever method of restoring the plantation is followed involves the pruning of roots and branches. In this connexion it is of the utmost importance to take steps to prevent the entry of fungi, which are now becoming so common in plantations. The cuts should be carefully made, then quickly dressed with Bordeaux mixture or other fungicide, and later covered with a dressing of tar. The great increase of late of bracket fungi in lime fields is disquieting. It is hoped that this matter will be fully investigated and experiments initiated with a view of finding if the fungi can be controlled by applying fungicides to the base of the trunk and to the lower branches, in which places infection usually occurs.

Following a common custom the lime has been referred to in the above notes as a tree. In habit and appearance however, the lime partakes more of the characteristics of a bush. Once this view is accepted, the method of renewing damaged specimens by means of suckers is easier to comprehend, and the deep-seated objection held by many against renewing trees by these means tends to disappear. A course which is regarded as utterly wrong in treating trees becomes acceptable and feasible in cases in which bushes are concerned.

**THE SOUR ORANGE AS A STOCK FOR LIMES.**

That several kinds of orange trees are much more firmly rooted in the ground than lime trees has long ago been noticed. Regarding the Sweet Orange, Dr. Nicholls, C.M.G., observed this after the hurricane of 1883 and mentions the fact in his work on 'Tropical Agriculture'.

Observations made during recent years in regard to the Sour Orange all tend to show the great root-holding power which this tree possesses. To this desirable quality may be added immunity from the root diseases now known to attack the lime. Knowledge of these facts led to experiments being made of its use as a stock for the common lime, which latter is now so largely grown in Dominica, and which suffers so severely by uprooting during the prevalence of stormy weather.

To show what can happen in lime fields in the case of a hurricane, the following passage is quoted from a report by the Assistant Curator after a visit to a lime estate in September last: 'There were practically no leaves on the lime trees when I saw them; they had been blown off, and the only trees that could be seen standing in one field of 25 acres were two orange trees, and they were stripped of their leaves'.

The above clearly indicates the need of a stock on which to grow the lime in order to overcome, if possible, the wholesale overturning of trees which now goes on.

### SOUR ORANGE STOCK FOR LIMES.

With a view of experimenting in this direction, the budding of limes on Sour Orange stocks was undertaken some years ago. There are now over 2 acres of budded limes at the Experiment Station,  $1\frac{1}{2}$  of which is upon the Sour Orange,  $\frac{1}{2}$  on Citron and  $\frac{1}{4}$  on the M'gergeb stock. Half an acre of plants on the Sour Orange are now approaching the fourth year from planting, and information on certain points such as rate of growth and bearing capabilities may soon be forthcoming. In addition to the stocks named above it is intended to make trials with the grape fruit seedling, which is a very hardy tree in Dominica.

It would however be premature to assume that because the Sour Orange is able to resist hurricanes, the same power will be retained when the lime is worked upon it. A well-grown lime tree has a top of much greater dimensions than the Sour Orange. Whether the Sour Orange stock with a large lime top in full bearing will be able to stand against the force of the wind remains to be proven. Nor must too much be expected in regard to the present immunity of the sour stock from root diseases. Once planted extensively, the two species of *Rosellinia* now so inimical to the roots of the lime may in time attack the Sour Orange stock.

Consideration must also be given to the fact that considerable areas of limes are fairly successfully grown on shallow soils overlying sheet rock. On such land the Sour Orange stocks would be of no use, though the Citron and M'gergeb stocks might prove of some value under these conditions. For the Sour Orange to be of value as a stock presupposes a good depth of soil, and a permeable subsoil through which the taproot may penetrate.

Apart from the budded plants in Experiment Stations about 400 have been sold to planters for trial, the bulk of which have gone to estates in the wet districts. In a few years reliable information should be forthcoming of the behaviour of the plants under varying conditions of soil and climate.

While it is desirable to carry on these experiments, the time is not yet, as some think, that the work of raising seedling plants should be given up at the Government nurseries and attention entirely devoted to raising budded limes. Even if this were done, it is doubtful, under present conditions, if 2,000 budded lime plants could be produced yearly against a present average annual distribution of 60,000 seedlings. That is to say, the equivalent as regards work of 60,000 seedlings is 2,000 budded plants or thereabouts and in the latter instance highly skilled labour is required. Unless it can be assured that planters will raise their own seedlings—and many try to do so and fail—it would appear to be economically unsound to take steps that would result in the planting of 20 acres of budded limes yearly, however considerable the advantages of this class of plants may be, in the place of 250 to 300 acres which under normal conditions are annually planted in seedling limes purchased at the Government nurseries.

In this connexion it should be borne in mind that not only is the production of budded limes very difficult, very great skill in budding being required to achieve success, but the expense, that is, at least 1s. per plant, or £5 per acre if the plants are spaced at 20 feet apart, is such that very few planters would be prepared to meet. For the present it would appear best to continue the experiments in which interested planters are joining, in order to extend the trials with a view of finding out whether the advantages claimed for budded lime plants over seedling lime plants are real and tangible in practice.

### GARDEN OR PROVISION CROPS.

Owing to the uncertain position in regard to imported food supplies due to war conditions, some concern has been expressed as to whether there is a sufficient area under garden crops in the island in the event of a shortage of imported foods.

With the exception of Roseau with its considerable population, the country districts of Dominica are self-dependent to a remarkable degree, and although the

## GARDEN OR PROVISION CROPS.

cessation of imported foodstuffs even for a short time would cause inconvenience, there is no community in the West Indian islands who are quite in so fortunate a position in regard to local foods as the people of Dominica.

In regard to Roseau, the question is not so much one of a supply of local vegetables, but rather the need of a cheap and easy method of transport. A good many gardens exist in the valleys near to the chief town, the produce of which finds a ready market, and considerable supplies are boated in from along the Leeward coast. On the Windward coast very large quantities of garden crops are grown, but here the peasant grows principally for himself and not to any extent for sale. Given a surplus, and the state of the sea permitting, a trip may be made to Roseau, but regular supplies cannot be expected from Windward owing to shipping difficulties. In the event of rough seas this source of supply is at once cut off.

It is clear that the Roseau market must always be principally supplied from the Leeward lands, and it is here that organization of transport is required on the lines found successful in neighbouring islands to the south. Owing to present conditions, planters in the vicinity of Roseau have given and rented out lands for gardens on a larger scale than formerly, with the result that more plots are being worked than at any previous time. But this is only temporary. At one time every working man had his garden. To-day the inclination is to depend more and more on wages earned, and to become solely a purchaser instead of, as formerly, being both a wage earner and a producer of garden crops. Therefore it is evident that the growing population of the capital town will have to look further afield for supplies. These may be secured in the numerous valleys along the western side of the island. For such development it would be necessary to build jetties at each of the principal villages, and to employ a steamer 80 to 100 feet long to ply daily along the coast, to go alongside all jetties in order to save the peasant the present high charges of boatage. It is only by organization on these lines that the people of Roseau can in the future be adequately supplied with vegetables at all seasons of the year.

The vegetable most popular with the peasantry is the Dasheen (*Colocasia antiquorum*, var. *esculenta*). There are several varieties, of which the most widely grown is one with streaks and blotches of red on the dark-green leaves. This is the Taro of the Fijians. The dasheen was introduced from Martinique about thirty years ago. Being a semi-aquatic plant, it has found a congenial home along the banks of streams in the damp valleys of Dominica. The acreage planted with this root crop is very large. Under Dominica conditions it is easy to grow, and certain to yield a large crop eight or nine months after planting.

Closely allied to the above is the eddoe, a plant which also grows in very damp places; the leaves are generally larger than those of the dasheen, and of a light-green colour. The root-stock is not so well liked as that of the dasheen, owing to its soft and watery nature. It is customary to lift the eddoe and allow it to dry in a warm place for several days before using. The peasants as a rule prefer vegetables which are hard. Thus a hard dasheen and tania are considered superior to those varieties which are soft after boiling.

Another largely grown crop is the tania. Of this excellent vegetable there are many varieties. It belongs to the genus *Xanthosoma*, and is readily distinguished by the leaf-stalk joining the leaf-blade at the base and not, as in the case of the dasheens and eddoes, near the middle of the blade. There is a good deal of confusion in respect to these two plants, and even text-books on agriculture sometimes show under the name of tania, what is really a good example of a dasheen plant. The food value of the tania is higher than that of the dasheen.

In Dominica the edible portion of the dasheen and eddoe is the root-stock, the small tubers which form around the root-stock being used for propagation. In the case of tanias, the tubers are used as food, and the root-stock for planting. This is the general rule, but there are one or two exceptions. In the case of the dasheen, tubers of a large size may occasionally be eaten, and there are two or three varieties of the tania in which the root-stock is appreciated. By a system of successive plantings crops of all the above may be reaped all the year round.

The several species of *Dioscoreas* which are grown on a considerable scale yield the excellent and highly prized tubers known as yams. It is to be regretted that since the advent of the dasheen there is a tendency to pay less attention to this cultivation. There is always a good market for all kinds of yams. It may be mentioned that one species of *Dioscorea* yields the large aerial tubers known locally as 'Addoes', which are used as food. When fresh they have a bitter flavour, but by keeping them for a few weeks before using the bitterness tends to disappear. At the present these tubers are not much used.

After the dasheen, perhaps the most widely cultivated crop is the sweet potato (*Ipomea Batatas*), which is to be found in every garden. The two principal varieties are the red and white, but there are many sub-varieties of both. The wet climate of Dominica is not altogether favourable for this crop, there being a tendency to make too much top growth and to yield poorly. By successive plantings, crops may be raised all the year round. Probably the best results are obtained from November plantings which mature during the dry season of March and April.

Another important root crop is the cassava (*Manihot utilissima*), which is largely grown in the Windward districts. The tubers yield a much valued meal which forms one of the principal foods of the people. This article is used to some extent for making cassava bread, but in Dominica, the meal and not the bread is the more popular of the two. The sweet cassava the tubers of which are boiled and served as a vegetable is not much valued, and little attention is given to it.

The Yam bean (*Pachyrhizus tuberosus*) is grown in some districts for the large amount of starch which it yields, but it also furnishes a tuber which may be dug four or five months after sowing the seeds. When grown for its tubers a few plants must always be allowed to mature in order to produce seeds for further sowings. This plant, which finds little favour in Dominica, is much cultivated in the East.

The Goa bean (*Psophocarpus tetragonolobus*), a popular vegetable in India in which place both the tubers and green pods are valued, was introduced about fifteen years ago, but failed to meet with sufficient appreciation to secure a position as a regular garden crop. It is not now grown, but it is possible that it continues to exist on the sites of the old garden.

Arrowroot (*Maranta arundinacea*) is also cultivated to some extent in the Eastern districts for the sake of its starch. Tous-le-mois, (*Canna edulis*) is grown on a small scale for its starch and sometimes the rhizomes are boiled and eaten.

Maize (*Zea Mays*) is also a garden crop of some importance, the young cobs being used as food, but very little meal is made, the peasants not caring for this valuable food. Maize is chiefly produced for sale in Roseau as stock food.

Bananas (*Musa sapientum*) and plantains (*Musa paradisiaca*) and their varieties are greatly liked and largely cultivated. The present shortage of bananas is due to the hurricanes of 1915 and 1916, from which there will be a recovery. In the case of plantains, the shortage which has existed for several years is due to persistent attacks of the plantain weevil (*Cosmopolites sordidus*), for which no remedy has been found.

Peas and beans are not cultivated to the extent that they should be, the peasants depending overmuch on starchy tubers. The larger production and consumption of legumes would give a better balanced dietary, which would mean better health and more energy to the consumers. This fact might be impressed upon the people by officials residing in country districts, and in close touch with the village communities.

Probably the most popular legumes are the pigeon pea (*Cajanus indicus*) and one or two of the cowpeas. Amongst beans, the bonavis and red beans appear to be the favourites, but dependence is chiefly placed on those which are able to exist in a semi-wild state in the neighbourhood of gardens. It is a most difficult

## GARDEN OR PROVISION CROPS.

matter to popularize anything new in this line. Recent attempts to introduce the Rounceval pea of Barbados, some of the cowpeas, the Barbuda white bean, the Sword bean, and others have meet with little success. The ground nut (*Arachis hypogaea*) exists in a few places but receives little attention culturally.

In addition to the above the native vegetables such as okras, sweet calabash, cucumbers, christophines, pumpkins, squashes, papaws, etc., are generally grown.

The demand for greens or spinach is met by the use of leaves and shoots of many plants, chief amongst which are the dasheen and tania, several species of Amaranths, the Calalu plant (*Arum* sp.), Indian spinach (*Basella alba*), and a Solanaceous plant the leaves of which have a slightly bitter flavour. Several other native plants are also used for this purpose in a lesser degree.

Nearly all the English vegetables do well under careful treatment in Dominica. Stocks of fresh seeds are kept for sale at the Botanic Gardens all the year round. The list includes cabbages, turnips, carrots, lettuces, egg-plants, beet, radish, tomato, parsley, onions, bush beans, etc. In the hills during the cool season Scotch kale, Brussels sprouts and cauliflowers have been successfully grown. It may be stated that the Jerusalem artichoke also succeeds very well in the island.

In or near to the majority of peasant gardens will be found trees of the breadfruit, bread nut, coco-nut and cacao, together with plants of the sugar-cane. It is well known that all these play an important part in the food of the people.

In addition to the garden crops briefly referred to above, Dominica is fortunate in possessing three wild food-plants which yield tubers of good quality. The most important of these is the 'Waw-Waw' or Carib yam (*Rajania pleioneura*), a plant common throughout the damp districts of the island.

The 'Waw-Waw' grows vigorously and yields abundantly. Its tubers may be seen in the market practically at all seasons of the year. There are two varieties, one which yields very large tubers, and the other compact clusters of a small type. The latter is known as the 'Waw-Waw Cush-Cush'. It is said that the young tender tubers of this plant are sometimes eaten raw.

The value of a plant like the 'Waw-Waw' is very great. It is unlikely that there will be any general failure of garden crops throughout the island, but even in the unlikely event of a shortage it is pleasing to know that very large quantities of an excellent tuber could be obtained in return for the effort of digging them up.

Recent investigations in the local Laboratory show that these tubers possess a food value but a little inferior to the tania, and superior to the much grown and popular dasheen.

Another plant which grows wild is a species of Dioscorea, evidently an escape from garden cultivation. It is now common throughout the island. It is known locally by the name of Baba-on-lé. The yams are dug from December to March. These form a considerable addition to the local food supplies of vegetables. The plant propagates itself by means of small aerial tubers produced on the climbing stems. In order to increase future supplies persons after digging the yams also take care to plant the head of the root-stock again in the soil from which the tubers have been taken.

The third food-plant growing wild is the Topee Tambou (*Calathea Allouya*), known in Porto Rico by the name of Lleren. It is common in the Windward districts. The small tubers appear in the market from December to March. When boiled they possess a pleasant nutty flavour, and form an agreeable addition to the vegetable dietary.

In normal times the existence of these wild food-plants together with an abundance of breadfruit trees, is deplored by employers of labour as tending to make the people indolent and averse to regular work on estates.

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Under present conditions, expressions of opinion such as are heard are those of thankfulness for the bountiful supply of vegetables, both cultivated and wild, which thrive in Dominica.

