THE DIVERSIFICATION OF CACAO.

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II.
INTRODUCTION.

When the Economic Survey of the Cacao Industry was started by the Department of Economics of the imperial College of Tropical Agriculture, the industry was giving the planters of the Island cause for great alarm. The industry was in a depressed condition, and symptoms of a crisis were developing. It was decided to start an investigation into the condition of the industry with three objects in view:

1. To obtain a reliable statistical and economic description of the industry as a whole.
2. To ascertain those dominating factors associated with the financial success or failure of estates.
3. To establish detailed standards of costs of production with which the individual planter could compare his own costs.

Up to the present time the work of the Survey has been directed mainly on the collection of the data. In addition, descriptive data has been submitted in the form of theses.

The problem of how to improve the cacao industry is being studied from various angles. Studies of a quantitative nature and of a non-quantitative nature have been included, and it is the purpose of this paper to deal with the subject of Diversification of cacao from both the above aspects. Since the paper was begun, the world financial crisis has arisen, and whether or not the improvements suggested to the industry, based on Diversification, still hold good is beyond the power of man to predict.

This paper deals first of all with the economic theory of diversification and specialisation. The theory is explained by the relative advantages and disadvantages of each system. In addition, some miscellaneous observations and a short history
of the cacao crop are given. In Section VI I have endeavoured to show how the economic theories have applied themselves to Trinidad, and in what measure they are responsible for the present position of the industry in the Island.

I have only attempted to summarise the present position of the Cacao Industry, but there again, since writing the paper recent events have altered the conditions. The devaluation of the pound sterling has increased the value of the commodity, but whether this increase is merely one of a sympathetic nature or not, still remains to be seen.

In the last two sections, IX and X, I have dealt with Diversification extensively. Firstly, I have described the existing diversification to be found in the island at the present time, and the reasons for its adoption. Secondly, I have given the methods whereby the industry might be improved by diversifying cacao with other crops. Lastly I have endeavoured to show how the methods of diversifying cacao can be applied to conditions in Trinidad.

The actual meaning of the two terms. Confusion is frequently caused by the inaccurate use of terms; for example, a fruit farm is said to be highly specialised, whereas it is frequently found to be highly diversified, at many types and kinds of fruit are grown.

A very clear definition of the two terms and the intermediate stages merging into each other is given by Gray. He divides farms into four classes:

1) Specialised.
2) Semi-Specialised.
3) Semi-Diversified.
4) Diversified.

"When a system of farming comprises a single product and only one main source of income, it is known as specialised farming." Examples of this are pure cacao estates.
A factor of great importance in determining the efficiency of production in agriculture is the degree of specialisation of output. There are innumerable degrees of specialisation possible, ranging from the concentration on one single crop to the most complete diversity. Cacao affords an excellent example of a highly specialised crop, usually grown alone, whose Diversity Index Number, according to Gray's method of measuring diversification, would be 1. Gray's method of indexing crops according to their diversification is based on the theory that diversity is the resultant of two factors, namely, the number of crops, and the degree in which they approximate equality in importance.

Before beginning to give the theory of relative advantages and disadvantages of specialisation and diversification, it will be relevant to define the actual meaning of the two terms. Confusion is frequently caused by the inaccurate use of terms; for example, a fruit farm is said to be highly specialised, whereas it is frequently found to be highly diversified, as many types and kinds of fruit are grown.

A very clear definition of the two terms and the intermediate stages merging into each other is given by Gray. He divides farms into four classes:

1. Specialised.
2. Semi-Specialised.
4. Diversified.

"When a system of farming comprises a single product and only one main source of income, it is known as specialised farming". Examples of this are pure cacao estates.
(ii). "When there is one main source of money receipts, but a number of subsidiary products, which are not produced for sale but contribute to the production of the main source of receipts, it is known as a system of Semi-Specialised farming." In the case of cacao estates, pen cattle are frequently kept in order to provide manure for the trees.

(iii) and (iv). "When a system of farming is characterised by several products, each of which is an important source of money income, it is known as a Diversified System, but when there are a number of minor sources of income and one principal money crop, the system is known as Semi-Diversified." Warren suggests that no estate can claim to be called a specialised estate unless 40% of its income is derived from its principal product. Examples of Diversified Systems with reference to cacao estates can be quoted. Cacao estates run in conjunction with coconut estates or sugar estates are frequently found; and Semi-Diversified Systems are mostly comprised of cacao, interplanted with coffee, figs, or nutmegs.

It must be noted here that cacao estates are therefore found either highly specialised on the one hand, or semi-diversified and even highly diversified on the other. The details of diversification and the methods employed will be given later, when the theory is applied to the conditions existing in Trinidad at the moment.

III.

The theory of Specialisation and Diversification, and the reasons for its adoption are best explained by the relative advantages and disadvantages of each system.

