MODERN TRENDS IN CACAO CULTIVATION
IN TRINIDAD.

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INTRODUCTION.

The export of Cacao from the colony of Trinidad and Tobago reached its peak in 1921 with 75 million lbs., and since then there has been a continuous and alarming decline in cacao production in the island. At present an attempt is being made to revive the industry, and at this stage one can perhaps look to the future with some optimism. However the large capital outlay, and the wide range of scientists now required to assist in its rehabilitation, are a striking reflection of the extent of the depression which the industry has gone through in the past.

Soil deterioration, disease infestation, inherently low yielding capacity, lack of standardisation in the methods of preparation of the 'beans', low prices, and the effects of war, are among the various causes for the decline in production. However, now that the price of cacao is at a very high level, and appears likely to remain satisfactory for some time, conditions seem to be more favourable for the rehabilitation of the industry by the application of scientific knowledge. This has been reflected in the establishment of the Cacao Board as the agency for improving the industry, and the introduction of the Cacao Subsidy Scheme as an incentive to growers to effect improvements in their systems of cultivation.

As a result of this, cacao cultivation in the colony is now going through a period of transition. The old traditional methods are being gradually abandoned, and replaced by more scientific and productive techniques. However this is a long term process, one of the main reasons being that cacao cultivation was a largely unplanned development, the industry arising without any scientific or administrative guidance, a factor which considerably magnifies the difficulties of modernising it now that it has grown to its
present stage of development.

However, cacao is a permanent plantation type of crop and changes in its cultivation become effective over a considerable period of time. The cacao industry in the island is a very old one, and there has been a fair amount of tradition bound up with its cultivation, and handed down from generation to generation. Accordingly most cacao growers are very conservative, and do not readily adopt any changes that may be recommended for improvement in the production of the crop. In addition, as stated above, the unplanned development of the industry has made modernisation difficult at this stage.

This makes the application of any new techniques in cultivation a very slow process. Thus although it may be claimed that there are certain modern trends in most aspects of cacao cultivation, it must be emphasised that their application is still limited in extent throughout the island, and is now only beginning to show effects on the industry.

Previously the system of rehabilitation on estates amounted to the annual supplying of missing trees within the fields, and the occasional conversion of some trees from the seedling stage to a larger frame (26). Within recent times, however, rehabilitation has been done entirely with rooted cuttings from selected clonal, distributed by the Cacao Board under the Cacao Subsidy Scheme (19). This, together with the high price for cacao on the world market, has acted as a tonic to the Cacao Industry, and today for the first time in about 30 years the industry can be viewed with a ray of optimism.
REHABILITATION

When the cacao industry began to lose prestige, and it became apparent that the declining yield of old and diseased trees could not be arrested by improved methods of manuring or cultivation, the more progressive Trinidad growers solicited Government aid. They realised that only through rehabilitation could the industry be revived. This led to the start in 1945 of the Cacao Subsidy Scheme under the administration of the Cacao Board (2).

At that time the Cacao industry was just emerging from its era of dark depression. Most of the existing cacao trees had grown past the peak of production, new planting or replacement was almost non-existent, due to the lack of incentive for growing the crop. War time uncertainties, labour shortage, more attractive alternatives for employment, shipping problems, and the use of land for food crops, all these factors contributed to neglect and almost abandonment of estates (26). However, with the end of the war in 1945, followed by a rise in prices and improved conditions, together with the incentive of the Cacao Subsidy Scheme, there has been an increasing impetus to salvage formerly abandoned and neglected properties, and to rehabilitate declining fields (21).

Previously the system of rehabilitation on estates amounted to the annual supplying of missing trees within the fields, and the occasional conversion of some trees from the seedling stock to a growing chupon (26). Within recent times however, rehabilitation has been done entirely with rooted cuttings from selected clones, distributed by the Cacao Board under the Cacao Subsidy Scheme (19). This, together with the high price for Cacao on the world market, has acted as a tonic to the Cacao industry, and today for the first time in about 25 years the industry can be viewed with a ray of optimism.
The Cacao Subsidy Scheme aims at resuscitating the cacao industry by:

1. Providing free planting material and a cash subsidy for the replanting, partial or complete, of fields on lands suited to continued cacao cultivation.

2. Providing aid for establishing mixed farming in the form of alternative crops to Cacao, and the purchase of livestock on land unsuited to continued cacao cultivation (19).

At the same time by formulating set procedure and insisting on the use of definite systems of cultivation, the Cacao Board with an effective inspection and supervision service, is tending to bring about a certain degree of standardisation of cultural practices, and the widespread application of new techniques in the field.