In this connexion the favourable position of Dominica in regard to imported foodstuffs may be referred to. According to the Leeward Islands Blue Book for 1914-15, the four principal foodstuffs imported into the Colony were flour, corn-meal, peas and beans, and rice. A computation shows that for every 100 lb. of the above imported into Dominica per head of the population, Antigua imported 180 lb. and St. Kitts 162 lb., per head.

The position of Dominica in these matters though good might be further strengthened by an increase in the production of legumes. There is a considerable annual importation of peas and beans, all of which might be produced locally.

The strong position of Dominica in this respect is due to the presence of a large body of peasant proprietors, part of whose work is the production of vegetables for local consumption.

Considerable as is the number of food-plants grown in Dominica, it is still desirable to introduce others with a view of adding further variety to locally grown esculents. In this connexion efforts are being made to introduce *Ullucus tuberosus*, a vegetable which grows in the mountains of Peru and Bolivia, and *Arracacia esculenta*, native to Venezuela and Colombia. There is a possibility of the tubers of the plants named proving useful additions to the local list of vegetables.

## Progress in the Chief Industries.

### LIME INDUSTRY.

#### GENERAL CONDITIONS.

The crop for 1916, calculated in barrels of a capacity of 4.55 cubic feet, amounted to 384,298 barrels or 6,160 below that of 1915, and 6,909 below the record crop of 1913. It is remarkable that such satisfactory results should have been achieved in spite of bad weather conditions.

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

1912	...	...	370,000
1913	...	...	391,000
1914	...	...	388,000
1915	...	...	390,000
1916	...	...	384,000

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 ...	228,904	59.5
Raw juice ...	76,548	20
Fresh limes ...	38,916	10
Citrate of lime ...	39,315	10

Comparison with the figures of last year's disposal of crop shows that concentrated juice and fresh limes continue to maintain the same position. In the case of raw juice there was a fall from 26.5 to 20 per cent., and citrate of lime rose from 3.5 to 10 per cent. The amount of fruit required to carry on the business in pickled limes and lime juice cordial was only 615 barrels.

For the second year in succession, the climatic conditions proved unfavourable. On the evening of August 28 a hurricane of much greater intensity than that experienced during August 1915 passed over the island and inflicted considerable damage on lime cultivations.

\* Note.—50 gallons of concentrated juice represent 75 barrels of lime fruits : 7½ gallons of raw juice represent 1 barrel of lime fruits : 1 ton of citrate of lime is equivalent to 206 barrels of lime fruits.

## THE LIME INDUSTRY.

Shortly after the hurricane, His Honour the Administrator approved of the suggestion to forward circulars to all planters in the island requesting information under various heads in order that the aggregate losses sustained by agricultural interests might be tabulated and recorded.

In all 120 circulars were sent out, and ninety-five answers were received. The thanks of the Agricultural Department are due to those planters who so kindly furnished the detailed information required.

The figures received show that the premier industry suffered considerably. This is to be expected as lime trees are susceptible to overturning by wind, and even a gale may at times account for some damage in this respect. Fortunately, the lime tree when blown over exhibits, under sound treatment, great powers of recovery, and the actual loss by deaths owing to storms probably does not average more than 2 or 3 per cent. In the present instance the high percentage of total loss in proportion to trees blown over is due to floods and landslides, and to some extent to the effects of large forest trees falling upon the cultivations.

The number of lime trees totally lost on estates is stated in the returns to be 23,000, and those blown over, but likely to recover in the course of two or three years, reach the high figure of 83,000. These trees are planted at varying distances apart, but if we take an average of 200 per acre, this means that 115 acres of trees have been destroyed and 415 acres blown down. The latter will recover in the course of several years, but their productive capacity practically ceases during that period.

The loss of crop is stated to be 118,000 barrels of fruit. Except in very sheltered positions, practically all the fruit, mature and immature, on the trees was blown off, and in turn much of this was swept away by the rush of water through the fields. Further losses were experienced owing to the difficulty of obtaining labour in emergencies of this kind. In this respect it was fortunate that a large proportion of the crop ripened before the end of August. As there has been no advance in the lime crop of Dominica during the past four years, observers confidently expected an increase of crop of close upon 100,000 barrels. This expectation was not realized owing to the hurricane. It is evident that a large increase of crop would have been recorded but for the adverse weather conditions.

The above figures do not include losses sustained by peasant proprietors. That these were considerable is undoubted, and if they could be expressed in figures would form an important addition to the estate losses given above.

The question of dealing with fallen trees is discussed in another section of this report. It is hoped that planters will apply sound methods in carrying out this work. Well directed efforts to this end, combined with the application of a sound system of manuring are the best and quickest means of effecting a speedy recovery, both agriculturally and financially, from the most severe set-back which the lime industry in Dominica has experienced.

## CONCENTRATED LIME JUICE.

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

1912	141,318	gallons.
1913	158,974	..
1914	148,179	..
1915	153,292	..
1916	152,608	..

The chief point of interest has been the production in increasing quantities of carefully prepared juice. For many years past planters have been advised to pay more attention to this matter and to ship a high-grade product. A number of

## THE LIME INDUSTRY.

planters followed this course, which proved to be a profitable one. Now that first-class juice can be obtained in quantity, buyers in London severely penalize the low-grade product. It is hoped that within a short time nothing but juice of the highest class will be shipped from this island.

## RAW LIME JUICE.

The exports during recent years were as follows :—

1912	508,766	gallons.
1913	336,728	„
1914	379,873	„
1915	777,064	„
1916	574,109	„

The heavy shipments made during the past two years are due in a large measure to the requirements of the Allied Armies and Navies.

Of the quantity shipped during 1916, 474,250 gallons went to the United Kingdom, 20,500 gallons to Canada, and 79,359 gallons to other countries.

## CITRATE OF LIME.

The exports of this product have fluctuated considerably during the past five years, as the following table shows :—

1912	3,910	cwt.
1913	4,753	„
1914	5,191	„
1915	1,102	„
1916	2,956	„

This has been largely due to varying market conditions, prices for high-grade concentrated juice having on various occasions ruled higher than those for citrate of lime. This has led to the establishment locally of what may be termed dual product factories in which steam concentrated juice and citrate of lime may be turned out with equal facility, as demanded by market conditions. These factories represent the highest efficiency yet attained in the manufacture of the two products.

## GREEN LIMES.

The shipments since 1912 have been as follows :—

1912	37,038	barrels.
1913	43,832	„
1914	45,283	„
1915	41,494	„
1916	38,916	„

During the past two years, a period of unparalleled prosperity in New York and other large cities, the shipments of this fruit to the United States have fallen off to the extent of 6,000 barrels. This decrease cannot be placed to lack of

## THE LIME INDUSTRY.

shipping facilities, the Quebec Line Steamers having been run as usual; the only change of importance being the need of securing space for this cargo seven or eight days in advance of sailing.

As it is unlikely there is any falling off in the demand in the United States, the cause of the decreasing shipment is probably due, in part, to competition of other countries. Porto Rico, Cuba and Florida, all share in this trade, while the West Indian islands of St. Lucia, Grenada, and Trinidad will from the present take an increasing part in it.

The New York market is mainly supplied by Dominica during the spring months. At this time prices rule high and a good deal of inferior fruit is forwarded by speculators, which has the effect of lowering the standard of Dominica limes. To the present no definite steps have been taken by those most interested to organize matters on a general scale with a view of preventing shipments of fruit of inferior quality.

The fruit shipped by leading business firms and estates is of the highest quality, but these efforts to build up a sound trade creditable to the island are largely discounted by the irresponsible action of others with no permanent interests in the business, who ship low-grade fruit during the time high prices rule in the market.

At the close of the year His Honour the Administrator in response to representations by the leading shippers laid the following proposals before the newly formed Chamber of Commerce with a view of affording assistance in organizing a system for the inspection of fruit before shipment.

## WHAT WE WANT TO SECURE.

1. The placing on the New York market of a good *standard* lime (green) with a Government guarantee that it has been inspected and passed before shipment.
2. The preventing of the shipment of bad, immature or damaged fruit.
3. The maintenance of the high standard of our fruit.
4. The stopping of the haphazard or rush shipping at the time when the fruit is in highest demand and brings the best prices.
  - (a) As to inspection. That need not present any insuperable difficulties. We can appoint some inspectors paid by the levy of 1*d.* per barrel on the fruit shipped. This tax would be paid to the Treasury, which would then pay the inspectors.
  - (b) No one would be allowed to ship any fruit unless it had been inspected and bore the mark of the inspector and the date of inspection on every barrel in a conspicuous place.
  - (c) Everyone wishing to ship green limes would be required to give a week's (?) notice to the inspector that they have fruit for inspection.
  - (d) Some central place would be appointed in Roseau for inspection, but visits could be made by the inspectors to places near Roseau for the purpose of inspection of shipments.
  - (e) Every shipment not fulfilling the standard of quality would be at once condemned and either refused the mark or an option offered of repacking or repicking the shipments to the satisfaction of the inspector.
  - (f) All shipments which did not satisfy the inspector would be prohibited, and any person shipping barrels without a mark would be liable to prosecution and to a severe penalty on summary conviction.
  - (g) The principal importers in New York would be informed by circulars that steps have been taken to ensure a standard quality of fruit, and asked to accept no fruit save that under Government guarantee.

## THE LIME INDUSTRY.

'I shall be much obliged if your Chamber will make any further suggestions which may occur to you, remembering that it is absolutely necessary to prevent the shipment of bad fruit, which can only result in the decrease and ultimate extinction of one of the most important activities of the Presidency. It is one which is likely in the near future to meet with active business-like and intelligent competition from other lime-growing countries.'

## LIME OILS.

Shipments of essential oil showed a considerable increase over the previous year's exports, whilst those of otto of limes showed a decrease. The production of lime oils during a period of five years is given below :—

Otto of limes.			Essential oil of limes.		
1912	1,057	gallons.	1912	4,150	gallons.
1913	1,505	"	1913	5,370	"
1914	1,619	"	1914	3,984	"
1915	974	"	1915	4,108	"
1916	680	"	1916	5,504	"

Prices for these products again ruled high, as a reference to the export value will show.

When the island's crop of limes is considered and allowance made for the green lime and raw juice trades (although in the latter instance the lees of the bulk of the shipments are returned to the island for the recovery of oil) it will be seen that the production of these valuable products is much below what it might be. This is partly explained by the fact that estates with young cultivation seldom possess the equipment for distilling during the early years of production. Also during the height of the crop it is only possible to deal with a portion of the fruit by means of écuelling.

Apart from this, the yield of oil on estates with the necessary equipment is often low, but may be accounted for by the rush of work during the period of maximum crop, and in some cases owing to inadequacy of equipment.

Under the stimulating effect of good prices, it is hoped that measures will be taken to recover a larger portion of these valuable oils than formerly.

The exports of lime products during 1916 were as follows :—

Product.	Quantity.	Value, £.
Concentrated lime juice ... ..	152,603 gallons.	44,379
Raw lime juice ... ..	574,109 ..	50,452
Raw juice cordial ... ..	5,000 ..	772
Green limes ... ..	38,316 barrels.	47,852
Pickled limes ... ..	415 ..	415
Citrate of lime ... ..	2,956 cwt.	9,244
Essential oil of limes ... ..	5,504 gallons.	16,803
Otto of limes ... ..	680 ..	2,435
		<b>£172,352</b>

Compared with the previous year there was a total decrease in values amounting to £2,052.

## CACAO AND COCO-NUTS.

## CACAO.

Another fall has to be recorded in the export of cacao. Twenty years ago the figures were the same, but with a progressive upward tendency. The maximum was reached in 1902 when 12,000 cwt. were exported. The output remained fairly constant around this figure until 1912. Since that time the falling off has been rapid, as is shown by the following table :—

1912	...	...	...	11,877 cwt.
1913	...	...	...	9,560 ..
1914	...	...	...	8,874 ..
1915	...	...	...	10,810 ..
1916	...	...	...	5,707 ..

This considerable decline in 1916 may be principally due to the hurricane of 1915. It may be expected that the tropical disturbance of 1916, which affected cacao cultivation to a much greater extent, is likely to cause a further reduction in the exports.

Returns furnished by planters after the hurricane placed the loss of cacao trees on estates at 10,000. As cacao is usually grown in sheltered positions, these losses were mainly caused by floods and landslides. The losses suffered by peasants in this respect cannot be estimated with any approach to accuracy, but it is thought they are greater than those sustained by estates. This considerable loss of trees coupled with damage to existing cultivations and their protecting wind-belts, is bound to have a further bad effect on an already declining industry.

## COCO-NUTS.

Shipments under this head for a five-year period are recorded below :—

1912	539,791
1913	448,747
1914	554,549
1915	506,360
1916	408,007

The falling off in exports during the year was primarily due to the cyclonic disturbance which caused the loss of over 1,000 trees.

A fair amount of development work is going on, and the suggestion to plant the frontages of coast estates is being followed in a number of instances. The existence of belts of coco-nut palms wherever possible along the coast-line, apart from their yield, serves to lift the wind when it blows off the sea, thus affording a measure of protection to cultivation further inland.

Whilst Dominica is generally well adapted for the growth of coco-nuts, certain parts of the Windward and the Lasoye districts are admirably suited to this cultivation. In the latter quarter considerable areas have been planted during recent years.

It has been pointed out on many occasions how important it is for planters to give attention to the cultivation of products other than the lime. What is now

## WORK IN THE CHEMICAL LABORATORY.

required is an extension of interest in coco-nut planting. All coastal estates with suitable lands might take part in this work and thus assure to the island a new industry and a stronger economic position.

## MINOR PRODUCTS.

The quantities and values of minor products exported during 1916 are given below :—

Produce.	Quantities.	Values. £.
Oranges ... ..	763 barrels	581
Orange oil ... ..	143 gallons	275
Bay leaves ... ..	379 cwt.	359
Bay oil ... ..	296 gallons	1,149
Bananas ... ..	805 bunches	40
Coffee ... ..	21 cwt.	180
Hardwood ... ..	23,371 feet	141
Vanilla ... ..	1,842 lb.	485

## Work in the Chemical Laboratory.

For several months during the year under review, work in the chemical laboratory was practically suspended. This was inevitable under the conditions which prevailed. During the latter part of the year a certain amount of investigation was carried out.

The hope was expressed in the last progress report that more adequate laboratory accommodation would be provided during 1916. Unfortunately this hope has not materialized and the work has had to be conducted under the trying conditions which prevail in a building badly suited for conducting chemical investigations.

The following is a summary of the samples analysed during the year :—

Lime juice samples (estates) ... ..	70
" " " (for investigations) ... ..	62
Manures ... ..	3
Citrate of lime ... ..	2
Lime oil (for kerosene) ... ..	4
" " in pulp ... ..	2
Standard solutions (estates) ... ..	5
Milk ... ..	10
Matches (Customs) ... ..	3
Meals ... ..	6
Bread ... ..	2
Soils (carbonates) ... ..	4
" (acidity-lime requirements) ... ..	15
<b>Total ... ..</b>	<b>188</b>

## CHEMICAL WORK CONCERNING LIME JUICE PRODUCTS.

## TESTING LIME JUICE.

The following table shows the steady progress made in the number of samples of lime juice sent in to be tested by planters during the last six years:—

Year.	1911	1912	1913	1914	1915	1916
No. of samples tested.	7	16	26	48	45	68

As in previous years the testing solutions used by Messrs. L. Rose & Co., Ltd., who purchase large quantities of raw lime juice not only in Dominica but also in the neighbouring islands, are checked in this laboratory from time to time. In this way any dissatisfaction which may have existed between the planters and Messrs. Rose on the question of test in the past has been removed, and both parties are satisfied that the juice changes hands on a correct basis.