A. The Advantages of Specialisation, whether estates are specialised or semi-specialised.

1. Sometimes there is a single crop that is more profitable for a region than any other crop. For example, take
cacao in Trinidad, sugar in Barbados, tobacco in Rhodesia, the price of which must be high enough to justify its production in an area where the natural conditions are most favourable to its production, to the exclusion of other crops that might otherwise be occupying the land. Where crops are grown under these circumstances, they have the outstanding advantage of a specialised system throughout their production. Where one crop predominates in an area, the entire system of marketing, credit, labour, and farm organisation is likely to be especially developed to meet the requirements of this particular crop, and in recent years scientific research has become highly developed in specialised areas.

2. A single crop production often obtains the benefits of large scale farming, and the advantages which are obtained by an increase in size. With a single crop such as cacao, the relative size of the fields will be increased if the crop is grown pure, rather than if the crop is diversified. The fields may also be large for the size of the estate. As a result, better use of specialised tools and equipment can be made. This applies especially to cacao as regards buildings and equipment.

3. A single crop estate can be more easily worked. A routine system can be more readily adopted for the management of labour. As with large farms, specialisation with labour can be effected, and in consequence the labour will become more highly skilled and efficient. With the possibility of having routine management and highly specialised labour, the cost of production will often be greatly reduced. The estates will enjoy the internal economies of production, which cause the law of increasing returns to come into operation.

This advantage of having highly skilled labour is of extreme importance in cacao production. The labourer must
be absolutely au fait with his particular job. The care and maintenance of the trees in proper condition has to be done by men of skill, and the pruning of the trees requires specialists. The labour force which is required for the maintenance of an estate is particularly suited to routine work. It can be seen that cacao is ideally suited.

4. Specialised crop production has the advantage of enabling the manager to concentrate his study on one crop, rather than on a large number of crops. This is one of the greatest advantages of specialisation. Cacao production calls for intensive methods. The grower must be a good commercial man. He must understand labour teams, the use of tools, methods of cultivating, - horticulture, including pruning, picking, and propagation. He should also have a knowledge of the plant pathology and physiology of cacao, and of the entomological diseases.

B. The Disadvantages of Specialisation.

The benefits gained by specialisation are gained, however, at the expense of many disadvantages, the disadvantages being converse to the advantages.

1. Soil fertility suffers through the absence of a rotation of crops and the diversification of cropping. Some crops are said to be greedy feeders, and consume a high percentage of the plant food contained in the soil, while others are restorative, e.g. the Leguminosae. By alternating the crops, the soil may not be so impoverished. With cacao the question of a restorative and alternative crop is very urgent. Many suggestions have been made of ways whereby the soil fertility could be maintained. This question will be dealt with further under the problem of interplanting. The absence of livestock on a cacao estate is often responsible for the decline in soil fertility.
2. Reliance on a single crop greatly increases the evil effects of fluctuations in yields and prices. If several articles are produced, compensating movements may lessen the force of such fluctuations. A striking example of the effect of prices can clearly be seen at the moment. Owing to the economic depression in the world's markets, cacao is very low in price and planters are very badly hit. It may be of some compensation to the specialist producer to realise that every agricultural commodity is similarly affected, with perhaps the exception of the citrus grower.

3. The proper seasonal distribution of Man and Horse Labour may be unobtainable if there are not several different operations to be performed at different seasons throughout the year, and specialised estates may thus fail to conform with the unit principle. It is generally more difficult to keep in constant employ, the same amount of labour throughout the year on a specialised estate as on a diversified estate. A specialised estate tends to have a rush period followed by a period of less activity. On cacao estates, however, the labour force can generally be profitably utilised throughout the year, while, as we shall see later, when cacao is diversified with other crops, the problem arises of how to grow these without increasing the amount of work at the busy harvest periods in the year.

4. The income of the specialised producer is not spread evenly over the year. This, however, may be remedied by means of Co-operative Marketing. In Trinidad the difficulty is overcome by the Cacao Planters' Association and the Agricultural Bank. Theoretically the disadvantages of specialisation generally outweigh the advantages. Warren concludes: "the vast majority of farmers find it pays better to have several
important crops." On the other hand, "while it is better to have 2 to 4 important products than 1, it is usually not desirable to have a lot of little things." However, these remarks do not hold good for cacao. Cacao is at present essentially a specialist production, and until it is possible to find a suitable crop with which to diversify it, the theoretical considerations will not apply. Cacao is the exceptional case in which specialisation is to be recommended, because it is grown in areas where particular physical advantages favourable to the crop exist. On this account it has made itself locally predominant, the result being that firstly it enjoys the internal economies of production, and secondly it profits by many of the external economies which arise in the localisation of an industry.

C. The Advantages of Diversification, as compared with Specialisation.

1. Suitable diversification maintains soil fertility.

2. It reduces risk from price fluctuations.

3. It makes possible a more uniform use of the factors of production throughout the year: man labour, horse labour, land and machinery.

4. It causes better utilisation of waste products.

5. A more regular income throughout the year being obtained, it makes possible a crop rotation, which may tend to preserve soil fertility.

6. Reduces the incidence of disease. Each crop has its own diseases, and by diversification the risk of diseases is often lessened.