The method for complete replanting is practised on areas where soil conditions are reasonable but the yields obtained are poor. It involves the removal of all the old seedling Cacao and shade trees from the field. This is a very intensive and costly system, but is said to give greatly improved yields when carefully carried out. The yield per acre obtained from a field of mature clonal material, under satisfactory conditions of site and soil, is normally more than twice the amount previously obtained from seedling fields (19).

Partial replanting, 35% or more, is the method used on land where some of the seedling trees are good yielders, and the management is unwilling to have them cut down and thus bring about a decline in yield during the course of rehabilitation (20).

In addition there has been a large amount of supplying of old seedling cacao with clonal material. However it is the opinion of most planters that such inter-planted clones come into bearing much later, (18 months -
2 years), than those planted by the clear felling method (22).

The replacement of cacao by alternative crops has been mostly done in areas where Witches' Broom, (Marasmius perniciosus), infection has made cacao cultivation impracticable or uneconomic, and during the period 1947 - 1953 about 4,500 acres of land were converted from Cacao to such crops. This represents about 1/25 of the total acreage under Cacao in the island. The main crops used as replacements under this system are Citrus, planted on about 2,000 acres of the above total, Coffee on 1,600 acres, Coconuts on 130 acres, and Avocado Pears. So far there has been no great demand anywhere in the island for replacement of Cacao by livestock (1).

The soil is of paramount importance in the rehabilitation of the Cacao industry, but so far under the present programme it has been greatly overshadowed by the emphasis being placed on the rejuvenation of the tree population. Even in many of the approved Cacao growing areas in the island the soil in its present condition is unsuitable for the growing of clonal cacao due to the rapid deterioration suffered as a result of the climate and the previous system of cultivation. In fact, except on a limited acreage in certain parts of the island, only by the rehabilitation of soil as well as plant can the potentialities of clonal material be exploited. Accordingly, the renovation of deteriorated soils is being treated as one of the fundamentals in the programme of Cacao research, and perhaps in the near future the rehabilitation system may involve not only the planting of high yielding material, but also treatment of the soil to restore its structure and fertility (10).
PROPAGATION

When cacao estates were first established, one of the most ignored factors was the selection of suitable planting material (25). Since its inception, the Cacao Board has been trying to bring this to the attention of cacao growers, at the same time advocating the use of its superior clonal material. However, it is only within the last eight years that planters have actually paid any serious attention to this aspect of cacao cultivation, and have decided, after much doubt and hesitation, to take advantage of the offers from the Cacao Board.

Many methods for propagating cacao vegetatively have been tried, including rooting of cuttings, budding, grafting, layering and marcottage. Although some success has been obtained from all of these methods, the greatest success has been obtained in the rooting of cuttings, and today it is by this method that the clonal selections are being multiplied for field planting (3). The material used by the Cacao Board for propagation and distribution, consists of a few varieties chosen from the 100 Imperial College Selections, made several years ago by Dr. Pound, and a few later selections and introductions. These plants have formed the basis for the improvement of the cacao industry, but this is only the first step in the development of a long term policy. New clones are still being developed and tested by the British West Indian Cacao Research Scheme for the future improvement of the industry.

The clones required for propagation are grown in nurseries at close spacing under about 50% light intensity, and are regularly manured to provide healthy vigorous material, one of the most important factors for successful propagation. Three types of cuttings are used for propagation, the fan type which is mostly used, the chupon type, and the single leaf.
cuttings, the latter only used when material is in short supply. Cuttings are taken early in the morning, the leaves trimmed, and the base of the stem dipped in a hormone mixture to stimulate rooting; they are then inserted into the rooting medium in the propagating bins (23).

The essential conditions for rooting are 100% humidity, adequate light, and good air-water relationship in the rooting medium, and propagators are designed to meet these requirements. They are of 3 types:

1. Closed bins, a very elaborate and costly set up requiring a great deal of labour.

2. Open spray beds, a cheaper but slightly less efficient system, used mainly in the wet season when there is an excess of cutting material.

3. The Centrifugal Humidifier, the most recent development, which reduces labour and handling to a minimum.

The rooting media used are coarse sand, composted sawdust, or coconut fibre (23).

After rooting, the plants are kept in "hardeners" for about 1 month, under glass - corrugated iron, (50 : 50), roofing for a similar period, and then under more exposed conditions until ready for planting in the field. The cost of production per plant varies from 49 - 72 cents (1).

From 1944 to 1953 the Cacao Board had distributed about 1,500,000 plants, and it is hoped to increase this amount to 1,000,000 plants per annum in the next few years. To implement this it has recently built a larger propagating station, and has also increased the number of estate propagators in the island (1).