One party was instructed in the method of testing juice during the year with the view of controlling the work of the factory. Several others were supplied with small quantities of standard solutions.

## IMPROVEMENT IN THE MANUFACTURE OF LIME PRODUCTS.

During the year under review, citrate of lime was sold on the basis of about £27 per pipe. During the same period concentrated lime juice was quoted at £22 per pipe.

Whilst many planters received this latter price and found difficulty in disposing of their product, a number of others received £28 and over per pipe, and found a ready market.

The difference in price was due entirely to the difference in the quality of the juice manufactured. Those who took the slight additional trouble of preparing a clean sample of concentrated juice were rewarded to the extent of £6 per pipe and over. Now that the trade has differentiated between clean and dirty juices and does not value the product on the acid content alone, a rapid improvement should soon be observable in the quality of the bulk of the juice leaving the island, and the shipment of thick dirty juice should be a thing of the past.

There is an idea abroad that clean juice cannot be prepared by the open-fire process. This of course is a fallacy, as some of the best juice leaving the island to-day is manufactured by the open-fire method. The writer has seen juice prepared by steam concentration having a sediment test of close on 100 units. The essential condition in the preparation of clean concentrated juice is that the raw juice should be as free as possible from pulp. To attain this end several different methods are practised. First the raw juice as it comes from the mill is kept for several days in vats to settle and only the clear juice drawn out for concentration; or the whole is passed through the still and after boiling is run into settling vats and allowed to remain there for twelve to twenty-four hours. It is well known that boiled juice settles quicker and more thoroughly than raw juice. In some cases planters use both the above methods, that is they settle the raw juice as much as is convenient, withdrawing the clear juice directly into the concentrating vessel and distilling only the cloudy juice. No doubt the cleaner juice is obtained by heating the bulk to boiling for some time, and then settling the juice, finally withdrawing the clear juice.

The chief difficulty in preparing clean juice is the treatment of the sediment. It contains a very considerable amount of acid which must be recovered. Filter presses—familiar objects in sugar factories—are not used in lime juice factories. Two processes are adopted to obtain the last of the acid out of the sludge. The latter is placed in bags made of cloth and allowed to drain, or still better, placed in a specially made filter bag consisting of two bags, one the larger placed within a second the smaller, the smaller of the two having no bottom. The other method is to allow the sediment to run into a separate vat, stirring it up with a quantity of water, allowing it to settle and drawing off the clear liquid. The second process

## CHEMICAL WORK CONCERNING LIME JUICE PRODUCTS.

appears the more practicable when large volumes of juice are being dealt with. In this second process it becomes a matter of some importance to determine the number of times it is economically sound to continue the washing.

With this end in view experiments have been conducted in this laboratory, and it would appear that if time is an important factor, the best way to treat the sludge is to add water to the extent of 2 parts to 1 of sludge. In a few hours—six to ten—the pulp settles and the clear liquid may be drawn off and concentrated. It is not economically sound at the present value of citric acid to further treat the residue.

If, however, the element of time is not pressing, then the most efficient way of dealing with the sludge is to add equal parts of water, allowing it to settle eighteen to twenty-four hours, drawing off the clear liquid and again adding water in equal parts. From data supplied to this Department as to the cost of concentrating a gallon of juice, which is given at 1 cent per gallon, it would appear that, at the present value of citric acid, the washing described may be repeated three times, but that the fourth washing is not profitable.

By the first method 66.6 per cent. of the acid is recovered from the sludge, and by the second process, provided the washing is repeated twice, 75.0 per cent. If, however, the washing is repeated three times, then 87.5 per cent. of the acid will be recovered.

On the majority of estates, with a little additional trouble and at a comparatively slight increased cost, clean concentrated lime juice can be readily produced.

## THE USE OF STEAM FOR CONCENTRATING JUICE.

The success of steam concentration plants having been established, a number of new plants of this nature were installed in the island during the year. No doubt the difficulty in procuring and the additional cost of purchasing boilers and copper fittings at the present time account to a large extent for the fact that many other estates have not yet installed steam concentrating plants. It should now be known generally that this method of concentrating effects a saving of acid to the extent of about 10 per cent. over the open-fire process, and that the destruction of acid is under 3 per cent.

At the request of a planter who was about to concentrate by steam for the first time, a concentration test was made, and the results obtained are published for general information.

Ounces of citric acid in 1,258 gallons of raw juice	...	...	= 16,300
" " " " " 137 " " concentrated juice	...	...	= 15,960
Loss of acid in ounces	...	...	= 340

= 2.17 per cent.

This is a very satisfactory result and confirms other experiments which have been conducted from time to time.

## USE OF THE HYDROMETER AND CITROMETER IN MAKING CONCENTRATED LIME JUICE.

The citrometer is a special form of hydrometer which is commonly used in the lime juice factory to determine the approach of the moment for 'striking'. Some form of hydrometer is essential for this purpose, but the obscurity of the scale of the citrometer, and the fact that there are several different citrometers on the market, some of them quite useless for the purpose for which they are required, have made it advisable now for several years, that the use of the citrometer be discontinued, and that in its place an ordinary specific gravity hydrometer of a certain graduation be used. The kind recommended was an ordinary specific gravity hydrometer standardized at 60° F. and reading between 1.200 and 1.300: this to be used in the boiling juice in exactly the same way as the citrometer.

## USE OF THE CITROMETER.

The readings of the hydrometer or citrometer are only meant to be a more or less approximate indication, though with steam concentration in wooden vessels a very close agreement is possible between the various 'strikes' when the same quality of concentrated juice is being manufactured, and when care is exercised in taking the readings. When different qualities of juice are being manufactured, a somewhat different set of results will be obtained by boiling to the same degree hydrometer.

In former days before clean concentrated juice was being prepared, it was customary to go on with the boiling until the citrometer read 60°, which is equivalent to the hydrometer reading 1.243, and which gave a juice testing about 100 oz. of citric acid to the gallon. It soon became evident that these figures did not hold good in the case of clean juice, and that to obtain a juice testing about 100 oz. per gallon, the boiling had to be checked before the 60° marked was reached. Several enquiries having been received from time to time as to the point on the hydrometer at which the boiling should cease in order to give a juice of a certain strength, the matter was investigated during the year under review, and below is given a table showing the results obtained. In the first column the reading is given on an ordinary hydrometer graduated at 60° F. ; in the second column is given the corresponding citrometer reading, and in the last column the strength of the resulting juice, in ounces per gallon. It may be stated that the concentrated juice was of a moderately clean quality containing 30 units of sediment when testing 93.07 oz. per gallon, and rising to 50 units when testing 123 oz. per gallon.

TABLE

showing relation between apparent specific gravity of boiling concentrated lime juice and the acid content of the same juice.

Hydrometer.	Citrometer.	Acid test in oz. per gallon.
1,200	50	93.1
1,205	51	94.9
1,210	52	97.1
1,215	53	99.7
1,220	54	101.5
1,225	56	103.8
1,230	57	105.1
1,235	58	107.0
1,240	59	110.0
1,245	60	111.0
1,250	61	113.8
1,255	63	115.6
1,260	64	117.9
1,265	65	120.2
1,270	66	122.8

## POINT OF ECONOMIC CONCENTRATION.

The raw juice used in this investigation, which was conducted by the kind permission of Mr. R. E. A. Nicholls at St. Aroment estate, had a purity of 80.5 per cent. This is slightly lower than ordinary fresh lime juice, and our experience indicates, as one would expect, that the lower the purity of the raw juice the lower the test of the acid in the concentrated juice. In support of this contention it may be stated that in one instance when the juice had been stored for a considerable time before boiling, a sample of concentrated juice boiled to 1.225 on the hydrometer gave a test of only 99.54 oz. per gallon.

It would appear, therefore, from the table given, that in the preparation of clean concentrated juice, and where a juice testing about 100 oz. per gallon is required, a hydrometer graduated from 1.175 to 1.275 would be the one best suited for the purpose, and that when this hydrometer reads between 1.215 and 1.220 the desired degree of concentration has been reached.

## POINT OF ECONOMIC CONCENTRATION.

Owing to the unusually high freight rates and other charges which exist at the present time, the table showing the economic point of concentration, based on the careful experiments conducted by the Hon. J. C. Macintyre in 1911, when boiling with open fire and in copper taches, was recalculated on the existing rates and published locally. This is reproduced below:—

Degree of concentration.		Acid oz. per gall. in concentrated juice.	Citrometer degree approximate.	Net value after concentration of 12,000 oz. when value of 1 pipe of concentrated juice is		
Basis 12 oz. /gall.	Basis 14 oz. /gall.			£25	£30	£35
7:1	6:0:1	78	45	£ s. d. 26 9 8	£ s. d. 33 12 8	£ s. d. 40 15 10
8:1	6:8:1	88	50	27 1 4	34 2 5	41 3 6
9:1	7:7:1	98	56	27 5 4	34 3 11	41 2 7
10:1	8:6:1	107	60	27 9 11	34 6 0	41 2 8
11:1	9:4:1	114	62	27 0 10	33 13 2	40 5 5
12:1	10:3:1	121	65	26 9 8	32 18 2	39 9 0

It will be seen from the above that under the present conditions, the economic point of concentration with concentrated lime juice selling at between £25 and £30 per pipe is 10 to 1.

It should be remembered however, that the greatest care is required when concentrating to this degree with open fire to avoid excessive loss of acid.

With steam coils the loss in concentration is so small (between 2 and 3 per cent.) even when the juice is highly concentrated, that the only point that need be considered in this connexion is the requirements of the trade; buyers would probably object to a juice containing much more than 120 oz. of acid per gallon, which is equivalent to about 11 to 1.

## ANALYSIS OF LOCAL FOODSTUFFS.

In a previous section of this report the position of the island with regard to the supply of foodstuffs was considered, and it was pointed out that official statistics

## COMPOSITION OF LOCAL FOODSTUFFS.

revealed the fact that Dominica is self-supporting to a much larger extent than Antigua and St. Kitts, the only important article of imported foodstuff being wheat flour. It appeared desirable, therefore, to conduct a chemical examination of the feeding value of some of the more common locally grown foodstuffs, in order that their relative value as foods might be ascertained. Some of these, such as sweet potato and various peas and beans had on many occasions been examined in this way and the data were already available; so it was considered unnecessary to repeat the analyses. Others, such as the dasheen and tania were but little known, and the wild yam 'Waw-waw' (*Rajania pleioneura*) had probably never previously been analysed, and the figures are therefore placed on record, it is believed, for the first time in this table.

## COMPOSITION OF LOCALLY GROWN FOODSTUFFS.

	Moisture.	Protein.	Fat.	Carbohydrates.	Fibre.	Ash.
Tania meal ...	8.47	5.09	.96	78.81	1.94	4.73
Dasheen meal ...	6.91	3.05	.42	86.72	.94	1.96
Farine ...	9.28	1.43	.61	85.11	2.11	1.43
Banana meal ...	9.52	3.57	.84	82.28	.83	2.96
Plantain meal ...	8.82	2.86	.71	84.71	.65	2.25
Waw-waw meal ...	6.07	3.58	.41	87.83	.83	1.75
Wheat flour* ...	12.3	10.1	1.3	75.6	.3	.6
Sweet potato meal* ...	12.6	3.6	.6	77.6	3.5	2.1
Bean, Bonavist* ...	14.3	20.1	1.2	51.1	9.5	3.8
Salt fish* ...	53.6	21.4	.4	...	...	24.6
Salt pork (fat)* ...	7.3	1.8	87.2	...	...	3.7

In order to appreciate fully the significance of the figures given, it may be advisable to give a brief account of the functions of the various constituents of foods. They are classed as follows:—

1	Non-nitrogenous	{ Carbohydrates Fats Ash	
2	Nitrogenous		Proteids
3	Non-digestible		fibre

The carbohydrates and fat are heat and work producers; the proteids are flesh formers and tissue renewers, and the ash goes mainly to form bone, etc., in growing children. An excess of carbohydrates or fat cannot be utilized by the system for the renewal of tissue, consequently a properly balanced ration is necessary. Fat has two and a half times the heat- and work-producing value of carbohydrates such as starch and sugar.

When we consider the figures given for the commonly grown Dominica provision crops in the light of the above explanation, we note the predominating quantity of carbohydrates and the very low protein and oil content. Of these the

\*See *Agricultural News*, Vol. XVI, No. 387 p. 51.

## SUBSTITUTES FOR WHEAT FLOUR.

tania is superior to the others in protein, and it will be noted that the wild yam 'Waw-waw' holds quite a favourable position when compared with the others.

It is obvious, however, that to produce a well-balanced ration, it is necessary to consume a certain quantity of meat, salt fish, and peas and beans. Though a large quantity of peas and beans are grown locally, there is not sufficient produced to meet the requirements of the population of the island, and over 40,000 lb. are imported annually. All this should most certainly be produced in the island. It will be noted that the common bonavist bean contains practically the same quantity of protein as salt fish.

## THE USE OF FARINE MEAL FOR DILUTING BREAD.

As there appeared to be a possibility of the wheat supply becoming short should the war be long continued, it became desirable to consider what local product could be used to augment the supply of flour.

The product which offers most promise of success is farine; it is produced locally in considerable quantity, and is used and appreciated by a large section of the population. When pounded and sifted it forms a meal of good colour. Its composition like that of most root crops is poor in proteids—the flesh formers; and rich in carbohydrates—the heat and work producers. The analysis may be seen on the preceding page of this report.

Three experiments were conducted with this meal in which different proportions were used as follows, in the manufacture of bread:—

- No. 1, equal proportions of wheat flower and farine meal.
- .. 2, two parts of wheat flour to one part of farine meal.
- .. 3, three parts of wheat flour to one part of farine meal.

Mr. Bernard Burton was good enough to undertake the mixing and baking of the bread, and we are much obliged for his co-operation.

Samples of the bread prepared were forwarded to His Honour the Administrator, His Lordship the Bishop, and Dr. R. H. Allport, Chairman of the Roseau Town Board. The unanimous opinion of these gentlemen was that Nos. 2 and 3 especially, were quite good samples of bread. No. 1 when quite fresh was also pronounced to be good, but in twenty-four hours it developed a pronounced flavour of the farine, which however was not in any way disagreeable.

It would appear, therefore, that quite eatable bread can be produced by an admixture of farine meal with wheat flour, and that should it become necessary, the importation of the latter could be considerably curtailed by diluting it with farine meal.

Analyses have been performed of the protein content of these breads as compared with bread made from wheat flour alone, and it was found that ordinary bread contained 9.17 per cent. of protein and 38.23 per cent. of water.

3:1	"	"	8.19	"	"	"	"
2:1	"	"	7.70	"	"	"	"
1:1	"	"	6.24	"	"	"	and 41.05 per cent. water.

The breads showed a decreasing percentage of protein as the proportion of farine meal increased.

## THE ROSEAU MILK SUPPLY.

The sale of milk in Roseau is regulated by the Town Board, and each milk seller is licensed. For several years past the purity of the milk has been checked with the hydrometer, and the officers of the Board have the power to confiscate any milk offered for sale which is below a certain standard; and are also empowered to take legal proceedings. The licensed milk seller is supplied with a hydrometer so

## COMPOSITION OF DOMINICA MILK.

that he or she may test any milk purchased from country people, and which is to be offered for sale.