These advantages are converse to the disadvantages of specialisation, and need no further explanation.
D. The Disadvantages of Diversification, as compared with Specialisation.

The disadvantages of diversification are converse to the advantages of specialisation.

1. A region may grow one specialised crop more profitably than a number of crops. This is applicable to the various soil types of Trinidad, where Cacao is grown alone.

2. Under limited areas the diversification of crops may reduce the acreage below that at which the large scale farming methods could be adopted, and consequently the cost of cultivation, etc. would be increased. Cost of production might also be increased by the fact that tools and machinery could not be utilised on account of the size of estate.

3. It might be impossible to utilise a routine labour force economically, and by diversification a labourer may have to be a "Jack of all trades". Thus the degree of labour specialisation is often reduced.

4. The Manager is not so highly specialised with many crops as with one crop.

IV. MISCELLANEOUS OBSERVATIONS ON CACAO.

Before attempting to show how the theory of Specialisation and Diversification has influenced the Cacao industry, and before giving a brief history of the crop in the island, a few observations about the crop should be made and borne in mind.

1. Cacao is both a specialist crop and a staple crop of the island. A staple crop is one which will always sell at some quotable price, and which is always quoted on the exchange markets. The chief problem in growing a staple crop is to reduce the cost of production. On the other hand,
Trinidad cacao is a specialist crop, the chief aim being not to find an ordinary market, but to find a market with a long price in order to compete with the inferior cacao from outside sources. It has therefore to be staple, yet highly specialised, and the great difficulty to be faced is how to diversify these cacao estates in order to bring in additional income without any detrimental effects to the quality, quantity and value of their cacao. Trinidad cacao commands a premium on the European markets, but in order to increase the income of some estates a diversification of cropping has been found necessary.

2. Cacao is essentially a specialist crop. Due to the fact that prices are low and that outside competition is keen, the days of incidental and haphazard cacao-growing are over.

3. On account of its habit of growth, the diversification of cacao with other crops is rendered extremely difficult. In Trinidad cacao is grown under shade, and in addition, if the trees are correctly kept, their structure forms a complete canopy through which sunshine, light, and air cannot penetrate sufficiently for the requirements of a diversified crop.

4. Even if environmental conditions are suitable for shade-tolerant plants such as some ground provision crops, their economic value does not warrant their production, on account of their low prices, and distance from the market.

5. Cacao is not a short-lived crop. Alteration in quality cannot be made by rapid varietal changes, and moreover a mature crop represents a heavy capital expenditure.
A SHORT HISTORY OF THE CACAO INDUSTRY IN TRINIDAD.

Little is known of the early history of cacao in Trinidad; in fact, our historical knowledge of Trinidad is very limited. Cacao was first imported into the island from Southern America from the basin of the Orinoco, and was believed to be of the Creola type. In 1727 a terrible 'blast' was recorded, which was either a hurricane or a blight. This completely ruined the cacao plantations. Thirty years later the Aragonese Capuchin Fathers revived cacao-growing in the island. They imported from the main land a new type of cacao, which, while giving an inferior quality, was said to have a hardier constitution. This type of cacao was the Forastero type, which is predominant in the island to-day.

De Verteuil states that, from the first settlement, cacao was exported from Trinidad, and on account of its fine quality and aroma it soon gained great popularity. He says that crops were even bought before they were harvested.

From local planters the oldest cacao plantations are said to be in the Toco area. These were planted by Spanish slaves, the idea being that Toco was near the sea-coast, so that the cacao could easily be shipped.

No doubt when it was realised that the cacao was of such quality, and when people found how profitable it was to grow, the area under cacao spread very rapidly. Early in the 19th century, and right up to within the last 25 years, the planting of cacao was carried on wherever possible.

The chief method of planting was on the old Spanish contract system. Cacao-planting in Trinidad was, however, done by two methods.

(i) A planter acquired some Crown land, felled the forest, and planted it in cacao himself.
By the old contract system, a planter acquired the land from the Crown, and then let it out in small lots to contractors. These people were small peasant-holders, often of Spanish origin. The contractor was bound to plant cacao-trees. He could, however, have the use of the land for five or six years, and could grow annual ground provision crops. These he sold off, and from them he derived his income. At the end of the period, usually six years, the owner would take over the area, and would pay the contractor a fixed price for every bearing cacao tree. It varied from 7½d. to 1/- per tree. This system had its advantages and disadvantages.

**Advantages.** If a contractor was honest and reliable, it was the cheapest and easiest way to establish a cacao plantation.

**Disadvantages.** If, however, the contractor was dishonest, the system was a complete failure. The contractor could grow a few crops for himself, and then vanish. This they frequently did. He could plant the land badly, or with very inferior cacao, or could leave the cacao trees at the end of six years in a very weak condition, due to excessive intercropping.