At present plants are generally distributed to growers as a mixture of clones which are then either planted by themselves or as mixed varieties. One of the reasons for
using a mixture of clones is that very little is known about quality in Cacao, and it may be that the distinctive quality of Trinidad cacao depends in part upon its being a mixture. In addition it is necessary in planting for self incompatibles to be mixed with enough compatibles to ensure adequate fertilisation. The chief argument in favour of planting mixtures however, is that it is a form of insurance against unforeseen weaknesses in any one clone. It may also tend to minimize fluctuations in yield from season to season, and to spread the crop over a longer period in each season (4).

Imperial College Selection 1 and 95 have always been predominant among the clones distributed, and accordingly are widely cultivated throughout the island, both as a pure stand and as parts of mixed plantings. Imperial College Selection 1 is an excellent clone under good conditions, but is sensitive to ecological environment, especially lack of shade and poor drainage. Imperial College Selection 95 is the best all round variety at present being distributed, and does uniformly well over a range of conditions (1). However the relative merits of different clones are greatly influenced by the local environmental conditions, and the most suitable clones for any particular area can only be discovered by trials in the actual locations (24).

In spite of the success with the use of cuttings as planting material, vegetative propagation in Cacao has not remained static; research has taken it a step further, and new developments have been made. At present field trials are being carried out on new clones, in the production of which, cuttings are grafted onto seedling root stocks (5). This gives a good indication of the general trend in cacao cultivation, since this system of stock-scion interaction is characteristic of the propagation of orchard tree crops.
THE LAYOUT OF ESTATES.

In the past, cacao cultivation in Trinidad was largely an unplanned development. Estates were developed in any areas where the crop would grow and where there was sufficient labour available for its cultivation. There was a complete lack of scientific or technical guidance with regard to their establishment; most planters of that time simply followed tradition and past experience in the choice of site, and in the layout of their estates.

Today with the upward trend in cacao production, stimulated by the high prices now being paid for the product, this tendency is slowly disappearing, particularly on the larger estates in the island, although to a certain extent small scale cacao production is still being continued along traditional lines. At present the local Department of Agriculture, and the British West Indian Cacao Research Scheme, centred at the Imperial College of Tropical Agriculture in Trinidad, are well equipped with the necessary staff and facilities for giving proper advice and assistance to planters with regard to the layout of their estates, and planters, after some years of sceptical observation, are now said to be making good use of these services.

Nowadays cacao is only planted in areas suitable to the proper growth of the crop, such factors as soil, rainfall, and incidence of disease being taken into account before any new areas are planted, or any replanting is done. Previously very little attention was ever paid to soil or to site in choosing lands for cacao cultivation. The change-over is in fact due to the policy of the Cacao Board in actively discouraging cacao cultivation on any but suitable land, by withholding subsidies and other benefits under the Subsidy Scheme for rehabilitation of the crop on unsuitable land.
On most estates, especially those on hilly land, the only system of communication consisted of narrow tracks through the fields for the passage of draught animals. Recently however on a few of the larger estates, gravel roads, sufficiently wide to accommodate small motor vehicles, have been laid down. This has enabled a few of these places to dispense with some, if not all of their draught animals, which were mainly mules and donkeys, and to undertake the use of light vehicles for transport through the fields. Unfortunately this is subject to many limitations in its application, due mainly to the original poor layout of cacao lands.

Except in some partially replanted fields, the haphazard method of planting is being discontinued; planting is now being done in a more systematic way involving the use of properly spaced rows. In general there is a slow and gradual raising of the crop from the status of semi-forestry to an orchard crop, thereby opening the way to more intensive and scientific production (17). Among the changes brought about in implementing this, one of the most effective is the designing of smaller fields, often small fields planted with one variety of clonal cacao, which allows for more efficient cultivation.
The problem of shade is perhaps the most difficult one with regard to the cultivation of cacao in Trinidad, due perhaps to the lack of a clear understanding of the role of shade trees (23). In the past opinion has always been in favour of shade, and the Immortelle tree was the traditional shade tree used.

It is invariable practice on all estates, that whether permanent shade is intended or not, ground shade is always used in the early years of growth of the cacao plant. The crops used for this purpose are Bananas, Tannias, Cassava and Pigeon Peas, planted at about nine months before, and at a distance of about 2 1/2 feet from where the cacao plant is to be planted. This shade is maintained until the permanent shade, where used, has become fairly well established, and is then gradually thinned out (19). In widely spaced cacao rows on some estates, the Bananas are sometimes maintained to provide an extra source of revenue from the fields.