This system, it is claimed, has worked with considerable success, and is responsible for a noticeable improvement in the quality of the milk sold in the town.

When a chemical laboratory was opened by the Government, the latter allowed the Chemist-in-charge to make the usual chemical analysis on a number of samples. This privilege was again extended to the Town Board during the year under review, when ten samples of milk were analysed. The results obtained are tabulated below. It will be observed that whilst the majority of the samples examined are of good quality, three samples, Nos. 2, 3 and 6, were below the legal standard, and were undoubtedly adulterated.

Examination of the specific gravity column (hydrometer readings) shows that by itself this method of testing the quality of milk is not sufficiently accurate to detect many cases of adulteration, and that, on the other hand, unless a fairly wide margin is allowed, this method might well lead to a miscarriage of justice.

These facts were brought to the notice of the Government, and after communication with the Town Board it was arranged that in future, whilst the employment of the hydrometer may be usefully continued as a general check, no prosecutions are to be instituted without a certificate of analysis as to adulteration from the Government Chemist.

No. of sample.	Total solids.	Fat.	Solids not fat.	Water.	Specific Gravity.
1	13.65	4.8	8.85	86.35	1.0286
2	9.94	1.5	8.44	90.06	1.0296
3	10.60	4.0	6.6	89.40	1.0207
4	13.61	4.6	9.01	86.39	1.0293
5	14.03	5.7	8.33	85.97	1.0264
6	9.00	1.5	7.50	91.00	1.0272
7	11.42	3.5	7.92	88.58	1.0259
8	12.73	4.2	8.53	87.26	1.0288
9	12.15	3.35	8.80	87.85	1.0294
10	15.01	5.8	9.21	84.99	1.0292
Mean ten samples.	12.21	3.89	8.32	87.78	1.0275

Legal standard United Kingdom 3 per cent. Fat, and 8.5 per cent. Solids not fat.  
 " " Jamaica 3.5 " " " " 8.25 " " " " "

## WATER FROM THE ROSEAU TOWN SUPPLY.

In the last progress report was given the results of Dr. Tempany's examination of three samples of water from the town supply collected in the wet months of the year, and it was then suggested that it would be useful to repeat the analyses on samples taken in the dry season. This was accordingly done, and the following report is by Dr. Tempany:—

## THE WATER SUPPLY.

'In continuation of my Report of October 1, 1915, on three samples of water from the town water-supply, of Roseau, Dominica, I now beg to submit a further report on two additional samples from the same source.

'The samples in question were taken by Mr. G. A. Jones, Assistant Curator and Assistant Chemist to the Dominica Department of Agriculture, during the month of April, after a prolonged period of dry weather. The samples are supplementary to those reported on by myself previously, which were taken after periods of considerable rainfall. The samples now reported on are two in number, viz:—

'No. 1 From the intake of the Reservoir.

'No. 2 From the tap in the Laboratory at the Botanic Gardens.

'The analytical results are shown in the accompanying table. In point of view of the content of dissolved mineral matter, the results are, in the circumstances, in surprisingly close agreement with those found in the case of the samples reported on in October last. From the point of view of the contained organic matter the samples are slightly superior in quality to those previously reported on, and for such types of upland surface water must be regarded as of extremely high purity.

'The groups of analyses taken together indicate that under the range of conditions occurring at the times of taking the two sets of samples, the quality of the water supplied to the Town of Roseau leaves little to be desired when judged by the usual chemical standards.'

## WATER FROM THE ROSEAU TOWN SUPPLY, DOMINICA.

Constituent.	A. From intake at Reservoir.		B. From Laboratory tap.	
	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.
Total solids ... ..	17.0	11.9	15.0	10.5
Chlorine ... ..	1.2	0.84	1.2	0.84
Equivalent sodium chloride ... ..	1.98	1.39	1.98	1.39
Temporary hardness ... ..	7.2	5.04	7.2	5.04
Permanent hardness ... ..	nil	nil	nil	nil
Nitrates ... ..	nil	nil	nil	nil
Free ammonia .. ..	trace	trace	trace	trace
Albuminoid ... ..	0.091	0.0007	0.0015	0.00105
Oxygen absorbed in 20 minutes ... ..	0.003	0.002	0.003	0.002
Oxygen absorbed in 4 hours ... ..	0.026	0.018	0.014	0.010

## LIME REQUIREMENTS OF DOMINICA SOILS.

Much attention has recently been given to the question of the lime requirements of soils. In temperate climates the leading authorities on agriculture have come to the conclusion that the fertility of the soil is directly proportional to the calcium carbonate content of the soil, these conclusions having been arrived at as a result of carefully conducted experiments and extended observations.

## LIME REQUIREMENTS OF DOMINICA SOILS.

It is well known that the soils of Dominica in common with many other West India islands of volcanic origin are remarkably poor in calcium carbonate. In a soil survey of Dominica made some years ago by Dr. (now Sir Francis) Watts, the calcium carbonate content of the different types of soil was determined, and rarely did it exceed 0.4 per cent., and in a large number of cases it was under .2 per cent.

It becomes a question of some importance for Dominica planters to know whether it is advisable for them to spend considerable sums of money on the application of lime to their soils. Good lime cannot be cheaply obtained in Dominica owing to the comparative scarcity of coral, and the high cost of transport, especially in the case of those estates situated some distance from the coast, is another obstacle.

Following the lead of European agriculturists, it has been customary to advise the periodic application of lime, but no definite experiments have been conducted in Dominica for any length of time to show that such applications would be remunerative. In some neighbouring islands such experiments have been carried out, and the writer knows of no instance where increase in orchard crops has been recorded as a result of the application of lime. Two experiments have recently been started by this Department—one with cacao and the other with limes—in which lime in conjunction with mulch is applied annually. It will take some considerable time before reliable results will be available.

That excellent results can be obtained in cacao cultivation without applications of lime over a lengthy period on soils known to be very deficient in carbonates (0.1 per cent.) is proved by reference to the table of yields of the mulched plots of the Dominica cacao experiment station, given in another section of this report. It is known positively that no lime has been applied at least during the last twenty-five years to any of these plots.

Recent investigators\* have distinguished between the lime requirements of soils to effect neutralization of acidity and that required to effect partial sterilization. Calcium carbonate or chalk could be used equally well with lime (provided it is finely ground) for the first purpose, but chalk would not bring about partial sterilization. The same investigators have devised methods for determining these requirements, and during the year under review a number of typical samples of Dominica soils have been examined in this connexion. It became evident after two or three determinations that the quantity of lime required for partial sterilization of Dominica soils was so great and the cost would be so prohibitive that it was not a practical proposition, consequently this determination was not proceeded with on the majority of the samples. It may here be mentioned that a minimum of 7.8 tons of lime per acre would be required to bring about partial sterilization.

The chalk required for neutralizing the acidity in soils was determined on fifteen carefully selected samples. The table following gives the locality where the soils were taken from, the amount of calcium carbonate required to remove acidity, and some general remarks on the soils:—

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\* *Journal of Agricultural Science*, Vol. VII, pp. 78-105.

## LIME REQUIREMENTS OF DOMINICA SOILS.

No. of sample.	Locality.	Calcium carbonate required to neutralize acidity.		Remarks.
		Tons	cwt.	
1	Cacao Experiment Station.	-	7	Sample taken from 15 yrs. mulched plot
2	" "	-	5	" " " " " control plot
3	Lime Experiment Station	-	18	A soil containing about 47 per cent. silt and clay.
4	Lasoye	-	16	A light soil, grown limes successfully for over 20 years.
5	"	1	10	A heavy soil recently drained.
6	"	2	19	A reclaimed swamp, surface well drained, most luxuriant growth of lime trees.
7	"	1	4	Reclaimed swamp, grew a heavy crop of sugar-canes in 1915.
8	Leeward Coast	0	12	Grew well-developed lime trees; recently infected with Sphaerostilbe root disease.
9	Interior	7	18	Soil of unfelled forest lying on sheet rock.
10	"	7	7	Similar soil now in cultivation, poor growth of limes.
11	"	5	11	Deep soils, cleared from forest during the last 10-15 years.
12	"	6	1	Typical of a large area of interior soils.
13	"	4	6	Limes grown successfully and in the
14	"	4	4	case of Nos. 13 and 14 most luxuri-
15	"	4	0	antly.

Without exception these soils show a pronounced acidity varying from a chalk requirement of 5 cwt. to the acre to an amount over 7 tons per acre. The dark, light, valley soils long cultivated, would require an amount varying from 5 to 20 cwt. per acre of chalk, whilst those of the interior, only recently felled from forest, would require from 4 to 7 tons of chalk merely to correct the acidity.

All these samples were personally collected by the writer and notes were taken of the condition of the cultivation in the immediate vicinity. The majority of the soils were taken from lime fields, and Nos. 6, 13 and 14, though showing such a pronounced acidity, carried lime trees of exceptional vigour and growth. It is evident that the presence of acid in the soil does not hinder in any way the growth of the trees.

Samples Nos. 9 and 10 are interesting in showing the very acid nature of forest soils, especially when drainage is difficult owing to the close proximity of the hardpan to the surface.

## LIME REQUIREMENTS OF DOMINICA SOILS.

The repeated applications of organic matter over a period of fifteen years to the mulched plot (sample No. 1) has only slightly increased the acidity of the soil as compared with No. 2, which is adjacent to it and receives no manure.

The amount of carbonates found in some of these soils (determined by the Shrewsbury method—see *West Indian Bulletin*, Vol. XIII, p. 278) is as follows:—

No. 5	·32	per cent. calcium carbonate.		
" 4	·35	"	"	"
" 6	·98	"	"	"
" 14	·20	"	"	"

It is regretted that the acreage of cultivation at the disposal of this Department is not sufficient to enable experiments to be conducted on any considerable scale to demonstrate the effect of liming on orchard cultivation on the lines suggested by these determinations, i.e. when lime is applied sufficient (a) to remove acidity, and (b) to cause partial sterilization. A few trees are being experimented with and the results will be recorded. Planters who are favourably placed with regard to a supply of lime may be disposed to conduct trials on their own estates, in which case the Department will be pleased to assist by making determinations as to the quantities which should be applied.

It should not be lost sight of that lime may exert beneficial results in several directions not dealt with in this investigation. Its undoubted benefit when applied to heavy lands in causing them to become more friable and workable is well known, and is made use of in preparing nursery beds on such lands by this Department. Further—though again this has not been proved by experiment—it is quite possible that if sufficient lime to cause a change in the soil reaction is applied to fields infected with root disease, the latter may be more easily checked and controlled. Planters whose fields are infected with root diseases would do well to give this matter consideration and a fair trial.

## Work Connected with Insect and Fungus Pests and Their Control.

Much attention is given by the officers of the Department to questions relating to plant diseases. They assist the scientific officers of the Imperial Department of Agriculture in their investigations, and by the experience thus gained are in a position to advise planters on questions relating to plant pathology. During the last few years annual visits have been paid to Dominica by the Mycologist, with the result that much information has been collected and placed at the disposal of the planters. Following the publication of the pamphlet on 'Diseases of Lime Trees in Forest Districts', and after a visit of eleven days to Dominica during the year under review, Mr. Wm. Nowell, Mycologist on the staff of the Imperial Department of Agriculture, has prepared and published in the *West Indian Bulletin*, Vol. XVI, No. 1, a paper entitled 'Rosellinia Root Diseases in the Lesser Antilles', which gives a comprehensive account of our present knowledge of these diseases.

It may be stated that the majority of the planters concerned with these diseases were taking steps to combat them, and were on the way to proving that these diseases when properly dealt with were controllable, when unfortunately, the hurricane caused so much damage to these properties that labour had to be diverted to other directions.

## PLANT DISEASES.

An outbreak of root disease was reported in a totally new locality and amongst cultivation of remarkable vigour. A visit was paid to the district when it was found that the trees were attacked by the red root disease, *Sphaerostilbe*. Remedial measures were suggested and it is hoped, when carried out, will prove successful.

It may be placed on record that uprooted Para rubber trees and Nicaruan shade trees (*Gliricidia maculata*) were observed attacked by the black root disease, *Rosellinia* sp. There are very few trees indeed that seem capable of resisting the attack of this particular disease.

In many fields of old limes in Dominica which have become unhealthy, a large number of trees are found to be infected with a fungus which produces 'bracket' fructifications. The same or a similar fungus occurs when trees are badly pruned. The number of such trees seems to be on the increase of late years, and it is hoped to have a thorough investigation of these diseases in the near future.

On the whole, lime cultivation in Dominica continues to be remarkably free from serious fungus and insect pests, and provided that sound methods of cultivation are followed, and planters keep a sharp look out for new outbreaks and deal with them promptly and thoroughly, there seems no reason why the present satisfactory position should not be maintained.

## Efforts to Improve the Condition of Peasant Agriculture.

It may be claimed that the Agricultural Department has since its inception endeavoured to assist the cause of peasant agriculture in the island. For several years an Agricultural Instructor was retained on the staff whose duty it was to assist this important class of the population. In later years a system of prize holdings competitions was held with success in two of the chief peasant districts, Laplaine and Grandbay; as far as possible annual visits are paid to each district. It may be stated that the Government is prepared to extend to other districts the system of prize holdings competitions mentioned above, should any district show a desire to have them. A sum is annually placed on the Estimates for this service.

### AGRICULTURAL CREDIT SOCIETIES.

In the island of St. Vincent, and more recently in St. Lucia, Ordinances have been passed establishing and regulating the working of Agricultural Credit Societies. In St. Vincent the effort has met with considerable success and over ten such societies have been formed. The Government of Dominica was prepared to consider the passing of a similar Ordinance for Dominica, and a report was asked for from the Agricultural Department on this important question. The matter was carefully considered and a visit paid to one of the districts which offered most prospects of success, viz. Laplaine. The main principles of the working of Agricultural Credit Societies were explained to a number of the leading peasants. A good number of these people were anxious to form such a society, but it was quite evident that the assistance they required most urgently was some means of disposing of the lime crop which they had coming on. After that had been satisfactorily dealt with would come the time for starting Agricultural Credit Societies. They urged that it was little use borrowing £5 or £10 to be expended in

improving their existing cultivation unless they were assured of a reasonable price for their crops after they had been produced. During the year under review, when limes were worth 5s. to 6s. per barrel, they received from the local buyers only 1s. 6d. per barrel. Individually they can accomplish little; but a co-operative factory run on sound lines for the benefit of these people would be a real boon, and a sure means of causing the extension of lime cultivation, which is now almost at a standstill as far as the peasants in these districts are concerned.

### GOVERNMENT CO-OPERATIVE FACTORIES.

The above facts were brought to the notice of the Government, and the great importance of organizing these small communities as far as the manufacture of their lime crop is concerned received the earnest consideration of His Honour the Administrator. As a start, His Honour appointed a Committee consisting of the Hon. J. C. Macintyre, A. H. Green, Esq., the Curator, and the Assistant Curator, to formulate plans for the erection of a Government Co-operative Factory at Grand-bay, where a crop estimated at over 6,000 barrels is produced annually. The Government is now in possession of the facts necessary to start such a factory, and it is earnestly hoped that the scheme will be carried through. Once the success of the undertaking is established in one district there is no reason why other districts should not be similarly served, and in time all the chief peasant lime-producing districts should not have their own Government co-operative factory run, not for the profit of the Government, but to ensure that the maximum prices may be given for the lime products of the peasant, putting him on an equal footing with larger planters.