About forty to fifty years ago, there was a rapid establishment, mostly done on the contract system, the price paid per tree being about one dollar. This was an arbitrary basis of valuation, based on capitalising the return to be expected at that time. In order to carry out this development and to make payment to the contractors, which in many cases involved thousands of pounds, the owners of estates borrowed money as mortgage. Subsequently further mortgages were often incurred in bad years. However, with a run of good fields and of good prices, the cacao planter could, without too great inconvenience, pay a high rate of mortgage per year. He did not, however, in the majority of cases pay off any of
the principal. This continued until 1920, when, with a 50% drop in prices, a climax was reached. Many of the planters found themselves financially embarrassed, and in a great many cases the estates fell into the hands of the Mortgagees.

It must be remembered also that output per acre in many cases had been growing less and less, owing to inefficient management and the lack of cultivation, which may or may not have been due to financial difficulties. The prices remained at a low level for four years. In 1925-26 there was an increase in prices again, and in 1928-29 the price fell. Since then the price of cacao has been steadily falling until it now stands at about 10 1/2 dollars per bag.

It must be noted also that the drought of 1926 and the terrible cloudburst have been very largely responsible for the chaotic conditions that prevail in some of the cacao plantations.

Before giving a résumé of the present position of cacao in Trinidad, and trying to show the seriousness of the situation, it would be pertinent at this stage to endeavour to make clear how the principles of specialisation have applied themselves to cacao production in Trinidad, and also how the same principles have proved responsible for the present situation.
<table>
<thead>
<tr>
<th>Year</th>
<th>Price of Cacao per Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1895</td>
<td>18.34</td>
</tr>
<tr>
<td>96</td>
<td>15.62</td>
</tr>
<tr>
<td>97</td>
<td>15.50</td>
</tr>
<tr>
<td>98</td>
<td>23.66</td>
</tr>
<tr>
<td>99</td>
<td>21.66</td>
</tr>
<tr>
<td>1900</td>
<td>22.80</td>
</tr>
<tr>
<td>01</td>
<td>21.56</td>
</tr>
<tr>
<td>02</td>
<td>20.00</td>
</tr>
<tr>
<td>03</td>
<td>20.00</td>
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<td>04</td>
<td>20.00</td>
</tr>
<tr>
<td>05</td>
<td>17.50</td>
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<td>06</td>
<td>18.58</td>
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<td>07</td>
<td>29.32</td>
</tr>
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<td>08</td>
<td>19.20</td>
</tr>
<tr>
<td>09</td>
<td>17.50</td>
</tr>
<tr>
<td>1910</td>
<td>17.43</td>
</tr>
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<td>11</td>
<td>17.43</td>
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<td>12</td>
<td>18.43</td>
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<td>13</td>
<td>21.69</td>
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<td>14</td>
<td>18.52</td>
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<td>15</td>
<td>24.68</td>
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<td>18</td>
<td>20.24</td>
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<td>19</td>
<td>29.40</td>
</tr>
<tr>
<td>1920</td>
<td>32.26</td>
</tr>
<tr>
<td>21</td>
<td>14.58</td>
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<tr>
<td>22</td>
<td>16.32</td>
</tr>
<tr>
<td>23</td>
<td>13.60</td>
</tr>
<tr>
<td>24</td>
<td>15.12</td>
</tr>
<tr>
<td>25/26</td>
<td>18.75</td>
</tr>
<tr>
<td>26/27</td>
<td>22.82</td>
</tr>
<tr>
<td>27/28</td>
<td>21.75</td>
</tr>
<tr>
<td>28/29</td>
<td>17.32</td>
</tr>
<tr>
<td>29/30</td>
<td>16.16</td>
</tr>
<tr>
<td>1930/31</td>
<td>11 approx.</td>
</tr>
</tbody>
</table>

A graph illustrating these figures is attached.
VI.

SPECIALISATION AS APPLIED TO TRINIDAD.

Trinidad is a specialist island. From a study of its chief exports it can be noted that its agricultural products are those of specialised productions. Trinidad's exports in pounds sterling are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Oil, Petrol</th>
<th>Cacao</th>
<th>Sugar</th>
<th>Copra</th>
<th>Bitters</th>
<th>Coconuts</th>
<th>Molasses</th>
<th>Rum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1928</td>
<td>3,051,450</td>
<td>1,446,127</td>
<td>1,049,863</td>
<td>209,732</td>
<td>87,570</td>
<td>66,320</td>
<td>18,227</td>
<td>13,639</td>
</tr>
<tr>
<td>1929</td>
<td>2,493,290</td>
<td>1,651,179</td>
<td>1,201,477</td>
<td>227,555</td>
<td>70,101</td>
<td>34,824</td>
<td>16,913</td>
<td>12,157</td>
</tr>
<tr>
<td>1930</td>
<td>2,326,361</td>
<td>1,671,383</td>
<td>762,366</td>
<td>146,926</td>
<td>79,570</td>
<td>32,298</td>
<td>14,471</td>
<td>8,155</td>
</tr>
</tbody>
</table>

Cacao, sugar, copra, bitters, coconuts, molasses, and rum being the chief agricultural produce, 52% of the exports are of agricultural origin, and of these all are of a specialised type of agriculture.

In order to show how the principles of specialisation have applied themselves in Trinidad, it would be advantageous to follow them step by step, taking the advantages first.