There is as yet no clear cut experimental evidence for the absolute necessity for shade in cacao, but research is still being carried out on this aspect of cacao cultivation, and some light is now being shed on the subject. The use of permanent shade is now known to be closely associated with soil nutrient status and the effect of fertiliser treatment (27), and it has also been found that the presence in the field of the Immortelle tree has no adverse effects on the crop, from the point of view of root effects or competition for nutrients.

On most estates the decision as to whether shade should be used or not is still commonly left to the fancy and experience of the manager. Attempts in Trinidad in recent years to grow cacao without shade have usually met
with poor results, but this must be associated with soils of
a low nutrient status. However, it has been observed on a
few cacao areas that unshaded cacao produces good crops and
remains healthy so long as it has a continuous unbroken
canopy, especially in well drained fertile soil with no
severed dry season (22). In fact the advocates of no shading
tend to believe in close planting as an alternative, but
concede that with wide spacing some measure of shading is
essential (23).

The Cacao Board has recently made compulsory the
provision of permanent overhead shade for clonal cacao, and
has recommended the use of the Immortelle and Gliricidia
trees (1). These are put in at the same time as the ground
shade, planted very closely at first, in the case of the
Immortelle, 24' x 24', and thinned out at a later stage to
about 48' x 48' to avoid over-shading. On some estates,
quick growing plants, e.g. the Wild Senna, (Cassia reticulata),
are used to provide temporary over-head shade until the
permanent shade is established.

At present the use of the Immortelle as an over-
head shade tree is of some concern, especially to planters
in the Central part of the island. The Anaaua Immortelle
has been attacked by a fungus, causing a Witches' Broom
disease, which has not yet been identified, but which has
resulted in the loss of many trees and in some damage to
the cacao in that area. The disease has not yet been found
on the Bocare Immortelle. However, both trees are attacked
by a fungus disease, caused by Calostilbe striispora, which
can also cause the loss of the trees. As a result a search
now has to be made for a suitable tree as a substitute for
the Immortelle, if the use of overhead shade is to be
continued.
WINDBREAKS.

The use of wind-breaks, although it cannot justly be called a modern trend in cacao cultivation, is nevertheless a factor which has been given much more consideration within recent years than in the past. Protection from wind in the dry season is of great importance in Trinidad, especially on exposed hill sides, and wind-breaks are planted in areas where belts of original forest are not available for wind protection, or where it is not advisable to depend wholly or partially on such (13).

Windbreaks are usually planted in two storeys. The lower storey is normally in the form of a hedge of a quick growing plant, e.g. Coffee, Hibiscus, or Dracaena, planted very close, (about 6"), and allowed to grow quite thickly and to a convenient height. The upper storey consists of large trees, e.g. Mango, Mahogany, Sapodilla and other large trees of some economic importance, either for lumber or fruit, planted very close, but at some distance from the actual Cacao trees in order to avoid root effects. In the well developed estates the system employed is to plant the trees along the roadway, which it helps to protect from erosion damage, with a drain running a few feet to the inside of the trees, thus cutting them off from the cacao.
INTERPLANTING.

It is general practice on estates in Trinidad to interplant cacao at some stage of its growth with one or more crops.

In the early years of cacao cultivation the crop was heavily interplanted in the first five to six years of its growth. At that time peasants used to enter into a contract with the owners of the estate. They would plant the land with cacao trees and attend to their cultivation, receiving for their labour the use of the land for the purposes of growing annual crops of provisions, plus a bonus paid to them at the end of the period. This system was adopted for many years in Trinidad but it had many serious drawbacks and is no longer practised (12).

In the early stages of growth of the cacao crop, Bananas, Cassava and Tannias are normally interplanted to supply ground shade for the growing plants, as well as to give some financial return from the field. The presence of this ground shade is very essential for the proper establishment of the young cacao, and is one of the requirements of the Cacao Board for benefits under the Cacao Subsidy Scheme. On the majority of estates, especially those with new clonal plantings, these crops are maintained for about five years, by which time the trees, if closely planted, would have begun to close in. They are then gradually cut out and the Cacao left as a pure stand.

On old seedling plantations, and also on some of the present day estates, the tendency has been to diversify the cropping of the fields, so that in the event of a decrease in the price of Cacao the estates would receive sufficient revenue to be able to maintain its cultivation. The crops used were generally Bananas and Coffee, planted between the
rows of Cacao, which were at least 12' x 12'. In some areas the Avocado Pear tree is used as an interplanted tree crop as well as to supply overhead shade.

This system has been practiced over a great number of years all over the island, and so far it has shown no adverse effect on the cacao crop.
PLANTING.