### SUPPLY OF QUININE MIXTURE, ETC., FOR LABOURERS ON ESTATES.

In the larger Colonies excellent work is carried on in connexion with the maintenance of the health of labourers on estates, by the respective Governments furnishing planters with free supplies of quinine mixture and antiseptic dressings for use in cases of fever and minor injuries.

It is well known in Dominica that a considerable amount of labour is disabled for long periods owing to malarial fever, which with proper and timely measures could be cured in a few days; and to sores mainly caused by working in fields in which the formidably armed lime tree is grown. It is felt that if prompt measures and proper dressings are applied, the majority of these cases would be quickly cured and an early return to work brought about. The adoption and successful working of these measures may be expected to result in a considerable accession to the labour supply—a matter of supreme importance in a country in which there is a want of labour.

With a view of starting this scheme in Dominica, His Honour the Administrator has addressed the following circular to owners and managers of estates. There is no doubt that all planters in the island will gladly support a measure which has for its object the prevention of suffering:—

Every year a considerable number of people belonging to the labouring population are disabled for varying periods by malarial fever, and by sores and ulcers that have resulted from scratches and other slight injuries that would have healed well and rapidly had proper dressings been applied to them.

This preventable disabling of numbers of the labouring population has been brought to the attention of the Government, who propose to distribute quinine and antiseptic dressings to those planters who express to me in writing their willingness to receive them and to use them for the benefit of their labourers.

## STANDARD MEASURE FOR LIMES.

'Should a sufficient number of satisfactory replies be received to this Circular arrangements will be made for importing a supply of quinine and dressings for distribution under regulations which will be made and published in due course.

'Should you be willing to receive quinine mixture and dressings for the use of labourers on your estate and its vicinity, I shall be glad if you will apprise me of the fact.'

## STANDARD MEASURE FOR LIMES.

As far back as 1912, the need of a standard measure for limes was brought to the notice of the Government. The Administrator at that time, His Honour Douglas Young, drafted an Ordinance to meet the requirements in this respect but owing to changes in the Administration which quickly followed, the draft Law was not brought forward.

Further representations having been made, the matter was considered at the Federal Council held in Antigua in February. As a result, Act No. 1 of 1917 contains a clause giving the 'standard measure of capacity of a barrel used in buying or selling limes.' Unfortunately this does not accomplish what was wanted. It does not prevent other measures being used in purchasing limes. What is really desired is a standard measure.

It is a remarkable fact that while the transactions in limes amount to scores of thousands of barrels each season, and while limes are sold by and paid for by the barrel, this measure is rarely used. It is assumed that certain boxes or baskets filled three or four times are equivalent to a flour barrel of 4.55 cubic feet capacity and no doubt this is correct; but in practice, owing to insistence on the part of some buyers to the small receptacles being heaped up each time instead of being filled level with the top, the purchaser obtains considerably more than he is entitled to. Naturally the sellers, who belong to the peasant class, are dissatisfied with these proceedings.

Considering the great importance attached to the system of Weights and Measures by all Governments, it is remarkable that the transactions in limes in Dominica, which amount to 55,000 to 60,000 barrels annually, are unregulated as regards a legal measure, and are, for all practical purposes, still outside the Law.

The question of a standard measure for limes is referred to at page 69 in the handbook issued by the Imperial Department of Agriculture, on 'Lime Cultivation in the West Indies', from which the following paragraph is quoted, and on which future action might be based:—

'Measurements were recently made of what purported to be a standard flour barrel, and it was found to contain, when filled to the top, 4.55 cubic feet, equivalent to 28.44 gallons or 3.55 bushels. When filled only to the level of the lining hoop, it held 27.57 gallons or 3.45 bushels. It may perhaps be suggested that a standard barrel for this purpose should be  $4\frac{1}{2}$  cubic feet. This would be equivalent to a box having an inside measurement of 24 inches  $\times$  18 inches  $\times$  18 inches. A box measuring 15 inches  $\times$  15 inches  $\times$   $34\frac{1}{2}$  inches would have almost the same capacity, the deeper box making more accurate measurements possible.'

## Extension of Interest in Agriculture.

### THE VICTORIA MUSEUM.

During the year the Victoria Museum lost the services, through removal to Trinidad, of Mr. L. P. Jarvis, its Honorary Secretary. The loss of two such valuable workers as Mr. E. A. Agar recorded last year, and now of Mr. Jarvis is keenly felt. Mr. Jarvis collected for the Museum the excellent collection of corals which is probably not equalled in any of the museums in the Antilles. He was also responsible for the bringing together of almost a complete set of the coins of Dominica. These exhibits will form a lasting tribute to his valuable share in the work of the Museum.

The Assistant Curator and Chemist, at the request of the Directors has undertaken the work of Secretary to the institution.

### PERMANENT EXHIBITION COMMITTEE.

As in the previous year it was decided that under the present conditions Dominica would not participate in exhibitions, no meeting of the Committee was held during the year. The vote allowed for this service was however utilized in purchasing and shipping fruit—mainly limes—to be forwarded to the naval and military hospitals in England. This work was carried on as steadily as shipping facilities allowed throughout the fruit season. In all 301 boxes of fruit were forwarded; these were contributed as follows:—

Permanent Exhibition Committee, Limes, ...	269
Botanic Gardens, Oranges ...	16
Botanic Gardens, Grape-fruit ...	10
Sylvania Estate, Oranges ...	6
Total	301 boxes

Mr. A. E. Aspinall of the West India Committee made all the arrangements for the distribution of the fruit in England, and the gratitude of the Government is due to him and to Messrs. Scrutton, Sons & Co., on whose steamers the fruit was carried free of charge.

From letters received from Mr. Aspinall it is apparent that the fruit arrived in good condition, and is much appreciated in the hospitals.

Mr. R. E. A. Nicholls is closely associated with this Department in the selection, packing and forwarding of the fruit.

## Report on Agricultural Instruction at the Botanic and Experiment Station.

In last year's report a very detailed account was given of the system of Agricultural Instruction which has been in vogue in this Department during the last six years. To this the reader who requires full information is referred. It is not necessary to reproduce in detail the work done during the year under review; it is sufficient to state that the work has been carried out on lines similar to that described in the report referred to.

### SELECTION OF NEW PUPILS.

No less than fourteen candidates presented themselves for the entrance examination in July last for which there were two vacancies. J. Hutton and J. Le Blanc were finally selected.

It may be of interest to record the fact that one candidate who failed in the entrance examination applied for admission as an unpaid pupil. This boy was allowed to enter for training and has attended regularly with the other pupils at the Gardens. This fact is very significant, especially when it is considered that the class from which the pupils are drawn often have to make considerable sacrifices to retain their sons at the Station, even with the allowances made. It seems possible that at no distant date it will not be necessary for the Government to make monetary allowances to the pupils, but that the training given will be so appreciated by the parents of the boys that they will be prepared to defray all expenses. It is quite probable that unpaid pupils would take a keener interest in their work than those who may be induced to enter for training mainly because of the allowance made.

### HALF-YEARLY EXAMINATION.

The half-yearly examinations of the agricultural pupils were held in July and December. The examinations are conducted by the Imperial Department of Agriculture, and the following extracts from the examiner's reports are reproduced:—

'The questions, which followed closely on the lines of the instruction given, were adequately and often very well answered; those which made demands on the pupils' powers of applying the knowledge acquired, or on their own observation even of familiar things, showed up their weakness in these respects but enabled the more intelligent of them to take the lead.

'The answers, taken as a whole, give evidence of sound instruction in the principles of tropical agriculture well impressed upon the pupils. In the latter respect the results were more satisfactory than in some recent examinations. I have gained the impression from a consideration of the papers that the differences in completeness, reflected in the marks given, arise rather from inability to frame expressive answers than from absence of knowledge of the matters discussed. Positive mistakes are very few.'

## EXPENDITURE.

## Details of Administration.

## EXPENDITURE, RECEIPTS, ETC.

The votes for the Agricultural Department for the year from local funds were as follows:—

	£	s.	d.
Salaries, Curator, Assistant Curator and Chemist and Foreman	602	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 pony	25	0	0
Telephone rental	8	0	0
Picket fencing	15	0	0
Purchase of special manures	40	0	0
Printing reports, etc.	40	0	0
Cacao Prize Holdings Competition	25	0	0
Lime Experimental and Coco-nut Plantations	175	0	0
Purchase of vegetable seeds	15	0	0
Trial shipments of fruit	20	0	0
Field experiments	20	0	0
Chemicals and Apparatus	55	0	0
New stove and wire netting for cacao drying house	20	0	0
Contingencies	10	0	0
Total	£1,680	0	0

The actual expenditure during the year under the above heads was £1,558 7s. 2d. After the hurricane a Special Grant of £40 was made for clearing away the wreckage of trees, and for executing minor repairs to buildings. The total expenditure was therefore £1,598 7s. 2d.

The receipts from sales of cured cacao, plants, fruits and seeds amounted to £462 5s. 10d.

The grant to meet the cost of training agricultural pupils was £195, of which £180 0s. 10d. was expended.

The amount available for Special Services on April 1, 1916, was £48 3s. 0d. This sum is all that remains of the lapsed balances on the Imperial Grant for the Agricultural Department in former years. It has been ear-marked to assist in furnishing the laboratory which it is proposed to build in the Botanic Gardens.

## STAFF CHANGES.

The Assistant Curator and Chemist was given leave of absence from November 18 to 28 inclusive.

E. B. Joseph, Overseer in connexion with Agricultural Instruction, resigned, and E. J. Pierre, late Agricultural Pupil, was selected to fill the vacancy.

### ADDITIONS AND REPAIRS TO BUILDINGS, NURSERIES, ETC.

Under present circumstances it is not possible to record much under this head.

Towards the close of the year a fence 225 feet long, of reinforced concrete pillars on a concrete base, was built on the southern boundary of the Gardens, in which place it affords a measure of protection which has long been needed.

A few minor repairs to buildings were also carried out.

### CORRESPONDENCE AND DISTRIBUTION OF INFORMATION ON AGRICULTURAL MATTERS.

During the year 1,115 letters were despatched from the office of the Department, and ninety-one minute papers were dealt with. Forty-nine copies of the various issues of the *West Indian Bulletin*, and 165 copies of the Annual Report of the Agricultural Department for 1915-16 were distributed free of charge to leading planters, officials, and others in the island.

As in previous years the Department was visited by a large number of planters and others desiring information on agricultural matters.

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 together. This opportunity is again taken of thanking those Departments who kindly forward their publications. Mr. A. H. Green, of Canefield estate, kindly presented to the library a copy of Rolf's 'Subtropical Vegetable Gardening'.

### VISITS TO ESTATES AND SMALL HOLDINGS.

During the year under review the travelling accomplished by the staff of the Department was far in excess of that attempted in ordinary years. As it happened, a considerable portion of the usual amount of travelling had been accomplished prior to the hurricane of August 28. A large number of estates had been visited in connexion with plant diseases, a tour of the Lasoye district had been made, and the peasants at Laplaine had been visited. After the hurricane it was thought advisable to make a tour of the island to prepare an estimate of the extent of the damage, and to give what assistance was possible to planters and peasant proprietors by advice and demonstrations.

It is not possible to publish in detail what was accomplished, but the Government was placed in possession of a confidential report which enabled it to form an opinion as to the extent of the damage.

It may however be stated, that in many instances during these visits planters on various estates placed at our disposal a sufficient number of labourers to make demonstrations as to how injured trees might be treated, and in the case of peasant proprietors advice was eagerly sought and in many cases acted on.

### 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; Royal Botanic Gardens, Ceylon; Royal Botanic Gardens, Trinidad; the Department of Agriculture, Jamaica; the Agricultural Departments of Northern Nigeria, St. Lucia, Grenada, and Antigua; also from the Hon. Dr. Nicholls, C.M.G., and A. H. Green, Esq.

## METEOROLOGICAL.

Seeds and plants were sent to: The Imperial Commissioner of Agriculture; the United States Department of Agriculture; Department of Agriculture, Jamaica; the Forest Department of Nairobi; the Agricultural Departments of Surinam, British Honduras, St. Croix, St. Lucia, Grenada, Antigua, Montserrat and Tortola; and also to A. Giraud, Esq., French Consular Agent; the Hon. Dr. Nicholls, C.M.G., and A. H. Green, Esq.

## VISITS BY OFFICIALS OF THE DEPARTMENT.

Sir Francis Watts, K.C.M.G., Imperial Commissioner of Agriculture for the West Indies, paid brief visits to the island on his way to and from Barbados from the Northern Islands on the following dates: August 25, September 18, and November 8. On each occasion the opportunity was taken of consulting the Commissioner on agricultural matters. On September 18, he visited the Layou Valley.

Mr. Wm. Nowell, D.I.C., Mycologist on the staff of the Imperial Department of Agriculture, spent eleven days in the island from August 11 to 21, continuing his investigations of the fungus diseases attacking limes and cacao.

## METEOROLOGICAL RETURNS

## RAINFALL.

The rainfall at the Botanic Gardens for 1916 amounted to 84.45 inches or 15.59 inches less than the previous year and 6.18 inches more than the average precipitation of the last twenty-four years, which is 78.24 inches.

The following tables show the monthly and annual rainfall at the Botanic Gardens from 1893 to 1916, a period of twenty-four years, and the accompanying chart shows at a glance the fluctuations from year to year.

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 5 inches, and that July and August are the wettest months with a precipitation of over 10 inches.

Following the above will be seen the monthly rainfall at the thirty-three recording stations located in different parts of the island, and 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 thirty-four stations is 125.70 inches or 11.41 inches less than that of the previous year. By taking the island in districts we obtain the following returns: the twelve Leeward coast stations registered a mean of 91.99 inches; the three Windward coast stations averaged 147.62 inches; the eleven Inland stations 169.65 inches, and the seven Lasoye stations 123.92 inches.

## ADDITIONAL METEOROLOGICAL OBSERVATIONS.

As was stated in the previous progress report, a reliable set of meteorological instruments including a barometer, anemometer, and a set of thermometers all corrected at the Meteorological Office, London, were received at the expense of the Imperial Government. Though these instruments have been on hand for over twelve months, owing to lack of a suitable house to place them in, no reliable thermometer observations were possible. The barometer is placed in the temporary laboratory, and the anemometer has been mounted on the fairly open lawn at Government house and His Honour the Administrator has kindly undertaken to take

## METEOROLOGICAL.

the readings. It is hoped that during the coming year it may be found possible to erect a suitable structure for housing the instruments to enable complete and reliable readings to be taken. With this object in view a small sum has been placed on the current Estimates.

## ANEMOMETER READINGS.

As stated above, the anemometer is mounted on a pole in a fairly open lawn at Government House. In a mountainous country like Dominica the observations of the anemometer are only of value to those in the immediate vicinity, and consequently, to obtain reliable information several stations would have to be established.