Advantages of Specialisation in Trinidad.

1. As I have stated above, the chief export of Trinidad is cacao. This is not only a specialised crop, but it is grown on a specialised plan. It fulfils the No. 1 advantage, i.e. sometimes there is a single crop that is more profitable for a region than any other crop. Cacao was planted in Trinidad in certain regions because the place fulfilled the conditions required for its successful growth.

Conditions required by Cacao Tree for successful growth.

a. Climate. In Trinidad there are regions where cacao
can be grown very successfully. The climatic conditions are admirably suited. Cacao requires tropical temperatures, the Mean 80°F. in the shade, with a Max. of 90°F and a Min. of 70°F. It must be shielded from wind, either naturally or by means of windbreaks, these usually being of Balata, Poia Mango. The Northern Range forms a natural windbreak.

b. Rainfall. Trinidad also has in places the correct rainfall required for successful cacao production. It must have a rainfall of at least 45", and is grown in places where the rainfall is up to 150", the optimum being about 80-90".

c. Soil. Soils rich in Potash and Lime, i.e. those obtained by the decomposition of certain volcanic rocks, are good for cacao. Open sandy or loamy alluvial soils are considered ideal. Heavy clays and water-logged soils are bad. For example, no finer cacao soils are to be found in the world than the so-called "chocolate soils" of the Montserrat district and in the Rio Claro district.

It seems, however, that during the periods when high prices were obtained, relatively large areas of land were put under cacao that were quite unsuitable. These areas can be picked out quite easily, and wherever bad estates cover a considerable area it is almost invariably due to unsuitable soil. Moreover, by the analysis of the estate accounts under the survey system, it can be easily discerned whether the estates are bad through inefficient management and working, or whether it is due to the fact that the soils are totally unsuited. Examples of estates being established on soils unsuited to cacao are estates in certain parts of Toco, the very hilly parts of Montserrat, parts of the Northern Range, the sandy soils at Matura, and the South-side of the River Caroni. The Department of Chemistry of the Imperial College
of Tropical Agriculture is making a survey of the cacao soils, the results of which will prove very useful.

Trinidad has approximately 379,000 acres under cacao estates, of which 209,000 acres are under cacao, representing 55%, 30,400 acres having been abandoned.

Represented as a percentage of the island's acreage of 1,215,000 acres, cacao estates are 31.3% of the total, and land under cacao 17.2%, so the magnitude and importance of the industry can well be appreciated. As would be expected where a crop predominates an area, the entire system of marketing, credit and labour is specially developed to meet the requirements of the crop. In Trinidad, however, these systems are not developed as well as might be expected, to the detriment of the industry as a whole. Admittedly there exist such organisations as the Cacao Planters' Association and the Agricultural Bank, from both of which a reputable planter can get credit, and to the former he can sell his cacao, but taken as a whole the entire system of processing and selling is deplorably bad. It must be remembered that 50% of the island's cacao is produced from estates of 50 acres and under by peasant producers. Many of these peasant proprietors are indebted to the village shop-keepers, from whom they obtain advances at a very high rate of interest, and to whom they are compelled to sell their produce at a very low figure. They are not in a position to produce high-class fermented cacao, on account of the lack of equipment. The solution of the peasant proprietor's credit requirements and the manufacture of his cacao lies in the formation of Co-operative Fermentary Societies.

2. The second advantage of specialisation, that a single crop often obtains the benefits of large scale farming, is certainly to be found in Trinidad. The relative size of the
fields is increased, and as a result better use can be made of equipment. As most of the cacao is grown pure, the fields are so arranged as to derive the benefits from large scale work. On the other hand it must be remembered also that many estates have been built up by the purchase of a vast number of small holdings, and we find a great many estates are difficult to run on account of their disjoined lay-out. Many estates seem to have been laid out with little design and without any foresight as to their future. This applies especially to the equipment. In Trinidad we find that the lack of adequate buildings for the preparation of cacao is exceptionally high, especially with the small holdings. With cacao, the necessity for having adequate buildings for the production of a high grade fermented cacao is of the greatest importance. Fermenting boxes and drying floors are essential for this type of cacao. It is surprising to find how many estates either have no buildings, or buildings of an inadequate size.

3. The third advantage, that a regular routine labour force can be constantly employed by specialisation, cannot be over-estimated in value. The labour has to be highly specialised and skilled. In Trinidad, East Indian imported slave labourers were taught to be expert pruners. The practice of keeping a regular routine labour force in constant employ was adopted until the great economic crisis occurred. In many cases the planters now are so badly hit that the number of resident labourers is greatly reduced, and the cultivation of the estates has had, through sheer necessity, to be reduced to a minimum. At present only skeleton staffs can be afforded, and cultivations are reduced to cleaning operations. With a regular labour force the "skill" of the
labour force is greatly increased. Much damage to cacao trees can be done by bad picking, i.e. the damaging of the cushions; bad pruning, i.e. unfruitfulness; and by bad cultivations, i.e. damage to root systems.