The preparation of cacao fields for planting is carried out on most estates about a year to six months before the cuttings are put in. The field is cutlassed, unwanted seedling and Immortelle trees are felled and lopped, and the debris placed in heaps along the outer row spaces of the proposed field. For interplanting, (partial replanting), the main preparation consists of a heavy pruning of the old seedling trees. The field is then lined and ground shade consisting of Bananas, Cassava, Tannia, or Pigeon Peas is planted; the permanent shade plants, if required, are also put in at this time (20).

The planting hole is dug at least 16" wide x 8" deep, and the excavated soil mixed with a basket of pen manure, where available, or with the organic debris from the field, and returned to the hole (14). This is built up into a mound, marked with a picket, and left to stand for about 2 - 3 months in the dry season to allow proper decomposition of the manure before the planting season.

Plants are delivered to the estates some time between June - October and planting is done immediately, to get as much benefit from the rain as is possible, and thus induce quick establishment and growth of the plant, an important factor in the planting of clonal material. For planting, the basket is removed and the cutting inserted with the potting soil attached to it. On many estates a round of the new plants is made about a fortnight after planting, and any loose plants moulded and made firm (7).
MANURIAL PRACTICES.

In the past, planters have depended largely on the inherent fertility of the soil, and such operations as pruning and cutlassing for the maintenance of yields. On some of the larger estates cattle were kept to supply pen manure for application to the field. The use of artificial fertiliser on estates was practically unknown, since the early experiments with these fertilisers gave such inconclusive results, that few planters would have undertaken a fertiliser programme. This has led to a general deterioration in fertility and soil structure, with the result that in many places, the replanting of vigorous high bearing clonal cuttings is not proving as satisfactory as was at first expected in accordance with their genetical constitution (11).

Today we know that their difficulties arose from the fact that the effect of artificial fertilisers is closely associated with shading, which normally tended to be too dense in the past (3). Thus with increased knowledge, the incentives offered by the Cacao Board, the economic changes brought about by high prices, and the rapid decline in cacao yields in recent years, the use of artificial fertiliser has become one of the more recent trends in cacao cultivation in Trinidad.

The increasing use of clonal material for new planting and supplying now requires large quantities of pen manure, for use in the preparation of the planting holes, if good initial growth is to be obtained. In Trinidad pen manure is an expensive item and presents some difficulty in handling and transport; as a result, a few of the larger estates are now contemplating the keeping of livestock for pen manure as was previously done.

Under the Cacao Subsidy Scheme planters are entitled
to a fertiliser subsidy which enables them to receive free fertilisers, (N.P.K.), for use on clonal cacao, as well as a subsidised supply for any seedling areas under the partial replanting programme. (19). This has made the use of fertilisers a common practice on most estates where clonal cacao is planted. It is still the tendency, and perhaps the correct one, to leave old seedling fields unfertilised. The fertiliser is normally applied in one dose, generally around April to May, the rate of application depending upon the age of the plant.

Trenching, whereby pen manure, tree trimmings, cut bush, and organic debris of all kinds were buried in trenches between the rows of cacao, was an old system practised on many estates long ago. Reports indicated that this treatment maintained yields and even gave economic increases, since the trenches provided an ideal rooting medium and perhaps gave the additional effect of improved drainage. In fact the system is thought to have been as beneficial as surface mulching, which has been tried in the past, and proved to have given increased, but perhaps uneconomic yields (15). The first practice seems to have been discontinued on estates, but mulching is still being practised in a few places, where not only/increased yield the object but also a residual effect on the soil. To a certain extent cacao fields can be said to be self mulched, since the amount of dead organic matter falling to the ground is usually enough to provide an effective ground cover.
PRUNING.

As the Cacao tree grows it is pruned periodically to keep its height convenient for harvesting, to prevent entanglement of its branches with shade trees, and to avoid too dense a cover (28). This operation which is carried out just after the main crop has been harvested, and before the new crop has set, i.e. March - May, consists of:

1. Removal of "chupona", except where they are required to replace the parent tree.

2. General shaping of the tree by the regulation of the branching system.

3. Removal of damaged and diseased shoots.

At the same time where labour supply permits it, the vines, moss and parasites which appear on the trees, especially in the wet areas, are removed.(7).

Pruning is a highly skilled operation, perhaps the most skilful in the cultivation of the crop, and on many estates great difficulty is experienced in getting suitable labour for this purpose, especially since, unlike most of the other cultural treatments, it is not usually done on a task basis. On almost every estate in the island can be seen trees which have been seriously injured by bad pruning; many of these trees show scars created by the careless use of tools, the original injuries perhaps having provided easy access to the entry of diseases (28).