The following data, supplied by His Honour the Administrator, cover a period of three months, May to July:—

Average breeze per 24 hours over three months	= 34 miles.
" " " 1 hour " " "	= 1.42 "
Maximum wind in any 24 hours " " "	= 106.2 "

## THE HURRICANE OF AUGUST 28, 1916.

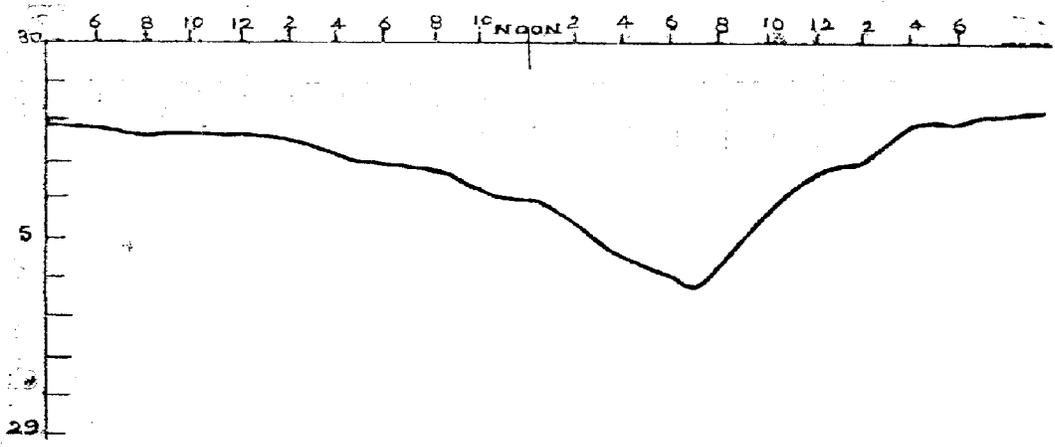
As stated in a previous section of this report, a severe hurricane passed over the island on August 28, 1916. This following so close on that of August 10, 1915 and being much more severe, inflicted considerable damage to the island.

Copies have been made of two barograph charts, the property of the Hon. W. H. Porter, and are reproduced. These show the barometer readings during the two hurricanes, and shows the greater depression which accompanied the hurricane of the year under review.

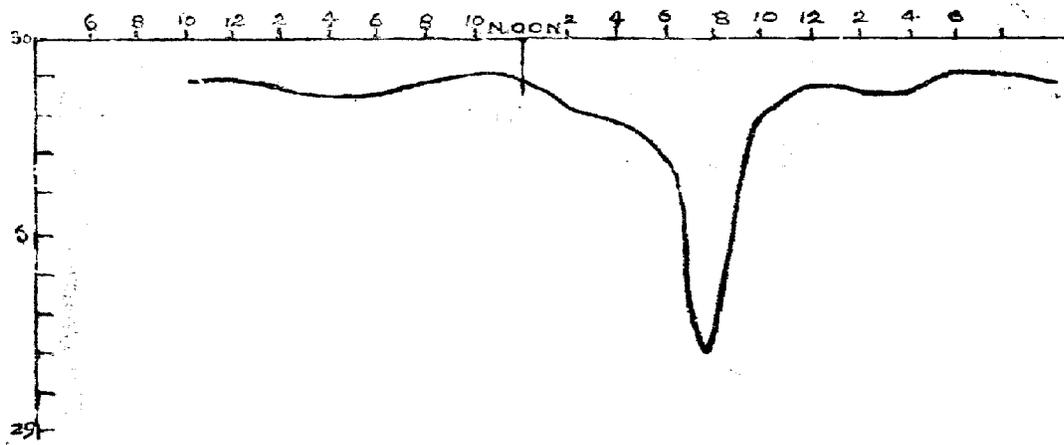
It may be of interest to place on record the anemometer readings during the period of the hurricane. Unfortunately the maximum mileage at any given moment is not recorded by the form of anemometer in use, which gives only the total for a certain period.

From 9 a.m. August 28 to 9 a.m. August 29, a total mileage of 996 was recorded = 41.50 miles per hour.

Between 6.30 on the evening of the 28th and 6.30 a.m. on the 29th, the average mileage per hour was 82.25. It is evident that at the time of the hurricane the mileage must have exceeded 100 miles per hour.



Barograph record of hurricane, 1915, Dominica Botanic Gardens.



Barograph record of hurricane, 1916, Dominica Botanic Gardens.

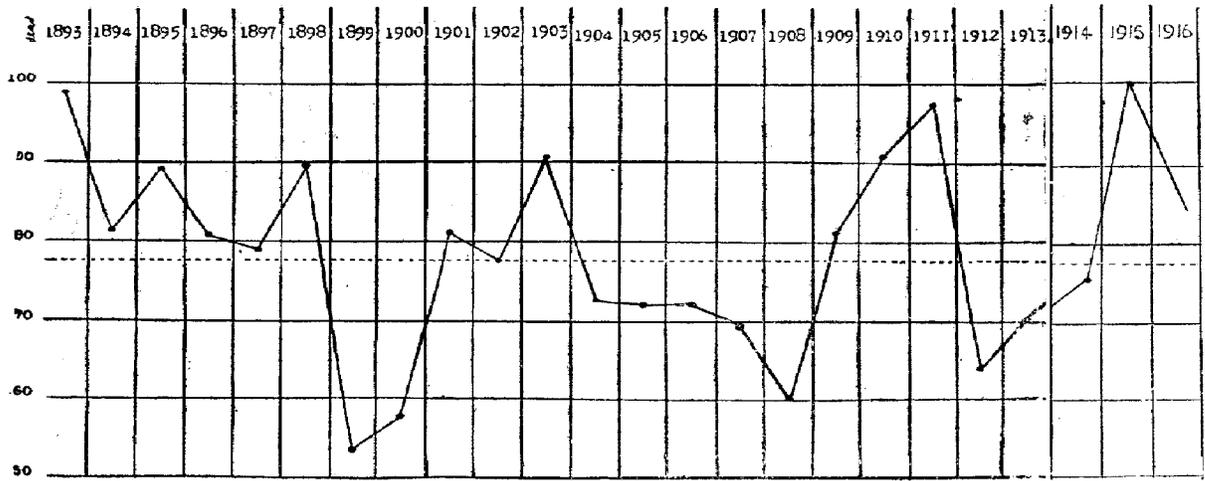


Diagram showing average annual rainfall in the Botanic Gardens, Dominica, 1893-1916.

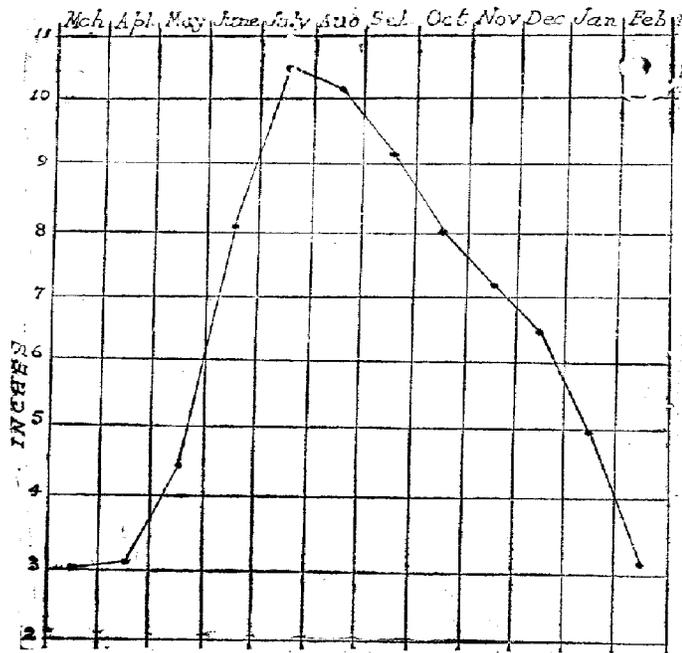


Diagram showing mean monthly rainfall, Botanic Gardens, Dominica, for 23 years, 1893-1916.

RAINFALL AT THE BOTANIC STATION, DOMINICA, 1893-1916.

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	Mean monthly rainfall
January	3.02	10.50	4.08	5.52	2.60	3.00	0.78	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	4.98
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	3.27
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	.84	4.32	3.02
April	4.71	2.33	2.92	1.27	1.39	0.75	0.60	1.29	0.25	2.86	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	3.45
May	5.45	3.09	10.08	6.12	12.75	1.19	1.76	7.62	2.05	6.86	2.44	1.58	4.32	3.78	1.64	2.24	1.92	7.30	11.16	1.56	3.46	2.58	3.65	2.05	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	6.34	5.44	3.49	7.27	9.17	4.82	8.06
July	13.67	8.62	7.13	14.88	8.80	14.75	10.08	10.56	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	14.81	8.23	10.63
August	11.36	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	9.11	13.12	10.22	11.43	4.88	10.93	3.98	14.74	16.58	10.49
September	11.15	8.22	17.42	6.17	4.51	7.89	7.04	5.28	5.86	8.62	9.69	11.32	8.92	10.88	11.69	7.52	6.44	8.90	15.34	3.32	8.39	7.71	11.36	6.20	9.16
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	8.09
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	7.25
December	10.61	4.99	5.66	6.60	10.55	5.86	2.19	3.68	1.32	7.16	11.23	0.84	5.72	2.94	8.42	7.80	5.82	7.50	7.14	6.66	2.72	9.70	8.40	3.77	6.59
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	63.75	69.90	75.10	100.01	84.42	



## Report on Manurial Experiments.

### 1. LIMES.

A series of manurial experiments with lime cultivation was laid out in the valley beyond Morne Bruce in the early months of the year 1913. Prior to this date co-operative experiments with planters had been attempted on two or three estates, but after a short period—mainly owing to the difficulty of recording the crops necessitating as it does close on 100 pickings in one year—it was found impossible to obtain reliable data.

It was fortunate that the Government possessed land in fairly close proximity to the Botanical Gardens, i.e. in the valley beyond Morne Bruce, which was available for conducting these experiments. As stated above, a vote was allowed for this service early in the year 1913 and has been renewed annually since that date. The experiments may be divided into two series:—

Series 1—with old lime trees found on the land when the experiment was started.

Series 2—with young lime trees planted in July of 1913.

#### SERIES 1.—WITH OLD TREES.

The condition of the lime trees constituting series 1 when the experiment was commenced in 1913 may be gathered from the following extract, taken from previous reports, which for ease of reference is again reproduced:—

'The limes in question were planted during 1893 by the boys of the Reformatory School, a Government institution which existed at Morne Bruce from January 1893 to December 1895. To the end of the latter year the plants were cared for, but from that time to the present the land has remained in bush amongst which the limes have struggled to exist. On the bush being removed, the lime plants were found, as expected, to be poor in condition and attenuated in appearance. With attention, these poor limes should develop into healthy well-shaped trees in the course of time.

'It is to be expected, under the conditions stated above, that the plots are not complete. Vacancies occur in each, which will be filled in as soon as possible.

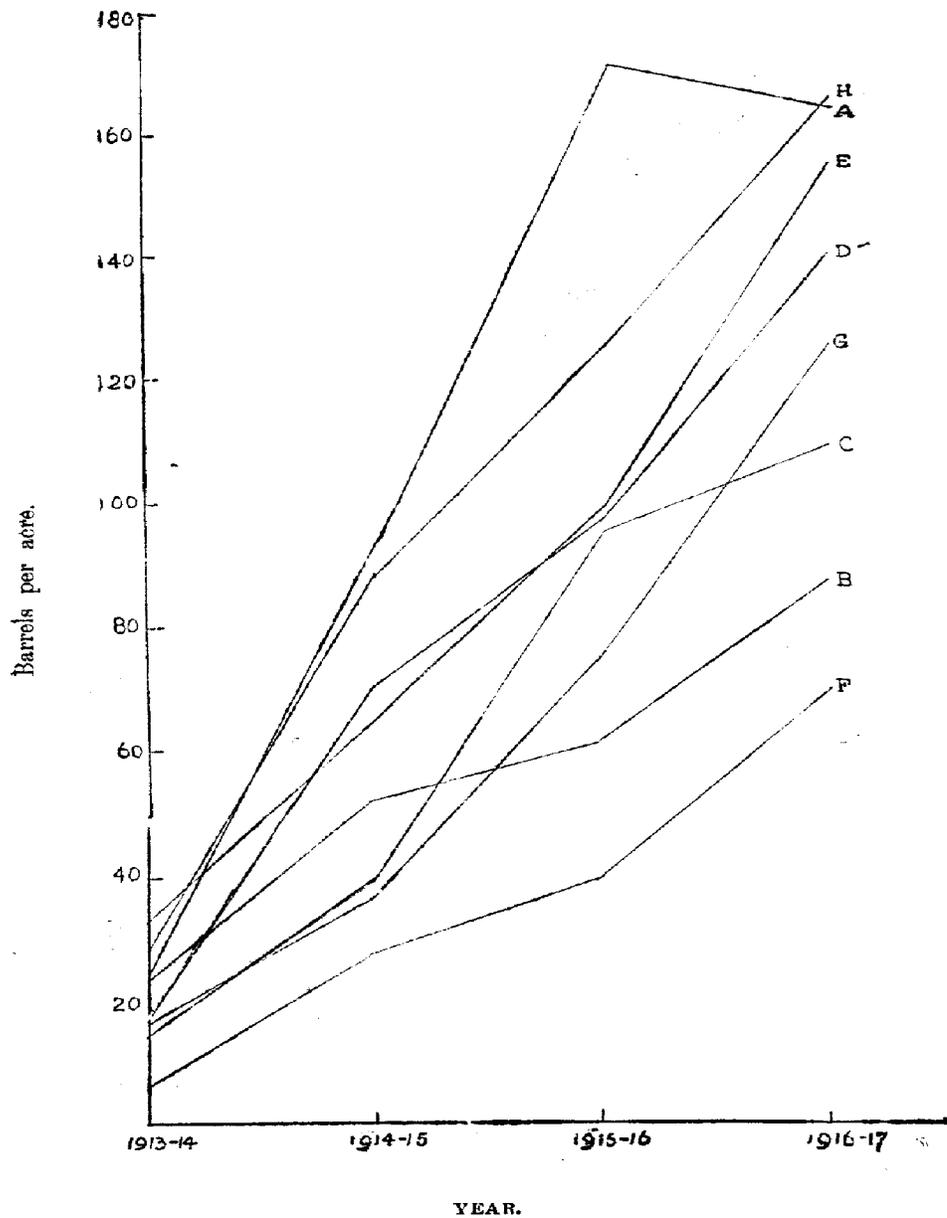
'The land occupied by the plots is sloping in character, conditions typical of large areas of lime cultivation in the island.'

The area of lime trees was sufficient to allow of eight plots of approximately  $\frac{1}{4}$ -acre each to be started. Up to August of the present year the trees improved in appearance almost beyond expectation. Each individual tree developed into well-shaped, healthy-looking specimens, and it may be stated that in proportion to the vegetative development, the trees improved in bearing capacity.

Unfortunately the hurricane of August 1916 caused very serious damage to these plots. A, B and C were so seriously injured that they had to be entirely replanted, only a few trees surviving. Both plots D and E, were considerably damaged but will recover; whilst plots F, G and H suffered comparatively little permanent damage. All the plots suffered a serious loss of crop by the blowing off of immature fruit.

The interruption to this series of experiments has been serious and will necessitate a complete reorganization of the plots. Meanwhile two tables are given below; the first shows the manurial treatment that each plot has received annually since 1913, and the number of standard barrels of  $4\frac{1}{2}$  cubic feet capacity yielded by each plot, and its equivalent per acre; the second table gives the yield per acre in barrels during the last two years, divided into two periods. This latter table shows the relative yields of the trees during the last two years to a date which includes the heavy pickings resulting after the hurricanes of the two years, and are therefore comparable, as the hurricane of August 1915 was sufficiently severe to blow off most of the fruit without seriously injuring the trees. The figures in this table also bring out the effect of the hurricane on the three plots A, B and C.