4. The last advantage is quite one of the most important, i.e. that specialised production enables the manager to concentrate his study on one crop, rather than on a large number of crops. When applied to existing conditions in Trinidad, criticism is bound to have controversial results. With the exception of a limited number of planters who keep pace with the times, the standard of management is not sufficiently high, when taking into account that they are specialists with one crop. One of the weaknesses in management is the lack of any records. For example, (a) cost accounts of the estates, and (b) field records or various fields on the estates, are, in many cases, non-existent. This automatically causes a laxer control. Lack of knowledge with regard to the trees seems prevalent, and many non-resident owners do not visit the estates often enough for efficient supervision. In the past, with high prices and good fields, estates would even make money if inefficiently run, but now, in these days of depression and with other external factors of competition arising, a higher degree of management and knowledge is required. Cacao managers who had no knowledge of the crop could formerly, as the common expression denotes, "get away with it" and show a profit, but now their day has gone. Cacao must be considered as an orchard crop, and must be managed as such. The old idea of being able to obtain yields year after year by picking alone has gone. The present position of the industry very largely arises from the fact that cacao was indiscriminately planted, and badly maintained, and the estates were bled to death. No practices
associated with good husbandry were ever carried out. On rich soils, high yields were produced year after year at the expense of the soil. Large profits were made, but no money was ever put back into the estate, with the result that very good soils were impoverished, and much money went into the planters' pockets. This was, however, spent on unproductive things with an incredible speed. Many parts of the Montserrat area are impoverished by bad management, and have been bled to death. The mortgages in many cases have not even been paid off, and now cannot possibly be paid.

With the exception of a few planters, the majority have insufficient knowledge of the tree, although they have in many cases been born and bred on cacao estates. They are not prepared to accept and profit by any advice or knowledge that is offered. The sooner they realise they are specialists, and must act as such, the better, and unless they are alive to their crisis many of them will fail in the near future.

B. Disadvantages of Specialisation as applied to Trinidad.

In this section I will endeavour to show how the disadvantages of specialisation have made themselves felt in the industry in Trinidad.

1. The soil fertility may suffer through the absence of a rotation of crops and the diversification of crops. In Trinidad cacao has been grown upon soils for any length of time up to a hundred years. It must be remembered that a cacao plantation is planted upon such soils as are suitable to the crop, and that it is expected to remain on that soil for a considerable number of years. We have little evidence to prove what is the optimum length of time a cacao crop can be grown profitably on the same soil, but such evidence as there is shows that, provided an estate is well looked after, cacao can be grown successfully for a great many years. Admittedly, by diversifying
crops we might maintain the soil fertility more economically, but evidence shows that with good management the fields of cacao can be maintained. In Trinidad, taking the island's production as a whole, the yield is gradually falling off. It may be because the same crop is being grown upon the same land year after year, but evidence tends to show that the predisposing cause is that the estates are impoverished and the yields are consequently falling through bad management, there having been no attempt in the past to maintain the soil fertility. The cacao plantations that were established on unsuitable soils must go out of existence in face of the present competition, and it is upon such estates that diversification will be carried out. Another point of interest is that the exports of cacao are decreasing. This must be due to the decline in the acreage of cacao, as figures from many estates show that the yield per acre is increasing. In the near future many hundreds of acres of cacao will be abandoned.

The absence of live-stock on estates is an important factor. There are only a very few estates that apply farm manure to this land regularly, and the use of fertilisers is practically negligible.

2. The fact that a single crop greatly increases the evil effects of fluctuations in yields and prices, and that the production of several crops tends to lessen the effects of its compensating movements, is a very debatable point at the moment. Theoretically it is sound: the evils of a single crop product come into force occasionally, but taking the cacao industry as a whole, the high prices must exceed the low prices, or else the cacao production would have ceased long ago. At the present moment the price of all agricultural commodities is low, in many cases far below the cost of production, and it is difficult to see how diversification

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could improve the position of cacao in Trinidad, with the exception of citrus.

3. With regard to the proper distribution of man and horse labour with a specialised crop, cacao is the exception. In many cases it is impossible to obtain the maximum output and employ the labour efficiently throughout the year with a specialised crop, but this is not so in the case of cacao. In Trinidad, as stated before, regular labour forces are employed throughout the year in order to maintain the estates in good order. When we deal with diversification of cacao in Trinidad, it will be seen that one of the difficulties is the selection of a crop that will not utilise much of the labour at the time when the cacao crop demands it. If coffee is planted with cacao, more labour is required, as both crops ripen at the same time. This may, or may not, be a disadvantage, depending upon whether casual labour is easily obtainable or not.

4. The income of the cacao producer is not spread over the year so evenly as with a diversified estate, but this can be remedied, as is the case in Trinidad, by loans to the planters from the Cacao Planters' Association and from the Agricultural Bank, provided always that the planter is not indebted to a serious extent.

Conclusions. In favour of Specialisation.

1. Trinidad is, in parts, well suited to a specialised type of industry such as cacao, but during the periods of high prices, cacao was planted in comparatively large areas which were totally unsuited. These areas will, in the very near future, go out of cacao cultivation.