The practice of pruning has remained relatively the same throughout the years, the only innovations being a few modifications in the system and tools for pruning clonal material. Unlike the seedling trees these clones cannot be "butchered", but must be carefully pruned and not needlessly damaged. In addition, being smaller than the seedlings, they can easily be pruned with a cutlass and hardly requires

- 19 -
the use of a pruning knife. Pruning in fields partially replanted with clones and still containing a number of old seedlings is quite a difficult task, since the pruner has to prune each tree in relation to the growth of the other. Maintenance consists mainly in keeping the land clear of weeds. Once planted estates this is a large factor until in the first five years after planting. After this time the plants have normally grown to a sufficient size to provide good ground cover and thus eliminate most weed growth (20).

Weeding of fields is done by slashing, a manual operation requiring the availability of a large labor force.

The number of slashings varies greatly from estate to estate, depending on the rainfall of the area, the spacing and staging of the trees, and on the labor supply. Slashling is of very great importance in fields of interplanted visual crops due to the linear branching habit of the clones; this renders the crops susceptible to black spot infection in the wet season when produced amidst thick undergrowth. Although slashling is rarely needed in fields of a pure stand of visual material after about five years, it is most important in the first five years of growth. At this time the individual attention has to be given to each tree by "surrounding", (round weeding), before slashing the fields, to ensure that the young plants are easily seen and not damaged during the slashing process which typifies the slashling operation.

It is always using old stock trees as overhead shade, a perindical but very important part of field maintenance is attention to fallen trees. The old trees tend to fall after heavy rains or strong winds, and can cause great damage to the crop, necessitating the provision of supplies to the farm and the replanting of temporary shade plants. It is general practice nowadays, wherever new planting or
FIELD MAINTENANCE.

In Trinidad there is no after-cultivation of the soil after the cacao crop has been planted, and field maintenance consists chiefly in keeping the land clear of weeds. On well planted estates this is a large factor only in the first five years after planting. After this time the plants have normally grown to a sufficient size to provide good ground cover and thus eliminate most weed growth (20).

Weeding of fields is done by cutlassing, a manual operation requiring the availability of a large labour force. The number of cutlassings varies greatly from estate to estate, depending on the rainfall of the area, the spacing and shading of the trees, and on the labour supply. Cutlassing is of very great importance in fields of interplanted clonal cacao due to the lower branching habit of the clones; this renders the pods susceptible to Black Pod infection in the wet season when produced amidst thick undergrowth. Although cutlassing is rarely needed in fields of a pure stand of clonal material after about five years, it is most important in the first five years of growth. At this time too, individual attention has to be given to each tree by "arrondering", (round weeding), before cutlassing the fields, to ensure that the young plants are easily seen, and not damaged during the slashing process which typifies the cutlassing operation.

On estates using old Immortelle trees as overhead shade, a periodical but very important part of field maintenance is attention to fallen trees. The old trees tend to fall after heavy rains or strong winds, and can cause great damage to the cacao, necessitating the provision of supplies to the crop and the planting of temporary shade plants. It is general practice nowadays, wherever new planting or
replanting is being done, to put in young shade trees at the same time, and with their establishment to poison the older trees, thus bringing about a gradual rotting and falling of the trees and minimising the amount of damage done to the cacao.

During the dry season a very important factor in field maintenance, especially on the larger estates, is the maintenance of fire traces. These are continuous strips of land, about six feet wide, around the borders of the estate, which are kept clear of as much organic matter as possible. On hill sides a short hedge of closely planted Dracaena is also planted on the lower side of the traces to prevent any burning material from rolling down into the cultivated areas. In flat areas however, roads and paths are so laid down that they can also act as effective fire traces.

On very steep land in some parts of the island where "seedling trees" were commonly planted in the past, it is a practice on the better managed areas to put in some protective measure against landslips. This is usually done by planting a row of closely spaced Dracaena along the lower edge of the areas likely to subside.

**DRAINAGE.**

Drainage systems on cacao estates have remained relatively unchanged throughout the years, due to the difficulty and expense that would be involved in making any modifications of the existing drainage systems. On hill slopes, drainage, except for naturally occurring channels, is practically non existant, while on flat land it is perhaps over done, giving rise to a maze of water ways criss-crossing the fields. On many estates the stage has been reached where a number of small elevated beds have been developed between the drains as a result of constant deepening, using the excavated soil to build the beds (14).
In general drains are often neglected and allowed to become blocked, owing to the high cost of clearing them and the general shortage of labour. Normally work on draining is only done after the ill effects of the first showers show up in the field.