MANURIAL EXPERIMENTS WITH LIMES.

A, complete manure ; B, control ; C, mulched with grass ; D, dried blood ;  
 E, sulphate of ammonia ; F, sulphate of potash ; G, phosphates ;  
 H, nitrogen and phosphates.

## RESULT OF MANURIAL EXPERIMENTS WITH LIMES.

TABLE SHOWING YIELD OF LIMES PER ACRE IN BARRELS DURING PAST TWO YEARS.

	A	B	C	D	E	F	G	H
April 1, 1915 to September 30, 1915 ...	117	50	71	75	75	28	54	85
April 1, 1916 to September 30, 1916 ...	142	79	106	102	132	56	91	122
October 1, 1915 to March 31, 1916 ...	55	12	25	23	24	12	22	41
October 1, 1916 to March 31, 1917 ...	23	9	4	39	24	14	36	45

Following the tables there is published a chart which brings out in a clear manner the varying yields of the plots under the different manurial treatment.

This series of experiments for the reasons given above comes to an end after four years' continuous treatment. Whilst it is impossible for many reasons to be exact, several important general principles in the manuring of limes have been brought to light. These may be discussed as follows:—

1. The application of a complete manure of nitrogen, phosphates and potash, has resulted in a very substantial and highly remunerative increase in crop. The apparent decrease in crop for 1916-17 is entirely due to the hurricane. The actual yield obtainable by this treatment per acre was not satisfactorily determined owing to the short period of the experiment, but it is probably well over 200 barrels per acre.

In normal times the cost of this manure would not be more than £4 per acre, and with limes worth 5s. per barrel, an additional crop of only 16 barrels per acre would cover the outlay.

Owing to the short period covered by the experiment it is not possible to give an opinion as to whether on continued application, the trees would maintain their present exceptional vigour.

2. The application of manure containing nitrogen and phosphates but no potash has given remunerative increases in crop, and is the composition of the manures mainly used in Dominica at the present time. Potash has not been used, due largely to the results obtained by the chemical examination of Dominica soils at the Government Laboratory, Antigua, by Dr. (now Sir Francis) Watts, in which it was found that the amount of assimilable potash is usually present in considerable quantities. These experiments however, have indicated clearly the advantage of having a manure which includes potash in its composition. This is probably due to the usual liking for potash which citrus plants in general exhibit. Analyses lately performed in this laboratory would indicate that a crop of 150 barrels of limes removes from the soil the following manurial ingredients:—

Nitrogen	46.7 lb.
Phosphoric acid	13.7 ..
Potash	33.1 ..

From these figures it is clear that the need for potash is much greater than for phosphates, and it is unfortunate that this series of experiments had no potash-nitrogen plot. In the new series a potash-nitrogen plot is included.

## DISCUSSION OF RESULTS.

3. Quite good results appear to be possible by the use of nitrogen alone, either in the form of dried blood (organic) or sulphate of ammonia (mineral.) These two forms of nitrogen were selected in order to demonstrate the harmfulness of the continued application of sulphate of ammonia as compared with dried blood. There is strong evidence in support of the contention that the continued application of nitrogen in the form of sulphate of ammonia is harmful to lime cultivation. It has been clearly demonstrated that such is the case with certain crops in Woburn, England.

It is unfortunate that the continuity of these experiments should have been interfered with so soon, and before sufficient time had elapsed to demonstrate the point referred to.

It would be well for the planter who might be disposed to use sulphate of ammonia as a result of the good returns obtained on these plots to bear in mind the possible ill-effects of its repeated application. At the same time, as a stimulant to trees that have long been neglected, these experiments show that it has its valuable uses.

4. It is not advised that either phosphates or potash be applied alone without nitrogen (plots G and F).

5. The experiments were not sufficiently prolonged to demonstrate the true value of mulching on lime cultivations. The indications were that, in the course of time the mulched plots would have given yields comparable with the complete manure plot. This form of manuring is included in the new series.

6. Without manures the yield of fruit is low and the trees present a starved appearance (plot B).

The reorganized experiments will consist of six plots, and they will be repeated twice with young limes, so that each experiment will be in triplicate. The plots will be 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. " " potash.
- F. Nitrogen alone.

## SERIES 2.—WITH YOUNG LIMES.

This series consists of eight  $\frac{1}{4}$ -acre plots of trees planted in July 1913 on land which had been in gardens for many years and was in a more or less ruinous condition. They were planted 20 feet apart each way with an additional 10 feet between the plots.

For the first two years the trees made excellent growth, the only cultural operations being weeding and spraying when necessary. No manures were applied. At the beginning of 1915 it was decided to give up the spraying operations hoping that the trees were sufficiently established to withstand any possible attacks of scale insects, and that with the aid of their natural enemies these would be kept in check. It soon became evident that the scale insects were making headway and the year closed with the large majority of the trees seriously injured. In many cases the branches were killed down to the main stem.

This is a condition of things not uncommon with limes grown on old cane or garden soils near the coast. It is however very seldom if ever met with on estates formed out of forest and on the best types of valley soils. It is evident that it is largely a question of soil conditions.

The plots in question were towards the close of 1915 thoroughly drained and forked, a small application of lime was made and each tree received 2 lb. of organic manure containing nitrogen and phosphates. In addition, the area between the trees was planted with the horse bean (*Canavalia ensiformis*). The effect of this

## EXPERIMENTS WITH YOUNG LIMES.

thorough treatment became evident during 1916—the year under review—when the trees made good growth and are now green in colour and comparatively free from scales. The horse beans were cultivated throughout the season. No spraying was again resorted to.

The future progress of these plots will be watched with interest. In addition to the eight plots referred to above, there are six other plots of young limes a year younger, having been planted in July 1914. Three of these plots consist of ordinary seedling limes, and the other three include two plots of ordinary spiny limes budded on sour orange stocks and one plot of spineless limes on sour orange stocks.

The three plots of seedling limes have been variously treated as follows: (a) clean weeded, (b) grown in tall green dressings (*Tephrosia candida*), (c) grown in short green dressings (horse bean). All these plots have been sprayed periodically and have also received an application of 2 lb. of organic manure per tree for the last two years.

The clean-weeded plot shows no advantage over limes grown in grass in the ordinary way and, naturally, the cost of cultivation is considerably greater. The trees are very liable to attacks of scale insects.

Plots b and c have made good progress, showing but little difference between one another. By spraying they have been kept comparatively free of scale insects and have not suffered the check in growth referred to above.

The three remaining plots consisting of limes budded on sour orange stocks have been treated as follows: the spineless variety has been cultivated in horse beans, one of the spiny plots has been cultivated in tall green dressings and the other in the ordinary way. All three have been sprayed periodically and have received 2 lb. of manure per tree.

The difference in growth of the plot growing in *Tephrosia* when compared with the grass plot is most remarkable. The trees in the former plot are now 8 to 10 feet high and are comparatively free from scale insects. The trees of the plot in grass are very liable to attacks by scale insects which require repeated sprayings to keep them down. Their average height is from 4 to 5 feet. It is evident that budding on sour orange stocks does not reduce liability to scale insect attacks. Early in 1917 this plot was forked and sown down to *Tephrosia candida*.

In a year or two it may be possible to summarize the results obtained in the growing of young limes. At the present time the plots seem to be passing through the critical stage in their development. It is a remarkable fact that in Dominica limes when once thoroughly established remain practically free from scale insect attacks. These experiments will, it is hoped, show how the critical period referred to may best be overcome.

## MANURIAL EXPERIMENTS WITH CACAO.

## II.—MANURIAL EXPERIMENTS WITH CACAO.

The customary review of the results obtained in the manurial experiments with cacao conducted by the Agricultural Department in Dominica is now given.

A change in the method of presenting the report was made last year and the method then adopted is again used. Nine of the eleven plots have been running for a sufficient length of time to draw definite conclusions therefrom, whilst the remaining two, started in 1913-14, are not strictly comparable and are therefore discussed separately.

The first seven plots are situated on level ground and occupy approximately 2 acres. The soil is moderately even in character, especially that of plots 1, 2, 3, 6 and 7. Plots 4 and 5, on a lower level, are rather heavier, plot 4 being distinctly so.

Plots 8 and 9 are situated on a steep hillside, a situation typical of many acres of cultivation in Dominica.

The physical and chemical nature of the soils of the plots have been ascertained at the Government Laboratory, Antigua, and may be seen on reference to the *West Indian Bulletin* (Vol. IV, pp. 81-119).

It is here necessary to make a correction in the published figures of the last few years. In a paper recently published\* on the significance of the results obtained in these experiments, the writer makes the following statement :—

‘In previous statements of the results of these experiments however, one important point has not been taken into account. It will be observed that the yield of the control plot began some 300 lb. of cured cacao per acre below the plots which were to receive treatment . . . allowance should have been made for this constant difference.’

On referring to previous progress reports of this Department it will be ascertained that in the year 1900-1, the Hon. (now Sir) Francis Watts laid out a certain scheme of manurial treatment, which after slight modification was adopted in that year. The manures were applied in May-June of the same year for the first time, and the same manures have been used annually without a break since that date.

In the following year, (Progress Report 1901-2, p. 5) the following report on these plots appeared :—

‘The cacao manurial plots failed to show any improvement over the control plot during the year. This is attributable to two very dry years, the rainfall in which was 33.31 inches and 23.95 inches, respectively, below the average. During the present period the rainfall has been normal, but badly distributed, nearly 50 inches falling in June, July, and August. The experiment will be continued and the result of the application of special manures, if any, noted under normal climatic conditions.’

‘What strikes one most in dealing with fields made of various strains is that certain kinds of cacao usually bear well, while other trees exist that year after year bear little or nothing. This shows the importance of selecting pods for seed only from prolific strains. This has been done largely in Dominica for the past nine years. All the plants and pods distributed are carefully selected, and in quality and bearing powers Dominica cacao should show a great improvement in the future.’

For the first two years the yields of the plots were not actually weighed, as it was then thought possible to estimate the results sufficiently accurately by the appearance of the trees and the crops thereon. After two years of manuring the plots failed to show any visible improvement over the control plot.

\* *West Indian Bulletin*, Vol. XVI, pp. 121-6.

## DISCUSSION OF DEPENDABILITY OF RESULTS.

During 1902-3 after the third application of manures it was decided to weigh the yields from each plot separately, and the figures were published.

The conclusion of the writer referred to above as to the natural yield of the control plot being lower cannot be accepted as definite. The increase of some 300 lb. of cured cacao per acre shown by all the plots over the control plot in 1902-3 may quite easily have been due to the two applications of manure they had received and not to the supposed smaller 'natural yield' of the control plot. As reference to these reports show, the control plot was in no way inferior to the other plots at the outset of the experiment.

It is regretted that these facts were omitted from previous recent reports; the omission has led to a certain amount of confusion.

The first five plots were thus started in the year 1900-1, and the crops were first weighed in 1902-3. Similar treatment has been accorded to each plot in every succeeding year, so that at the present time the condition of each represents the accumulated results of seventeen years' continuous treatment on the same lines. The remaining four plots were started eight years later, and each plot has thus obtained identical treatment for ten years.

The following supplementary table gives the average annual returns of wet and dried cacao in pounds for fifteen years in the case of the first five plots and for nine years in the case of plots 6-9. The last column shows the percentage increase of each plot over the no-manure plot:—

No.	Manurial treatment.	Wet cacao,		Cured cacao,	Increase over no-manure plot, per cent.
		per plot.	per acre.	per acre.	
1	No manure ... ..	790	2,821	1,185	...
2	Phosphate and potash ... ..	1,018	3,493	1,467	23·8
3	Dried blood ... ..	1,236	3,433	1,442	21·7
4	Dried blood, phosphate and potash	1,156	3,986	1,674	41·3
5	Mulched with grass and leaves ...	1,590	4,297	1,805	52·3
6	Mulched with grass and leaves ...	1,250	5,000	2,100	77·2
7	Cotton-seed meal ... ..	1,050	4,200	1,764	48·8
8	No manure ... ..	920	2,222	933	...
9	Mulched with grass and leaves ...	1,515	4,062	1,706	82·8

The pecuniary aspect of the experiments is dealt with in the two following tables in which are shown the gain from the application of the different manures both for the average return of the entire period during which the experiments have been conducted, and that for the year under review. In calculating the monetary gain, the value of cured cacao has, as in previous reports, been assumed at 6*d.* per lb. During the last two years the value of cacao has been very considerably higher than this, but at the same time the cost of the manures has risen, especially sulphate of potash now practically unobtainable on a commercial scale.

Under these circumstances, it is thought best not to change the values, at least not until conditions are more settled.

In calculating the monetary gain resulting from the application of the various manures, the cost of collecting and applying the mulch to the various mulched plots has been assumed at 80*s.* per acre. In practice at the Botanic Gardens, it is

## MONETARY GAINS FROM MANURING.

considerably less than this since the collecting of the fallen leaves constitutes a part of the ordinary routine in the care of the grounds. It is estimated, however, that a mulch of the size indicated could be obtained from the surrounding bush and applied under the conditions obtaining on a cacao estate in Dominica, for the sum mentioned. Further, under estate conditions in Dominica sheep and pen manure can be made at a cost of under 20s. per ton, and this when applied to the cultivation would produce similar results to the mulch referred to above.

The following table shows the average monetary gain from manuring over the whole period of the experiments:—

Plot.	Average annual yield of cured cacao, per acre.	Gain in cured cacao over No manure.	Value per acre of increase over No manure at 6d. per lb. of cured cacao.	Cost of manuring per acre.	Net gain per acre by manuring.
	lb.	lb.	s. d.	s. d.	s. d.
1	1,185	...	...	...	...
2	1,467	282	141 0	45 3	95 9
3	1,442	257	128 6	52 0	76 6
4	1,674	489	244 6	97 3	147 3
5	1,805	620	310 0	80 0	230 0
6	2,100	915	457 6	80 0	337 6
7	1,764	576	288 0	40 0	248 0
8	993	...	...	...	...
9	1,706	773	386 6	80 0	306 0

The monetary gain for manuring during the year 1916-17 may be shown as follows:—

No.	Yield per acre of cured cacao 1916-17.	Gain per acre over No manure.	Value per acre of increase over No manure at 6d. per lb. of cured cacao.	Cost of manure per acre.	Net gain per acre, by manuring.
	lb.	lb.	s. d.	s. d.	s. d.
1	1,412	...	...	...	...
2	1,861	449	224 6	45 3	179 3
3	1,746	334	167 0	52 0	115 0
4	2,152	740	370 0	97 3	272 9
5	2,011	599	299 6	80 0	219 6
6	2,318	906	453 0	80 0	373 0
7	1,878	466	233 0	40 0	293 0
8	1,140	...	...	...	...
9	1,760	620	310 0	80 0	230 0

## INCREASES DURING 1916-17.

The yield of the plots during the past year when compared with that of previous years gave satisfactory results. When compared with the results of the preceding year, which owing to unfavourable climatic conditions was not a good year, the increase looks abnormal, but when compared with the average yields of the whole period we find that all the plots show substantial increases.

The results obtained by this method are tabulated below :—

No.	Average yield over whole period of experiment, cured cacao lb. per acre.	Yield for 1916-17 in cured cacao, lb. per acre.	Increase or decrease in lb. of cured cacao.	Increase in 1916-17 over whole period, per cent.
1	1,185	1,412	+227	19.1
2	1,467	1,861	+394	26.8
3	1,442	1,746	+304	21.1
4	1,674	2,152	+478	28.0
5	1,805	2,011	+206	11.3
6	2,100	2,318	+218	10.7
7	1,764	1,878	+114	6.4
8	933	1,140	+207	22.0
9	1,706	1,760	+54	3.1

During the past year a hurricane was experienced which accounts for the variation between the increased yields of the various plots.