2. Special organisations connected with a predominant crop exist in Trinidad with regard to cacao, but there is room for great improvement. Greater facilities for cheaper credit
and better marketing for the peasants' cacao are required.

Central fermentaries might also be established to advantage.

3. The lack of adequate equipment is deplorable, considering the specialised conditions in the island.

4. Specialisation suits the routine labour requirements admirably, the labour being actually imported in the past from India. The higher skill obtained by specialisation is beneficial to cacao production.

5. Specialisation with regard to management efficiency is disappointing in Trinidad. There is room for great improvement in the systems of management. Insufficient scientific knowledge is marked.

Trinidad has failed to make use to the maximum extent of the advantages which can be derived from specialisation of a crop.

Taking the disadvantages of a specialised system, the conclusions which may be arrived at from the position in Trinidad are as follows:-

1. The soil fertility has, in most cases, suffered very considerably through the lack of a rotation. The soils of many estates have been bled to death by mismanagement. Alternative crops must be suggested for the maintenance of soil fertility. Intensive methods of cultivation would increase very considerably the output per annum.

2. It has also been shown that the evils of yield and price fluctuations are increased by a specialised crop production.

3. The disadvantage of specialisation is that it is often impossible to secure the maximum output from a regularly employed labour force does not apply to cacao estates in Trinidad.

4. The effects of an uneven income are remedied in Trinidad, provided the estates are not heavily mortgaged.
As would be expected, the diversification of cacao in Trinidad is not carried out to any extent. This is very largely due to the fact that cacao is a specialist crop, and that it is better to work it as such. It is far better to work the crop pure on suitable lands and obtain a profit, even in these bad times, than to continue to attempt to work it under unsuitable conditions, and so make ends meet, by diversifying it with other crops for which it is not suited.

Let me attempt briefly to show why diversification is not suited to conditions of cacao production in Trinidad.

C. The Advantages derived from Diversification.

1. Admittedly soil fertility is more easily maintained by diversification of cacao with other crops, but the question of which other crops has not yet been solved. If the cacao is well managed, the conditions are such that no other crop will grow underneath the canopy, with perhaps the exception of coffee. These difficulties will be discussed in detail when methods of diversification are dealt with.

2. The point that diversification reduces the risk of price fluctuations has already been dealt with under specialisation. It has been seen that all agricultural commodity prices are low.

3. The question of a better utilisation of man and horse labour does not apply to cacao estates, in that with good management the labour force can be employed constantly and profitably. The economic conditions that are prevailing at this time necessitate part-time employment only, i.e. skeleton staffs.

4. Better utilisation of the waste products by diversification has no influence upon the cacao crop, and can be dismissed. All waste products are returned to the land as manure.
5. By diversifying crops, more regular income can be obtained. This difficulty has been largely overcome in Trinidad by the formation of the Cacao Planters' Association and the Agricultural Bank, from whom credits can be obtained. The question of credit with a large number of estate owners is, nevertheless, acute, due very largely to their improvident actions in the past in not paying off mortgages when times were good. This, however, is beside the point when applying the theories of diversification to Trinidad. The same thing applies to the majority of smallholders, who are seriously in debt to shop-keepers, owing to their extravagance in unproductive amusements, etc.

6. A point of great importance is that diversification weakens the incidence of disease. Whether diversification might have improved the position as regards disease in Trinidad no one can say, but the position is critical with regard to Witch Broom. In Trinidad, with 17% of its acreage under cacao estates, the menace from this disease is considerable; in fact it is the greatest potential danger at the moment, and may very easily prove to be the cause of ruin to the cacao industry of the island. It was first reported in 1928, and since then it has reached the following dimensions:-

Of the 209,000 acres under cacao, 1.2% is heavily infected by Witch Broom, 1.2% moderately infected, 4.3% lightly infected, and 21.5% of the acreage has scattered infection.

With regard to the other diseases, such as Black Pod and Thrips Beetles, the disease appear to be controllable by the specialist managers. These diseases can be kept under control by efficient management. However, there is no justification for using this argument in favour of diversification when applied to cacao. In fact, it is interesting to note that when cacao estates were interplanted with rubber trees in Trinidad, the
effects were disastrous. Diseases started which were common to both trees, with the result that in many cases both types of trees were lost. This happened to some of the best cacao estates in the Montserrat Hills.

D. The Disadvantages of Diversification as applied to Trinidad.

The disadvantages of diversification with reference to the conditions in Trinidad are converse to the advantages of specialisation, and have already been given.

1. It has been shown that Trinidad is in parts admirably suited to cacao production, e.g. Montserrat Hills. Where it is grown under those conditions it will continue to do so, but the degree of specialisation has been extended too far, in that cacao was planted indiscriminately, irrespective of whether it was suited to the environmental factors or not. Cacao, where planted on unsuitable soils, will go under in the very near future. It is under these conditions that I shall endeavour to show that the diversification of a specialised crop is justifiable and, in fact, one of the solutions to the cacao problem in Trinidad.