There is one great criticism with regard to drainage, - the fact, that like most cultural practices in Cacao, - it is done more by rule of thumb than in accordance with the requirements of the soil or the crop. On most estates, especially those on undulating land, drains are dug without sufficient regard for soil conservation, nor are they constructed in any relationship to shading, with which damage has been proved to be complementary (25). In addition, drainage systems as they normally occur, make the transport of materials within cacao fields extremely difficult, and would completely rule out the application of mechanization to cacao lands in the near future.

A systematic drainage system based on soil type and topography is to be strongly recommended on newly established cacao fields. In fact this could well be one of the stipulations of the Cacao Subsidy Scheme, since it is a most important factor in the successful cultivation of the crop.

After selections issued to Bidnes' Broon, e.g. B-15 and 18, are available for planting, but they have not been widely used due to the poor yields obtained from them. Among the Imperial College Selections there are no clones issued to Bidnes' Broon, but there are a few clones highly resistant to the disease. Control by spraying with Bordeaux mixture has been successfully tried on an experimental scale, but is unlikely to be economically feasible with the use of ordinary equipment (36).

In the past Black Pod has been responsible for the
DISEASE AND PEST CONTROL.

Regardless of what is done to rehabilitate the cacao industry, the dominant feature in the situation for the next few years will undoubtedly be the relative success or failure of efforts to check the spread of diseases, one of the most important limiting factors to increase in yields (28). In Trinidad the fungal disease, Witches' Broom, (Marasmius perniciosus), is the scourge of the cacao industry, but Black Pod, (Phytophthora palmivora), and insect damage are also responsible for heavy crop losses. In spite of this, control measures have been given very little consideration in the past, and it is only recently that some planters have begun to apply such measures in the field.

Control of Witches' Broom is carried out by the manual removal of the diseased tissues twice per year, in April and October, except in very heavily infested areas, and on susceptible varieties where cutting out of the trees may be practised (16). The effectiveness of this treatment has been shown at River Estate where pod losses in fields of badly infested young cacao had been reduced to less than 10%, following removal of heavily infested old trees in the vicinity, and cutting out of brooms twice per year (6).

A few selections immune to Witches' Broom, e.g. S.C.A. 6 and 12, are available for planting, but they have not been widely used due to the poor yields obtained from them. Among the Imperial College Selections there are no clones immune to Witches' Broom, but there are a few clones highly resistant to the disease. Control by spraying with Bordeaux mixture has been successfully tried on an experimental scale, but is unlikely to be economically feasible with the use of ordinary equipment (6).

In the past Black Pod has been responsible for the
majority of pods lost through disease, no type of cacao of the whole range in Trinidad seemed to be immune to it, but comparatively little attention is paid to it now, due to the presence of Witches' Broom which is of greater local importance. Black Pod, unlike Witches' Broom, attacks pods of all ages as long as humidity is high, but some black pods yield usable 'beans', while pods infected with Witches' Broom seldom do. Formerly, planters made a special picking round in November to remove all infected pods, but nowadays even the best estates seem to have abandoned this practice. Frequent harvesting of mature pods is the best method for reducing losses due to Black Pod, but it is believed that such cultural practices as good drainage, careful pruning, and regulation of overhead shade, would reduce the effects of the disease, except in abnormally wet years, when it is looked upon as an unavoidable occurrence (25).

Fortunately for Trinidad there are only two insects that can be classed as major pests of Cacao:


The former feeds on the foliage causing staining and russetting of the leaves, while the larvae of the latter burrows into the bark of trees and can bring about the death of some trees. There is however a very large number of insects associated with Cacac, some of which are potential pests, but usually they are naturally controlled to a low and harmless level (18).

Virus infection also exists in Trinidad, two types being largely confined to the Northern section of the island. Reduction in yield as a result of this infection is very small, but a certain amount of importance is attached to it, not because of its present economic significance, but because of the potential menace to future production. The present
policy is one of watchfulness, with the addition of a cacao free barrier to isolate the disease (9).

A serious menace is now recognised as requiring more scientific knowledge of the crop and its requirements than has hitherto been available. This calls for research into all important aspects of cacao production, and the wide scope of scientific new employed in the field of research is a striking reflection of the importance to the industry (24).

Cacao research in the British West Indies is carried out mainly by the British West Indian Cacao Research Bureau, which is centred at the Imperial College of Tropical Agriculture in Trinidad. The programme of research falls into 2 main sections:

1. Selection, breeding and propagation of Cacao.
2. Soil and nutrient factors in relation to cacao growing.
3. Other environmental factors in relation to cacao growing.
4. Pest and diseases of Cacao.
5. The preparation and quality of Cacao.

This embraces research by a number of specialists officers upon whose work the long-term improvement of the Cacao Industry depends to a very great extent (24).