Some of the plots suffered the loss of several trees, others were only badly shaken. From observations made it would appear probable that when fruit trees are seriously shaken the tendency is for them to flower profusely and produce an abundance of fruit. This is probably what has happened to the complete manure plot, which produced the highest crop on record for this plot and 28 per cent. more than the average return over seventeen years.

## NUMBER OF TREES PER PLOT.

The following table shows the number of trees per plot and per acre at the present time, the area of each plot, the manurial treatment received, and the year of the first application of the manure:—

No.	Letter on station plan.	No. of trees per plot, 1917.		Area of plots in acres.	Manurial treatment.	Year of first application.
		Bear-ing.	Non-bear-ing.			
1	C	54	15	0.28	No manure.	1900-1
2	A	60	6	0.29	Basic slag 4 cwt. per acre. Sulphate of potash 1½ " " "	"
3	R	66	5	0.36	Dried blood 4 " " "	"
4	E	42	6	0.29	Basic slag 4 " " " Dried blood 4 " " " Sulphate of potash 1½ " " "	"
5	D	49	4	0.37	Mulched with grass and leaves 5 tons per acre.	"
6	F	49	6	0.25	Mulched with grass and leaves 4 tons per acre.	1907
7	G	50	3	0.25	Cotton-seed meal 660 lb. per acre.	"
8	H	86	2	0.414	No manure.	"
9	I	88	1	0.373	Mulched with grass and leaves 5 tons per acre.	"
10	K	106	...	0.4	Mulched with grass and leaves 2½ tons per acre. Lime 5 cwt. " "	1913
11	L	95	...	0.25	Calcium cyanamide (Nitrolim) 2½ cwt. per acre.	"

Some years ago the plan was adopted of planting on each plot a sufficient number of trees to cover the ground, and the figure given represents the number of bearing trees in each plot at the present time. In several plots a number of trees have recently died, especially in the control plot 1, there being no fewer than fifteen non-bearing trees in this plot at the present time. The continued fluctuation in the number of trees renders the figure for the yield per tree very uncertain, and this has in consequence been omitted from the results for the season now under review.

The plots have received the same manurial dressings as in previous years. The method of application consists of raking the leafage in a circle round each tree, to apply the manure in the space thus uncovered, and then to rake back the leaves over the manure. In those plots receiving both basic phosphate and dried blood, an interval of several weeks is allowed between the application of the two manures. The mulch after being carefully weighed is scattered evenly over the surface of the plot. The material of which the mulch is composed is of two types, varying widely in their chemical composition. To the mulched plots 5 and 6, varying quantities of mulch composed largely of fallen leaves and pods of the Saman tree (*Pithecolobium Saman*) are used; for plots 9 and 10 no Saman tree material is utilized, but in this case the fallen leaves of the West Indian mahogany tree (*Swietenia Mahagoni*) supply the mulching material. The manures and the mulch are applied once a year. These are the sources of coarse organic matter

## RAINFALL RECEIVED.

which are available in an experiment station of this nature. Similar results would in all probability be obtained by the use of many other forms of organic matter. As an appendix to last year's report there was given the analysis of a large number of materials which could be utilized equally well. Several of these are under experiment in this station, and reliable information as to the quantity which can be produced, and the cost of production will we hope be soon available. The value of several of these manures such as pen manure, sheep manure, etc., are well known and appreciated by planters.

No forking has been performed in any of the plots since the inception of the experiments, the only cultural operations undertaken beyond the application of the manures being the usual ones connected with the pruning of trees and sanitation of the orchard.

The yields of cacao recorded each year are for periods of twelve months terminating on June 30. This date is chosen because there is no cacao being gathered at that time. Other dates possess the disadvantages that, owing to the fluctuations in the spring or carême crop, it may happen that two such crops are included in one year: a late crop of one year and an early crop of the succeeding year; while on other occasions there may be no carême crop in the year under review. Such fluctuations disturb and confuse the records, hence the results are made to refer to the crop year extending from July 1 to June 30. This mode of reckoning is recommended for adoption as a basis of records in connexion with West Indian cacao crops.

The annual rainfall for each year since the inception of the experiments is given below. In accordance with the matter in the previous paragraph, the figures are given for twelve months commencing on July 1 of one year and ending on June 30 of the next.

Period.	Year.	Inches.
Twelve months ending June 30.	1903	72.46
" " " " " "	1904	93.02
" " " " " "	1905	70.13
" " " " " "	1906	74.60
" " " " " "	1907	69.02
" " " " " "	1908	67.08
" " " " " "	1909	69.47
" " " " " "	1910	94.90
" " " " " "	1911	89.71
" " " " " "	1912	80.54
" " " " " "	1913	61.76
" " " " " "	1914	71.60
" " " " " "	1915	80.00
" " " " " "	1916	94.10
" " " " " "	1917	93.71

The following table shows the yields in the year under review, together with those from the plots in each year since the systematic record of the returns was first undertaken.

The yields of the past year are shown in the bottom line of the table. This method enables the progress of each of the plots to be seen at a glance. The yields are given in terms of wet cacao per plot, and pounds per acre, and cured cacao pounds per acre. In calculating the yield of cured cacao per acre, the assumption is made that 100 lb. of wet cacao will yield 42 lb. of cured cacao.

## COMPLETE RESULTS.

Year.	Plot 1.		Plot 2.		Plot 3.		Plot 4.		Plot 5.	
	No manure		Phosphate and potash.		Dried blood.		Dried blood, phosphate and potash.		Mulched with grass and leaves.	
	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.
1900-2.	No records were kept.									
1902-3.										
Wet cacao ...	759	2,711	1,063	3,666	1,281	3,588	1,104	3,807	1,145	3,095
Cured cacao ...	...	1,138	...	1,540	...	1,491	...	1,599	...	1,300
1903-4.										
Wet cacao ...	548	1,956	808	2,786	970	2,694	738	2,545	962	2,600
Cured cacao ...	...	822	...	1,170	...	1,131	...	1,069	...	1,092
1904-5.										
Wet cacao ...	673	2,403	814	2,801	970	2,694	979	3,376	1,279	3,457
Cured cacao ...	...	1,009	...	1,179	...	1,131	...	1,418	...	1,450
1905-6.										
Wet cacao ...	748	2,672	763	2,631	1,056	2,933	1,040	3,586	1,519	4,105
Cured cacao ...	...	1,122	...	1,105	...	1,232	...	1,506	...	1,724
1906-7.										
Wet cacao ...	730	2,607	887	3,059	972	2,700	1,009	3,479	1,536	4,151
Cured cacao ...	...	1,095	...	1,285	...	1,134	...	1,461	...	1,743
1907-8.										
Wet cacao ...	906	3,225	1,160	4,000	1,381	3,836	1,180	4,069	1,773	4,792
Cured cacao ...	...	1,354	...	1,680	...	1,611	...	1,709	...	2,012
1908-9.										
Wet cacao ...	978	3,492	1,205	4,155	1,377	3,825	1,344	4,634	1,777	4,803
Cured cacao ...	...	1,467	...	1,745	...	1,607	...	1,946	...	2,017
1909-10.										
Wet cacao ...	848	3,029	963	3,321	1,167	3,241	1,267	4,369	1,822	4,924
Cured cacao ...	...	1,272	...	1,395	...	1,361	...	1,835	...	2,068
1910-11.										
Wet cacao ...	859	3,067	1,097	3,783	1,289	3,581	1,297	4,473	1,890	5,107
Cured cacao ...	...	1,288	...	1,589	...	1,504	...	1,879	...	2,145
1911-12.										
Wet cacao ...	804	2,871	1,012	3,490	1,272	3,533	1,272	4,387	1,721	4,651
Cured cacao ...	...	1,206	...	1,466	...	1,484	...	1,842	...	1,953
1912-13.										
Wet cacao ...	892	3,186	1,088	3,752	1,512	4,200	1,314	4,531	2,001	5,408
Cured cacao ...	...	1,338	...	1,576	...	1,764	...	1,903	...	2,271
1913-14.										
Wet cacao ...	678	2,422	885	3,050	1,133	3,147	1,104	3,807	1,509	4,078
Cured cacao ...	...	1,017	...	1,281	...	1,322	...	1,599	...	1,713
1914-15.										
Wet cacao ...	779	2,782	1,049	3,617	1,366	3,794	1,133	3,907	1,715	4,635
Cured cacao ...	...	1,168	...	1,519	...	1,593	...	1,641	...	1,947
1915-16.										
Wet cacao ...	715	2,554	1,110	3,827	1,298	3,607	1,069	3,686	1,474	3,984
Cured cacao ...	...	1,073	...	1,607	...	1,514	...	1,548	...	1,673
1916-17.										
Wet cacao ...	941	3,361	1,285	4,431	1,497	4,158	1,486	5,124	1,772	4,789
Cured cacao ...	...	1,412	...	1,861	...	1,746	...	2,152	...	2,011

## ADDITIONAL SERIES.

Year.	Plot 6.		Plot 7.		Plot 8.		Plot 9.		Plot 10.		Plot 11.	
	Mulched with grass and leaves.		Cotton-seed meal.		No manure.		Mulched with grass and leaves.		Mulched with grass and leaves.		Calcium cyanamide (nitrolim).	
	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.
1907-8.												
Wet cacao ...	881	3,524	1,019	4,076	882	2,130	1,053	2,823				
Cured cacao ...	...	1,480	...	1,712	...	895	...	1,186				
1908-9.												
Wet cacao ...	1,119	4,476	1,060	4,240	957	2,311	1,214	3,255				
Cured cacao ...	...	1,880	...	1,781	...	971	...	1,367				
1909-10.												
Wet cacao ...	1,242	4,969	1,039	4,156	965	2,331	1,352	3,625				
Cured cacao ...	...	2,087	...	1,746	...	979	...	1,523				
1910-11.												
Wet cacao ...	1,225	4,900	1,006	4,024	977	2,360	1,897	5,086				
Cured cacao ...	...	2,058	...	1,690	...	991	...	2,136				
1911-12.												
Wet cacao ...	1,070	4,280	923	3,692	924	2,232	1,669	4,476				
Cured cacao ...	...	1,798	...	1,549	...	937	...	1,879				
1912-13.												
Wet cacao ...	1,377	5,508	1,207	4,828	845	2,041	1,674	4,487				
Cured cacao ...	...	2,313	...	2,028	...	857	...	1,885				
1913-14.												
Wet cacao ...	1,300	5,200	924	3,696	767	1,853	1,548	4,150	667	1,667	609	2,436
Cured cacao ...	...	2,184	...	1,552	...	778	...	1,743	...	700	...	1,023
1914-15.												
Wet cacao ...	1,529	6,116	1,229	4,916	947	2,287	1,750	4,692	899	2,242	782	3,128
Cured cacao ...	...	2,569	...	2,065	...	960	...	1,971	...	942	...	1,314
1915-16.												
Wet cacao ...	1,380	5,520	977	3,908	814	1,966	1,432	3,839	1,024	2,560	795	3,180
Cured cacao ...	...	2,318	...	1,641	...	825	...	1,612	...	1,075	...	1,336
1916-17.												
Wet cacao ...	1,380	5,520	1,118	4,472	1,124	2,715	1,563	4,190	1,234	3,085	862	3,448
Cured cacao ...	...	2,318	...	1,878	...	1,140	...	1,760	...	1,296	...	1,448

END OF MANURIAL EXPERIMENTS.

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The trees on this plot certainly do not look well, and one fears that in spite of this heavy crop, they are not in a satisfactory condition and that, in a few years a considerable falling off will be recorded.

Though the foliage of the trees on plot A (phosphates and potash) is scanty, the trees continue to bear well. Nevertheless phosphates and potash without nitrogen cannot be regarded as a satisfactory manure for cacao.

The cotton seed meal plot again maintains its satisfactory condition as regards yield, and it is certainly a very sound manure to use. We would, however, recommend that for the best results a heavier application than 600 lb. per acre be given; 1,000 lb. per acre would probably be sufficient not only to give satisfactory crops but also to maintain the trees in a vigorous state of health.

Dried blood or some other form of organic matter of a similar nature can be recommended, though much better results are obtainable when the nitrogen of this manure is supplemented with phosphates and potash.

The chief feature of these experiments is, however, the way they have proved that, by maintaining the humus content of the soil by systematic applications of organic matter, it is unnecessary to resort to the use of artificial manures. The high yields recorded in previous reports are again reached on these plots during the year.

With a view of ascertaining the least amount of mulch necessary to produce satisfactory results, a plot was started in 1913-14 which receives only  $2\frac{1}{2}$  tons per acre as against the higher amounts (5 tons and 4 tons) used on the other mulched plots.

In three years the output from this plot has been nearly doubled, and, instead of yielding at the rate of 700 lb. of cacao per acre, it now yields 1,296 lb. It is too early yet to say whether by making the smaller application the high yields of the other mulched plots will be reached and maintained.

The nitrolim (calcium cyanamide) plot continues to maintain the increased crop produced after the application of this manure.

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**PLANT LEGISLATION IN DOMINICA.**

Under present time agricultural conditions it is absolutely necessary for Governments to take steps to endeavour to prevent as far as possible the introduction of plant diseases. To illustrate this it may be pointed out that the importation of coco-nuts and coco-nut plants from countries in which place the 'bud rot' disease is prevalent, and of plants from Dutch Guiana in which place the 'witch broom' disease of cacao has caused so much loss to planters, would be hazardous proceedings as regards the agriculture of this island. The presence of Citrus canker in the United States and other countries to the north makes the application of safety measures of prime importance, especially in an island like Dominica which is practically dependent upon a citrus industry.

These precautionary measures, carefully applied, though accomplishing much, cannot make the exclusion of plant diseases certain, but there can be no doubt that the authority given by the Government in these matters is a wise proceeding for the benefit and protection of local agriculture.

It behoves all planters in the island to make themselves acquainted with the main aspects of the situation, and further to obtain the opinion of the officers of the Agricultural Department before taking steps to introduce plants from abroad.

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 disease 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 annulled 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 fruits 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 article 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 the Island of Trinidad, also coco-nuts in husk and all growing plants or parts of plants of coco-nut 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 or plants in earth other than Citrus plants from the countries named in the above Proclamation.

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 would arrange for the inspection, and the issue of the necessary certificates.

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

**CROP YIELDS AT THE GARDENS.**

The cacao crop for the year ended June 30, 1917, was 105½ cwt. This is the largest crop of cacao gathered at the Gardens.

The yield of the cacao cultivation, which is estimated at 7½ acres, was 11,800 lb. equivalent to 59 bags of a standard weight of 200 lb. each.

The crops gathered for the past five years are as follows :—

1913	...	...	88½ cwt.
1914	...	...	74½ ..
1915	...	...	84 ..
1916	...	...	83¼ ..
1917	...	...	105½ ..

The rainfall for the year ended June 30, 1916, was 93.71 inches.

Three bags of cola nuts of a total weight of 675 lb., and 1 bag of nutmegs of a weight of 185 lb. were shipped to London.

There were also sold locally, 541 barrels of ripe limes, and a considerable quantity of mangoes, oranges, tangerines, and grape fruits