The programme of work includes both short-term investigations and longer-term basic research. The short-term investigations aim at the solution of urgent and relatively straightforward practical problems. Work along these lines has already yielded valuable information to the cacao grower enabling him to make important improvements in his methods of production. The development of the technique of vegetative propagation of planting material, and the study of the relative behaviour of different clones under varying environmental conditions.
RESEARCH.

Maintenance of cacao production on an efficient permanent basis is now recognised as requiring more scientific knowledge of the crop and its requirements than has hitherto been available. This calls for research into all the important aspects of cacao production, and the wide range of scientists now employed in the field of research in this line is a striking reflection of its importance to the industry (24).

Cacao research in the British West Indies is carried out mainly by the British West Indian Cacao Research Scheme, which is centred at the Imperial College of Tropical Agriculture in Trinidad. Its programme of research falls into 5 main sections:

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The programme of work includes both short term investigations and longer term basic research. The short term investigations aim at the solution of urgent and relatively straight-forward practical problems. Work along these lines has already yielded valuable information to the cacao grower, enabling him to make important improvements in his methods of production. The development of the technique of vegetative propagation of planting material, and the study of the relative behaviour of different clones under varying environmental
conditions, are two most impressive pieces of work among these investigations. The long term basic research is designed to furnish fundamental information to be used in the solution of the more involved and far reaching problems of the industry. This aspect of the research programme promises to yield information on which further big advances can be made in the efficiency and profitability of cacao production, and in this respect the breeding programme is of major importance (24).
ACKNOWLEDGEMENTS.

Thanks are due to the late Professor R.E.D. Baker and Mr. J. Wilson for their help and guidance with this dissertation; also to certain other members of the College Staff, and to the owner of a private estate, from whom useful information was obtained in the absence of any relevant literature.

The introduction and development of vegetative propagation have made the present rehabilitation programme possible, and may well be looked upon as the most important contribution so far to the cane industry in Trinidad. In fact these two factors, selection and propagation, have gone a long way in making possible more intensive methods of improving the industry than those recommended from earlier investigations.

The rehabilitation of the cane industry has followed a slow course. The present programme has grown out of experience gained from past failures, and today, with new knowledge gained from research, and the co-operation of the grower, it is expected to solve the problem of rejuvenating the industry to a point somewhere near the old level, when it was the foremost agricultural export of the colony. However, this programme is not strictly a cane improvement scheme, but in fact it assists the general agricultural development by providing for the establishment of alternative lines of husbandry in areas with poor cane growing potentialities.

Improved efficiency in cultivation does not appear to be possible by modifying certain of the old cultural practices to suit the growing of clones. The work of building up a new industry lies as much in the cultivation of the crop as in the development of high yielding clones. The scientist.
CONCLUSION.

The Trinidad cacao industry has now been given a new lease on life, the gloomy outlook of the war years is now gone and the crop once again shows some signs of holding its place in the economic life of the island. Good progress in the selection and development of high yielding, and disease resistant plants, has been made over the past few years and the work is still being continued. The introduction and development of vegetative propagation have made the present rehabilitation programme possible, and may well be looked upon as the most important contribution so far to the cacao industry in Trinidad. In fact these two factors, selection and propagation, have gone a long way in making possible more intensive methods of improving the industry than those recommended from early investigations.

The rehabilitation of the Cacao industry has followed a slow course. The present programme has grown out of experience gleaned from past failures, and today, with new knowledge gained from research, and the co-operation of the growers, it is expected to solve the problem of resuscitating the industry to a point somewhere near the old level, when it was the foremost agricultural export of the colony. However, this programme is not strictly a cacao improvement scheme, but in fact it assists the general agricultural development by providing for the establishment of alternative lines of husbandry in areas with poor cacao growing potentialities.

Improved efficiency in cultivation now appears to be possible by modifying certain of the old cultural practices to suit the growing of clonal cacao. The work of building up a new industry lies as much in the cultivation of the crop as in the development of high yielding strains; the scientist.
sets the pace in the race for improvement, it is for the
growers to follow at his heels with confidence in his
guidance.

Research has pointed the way to more intensive
methods of cacao production with high returns per unit area.
The limiting factors in cultivation are being minimised, in
the process of gradual elimination, and light is continually
being shed on the more abstruse aspects of the cacao industry.
Trinidad has taken the lead in the development and application
of modern trends in Cacao cultivation, but there is still a
great amount of ground to be covered before the goal in
rehabilitation is reached. The Island must build now for a
future cacao industry, sufficiently sound to allow for the
most efficient use of management and labour, and high enough
in cultivation standards to withstand any future economic
stress.