2. By diversifying the cacao crop with other crops, the system may tend to reduce the acreage of cacao below that at which the large-scale farming benefits can be derived, with the consequent effect of increasing the cost of production of cacao. In Trinidad it is extremely difficult to obtain figures from estates that interplant the cacao with other crops which denote any increase or decrease in cultivation since interplanting has been done.

3. The disadvantage of diversification in relation to the labour, namely, that a routine labour system may not easily be adopted, can, in the case of cacao estates, be overcome by careful diversification. It is true that some crops suitable for interplanting do increase the labour required, but when
dealing with the various systems I shall endeavour to show how this difficulty can be eliminated.

4. The problem of whether the manager's efficiency is improved by diversification or not is purely individualistic. Many managers are quite capable of running properties efficiently with more than one crop.

CONCLUSIONS.

Advantages of Diversification as applied to Trinidad.

1. Diversification would help to ameliorate the position of cacao estates, where these have been planted on unsuitable soils. Maintenance of soil fertility is easier when crops are diversified.

2. Labour force is fully employed, whether pure or diversified cacao is grown.

3. Better utilisation of waste products does not apply to cacao.

4. Income can be regularly supplied.

5. Diversification of cacao may reduce the incidence of disease in Trinidad. Better management could, it was shown, have the same effect.

Disadvantages of Diversification as applied to Trinidad.

1. It is still more profitable to grow cacao pure under suitable conditions than to diversify it.

2. There is little information to show if the diversification of cacao estates tends to increase cost of production by reducing the size of cacao estates.

3. By careful diversification the labour requirements may not be increased.

4. Manager's efficiency may, or may not, be impaired by diversifying crops.
Before giving a summary of the present position of the cacao industry in Trinidad, it would be advantageous to give a very brief résumé of the work done on cacao at the Cacao Research Station. When giving the advantages of specialisation I mentioned the fact that it gives scope for specially developed requirements, and in regard to scientific research cacao has been neglected in comparison with other crop research activities.

The results of most of the cacao work have come from River Estate. It was found that manuring played a very minor part in determining the yield of a cacao estate. When once this fact was established, work was started to try and ascertain the cause of this unexpected result. It was found that the yield varied according to the relative productiveness of the trees on the estates, and to the relative number of heavy and poor bearing trees. It was also found that many trees gave less than thirteen pods per tree per annum, even in a favourable year. The trees can be grouped into three classes:

(i) Heavy bearers.
(ii) Medium bearers.
(iii) Poor bearers.

In general it was found that heavy bearers continued to be heavy bearers, and poor bearers continued to be poor bearers. Poor bearers were found to be either retarded or weak trees, but others were equally strong and vigorous as the good bearers. Moreover, special manurial and cultural treatment seemed to produce no fundamental change.

De Verteuil found that on estates between 20% and 50% of the trees were poor bearers, not yielding more than 1 lb. per tree, and that 20% were giving below 2 lbs.
Having established this fact, work was at once begun to improve the condition of estates. The replacement of poor bearers by means of known heavy bearing progeny was carried out. The results were very promising. With the loss of a practically negligible crop for five years, and a very moderate expenditure, it was found that the yield could be increased nine times. The grafting of high yielding scions on to poor yielding stocks seems about the only possible way of increasing yield. Barbour very aptly summarises the problem of poor yielders: "The evil is very difficult to remedy, for one cannot replant; it is idle to expect a seedling to survive when surrounded by a plantation of mature trees...... the only possible way of improving these poor bearers would appear to be by grafting. They cannot be simply cut out, because of the injurious effects of the sun and the wind upon the soil and upon the other trees."

Work was carried out by Harland on the botanical side of cacao, as to whether heavy bearing characteristics were hereditary or not. His conclusions were as follows:- "A heavy bearing tree may transmit heavy yield to its budded offspring. On the other hand, it may absolutely fail to transmit, and may give rise to trees which are much worse than the average. There is no method of telling whether a tree will transmit high yield either to its budded offspring or seedling offspring, except by testing it." In Trinidad planters have at their disposal trees which have been known to transmit their heavy yielding to their progeny, and these are now being planted as supplies. At River Estate, work was also done in connection with shade, a very controversial problem. The most recent opinions are that the optimum shade for cacao is the Partial Shade, the optimum being based on the best cacao yield. It has been found that with partial shade the biggest yields per acre have been
obtained, and the period of fruiting has also been extended.

Work has also been done on the cultivation side of cacao, but until recently this branch of cacao production has been strangely neglected, especially as regards cultivation research. It is beyond the scope of this paper to give a detailed account of the recent experiments, but it is relevant to give a resume of the work done on River Estate. "Trenching" has been done successfully, and an increased yield per acre resulted. Further, it was noticed that the damage done by Thrips was greatly reduced. These experiments have been operating for a comparatively short period, and it would be dangerous to generalise on the benefits obtained from this practice.

Experiments have been carried out to try out the merits and demerits of "Forking" between the trees, and of "Hoeing". The results obtained showed an increase in crop yield, and were beneficial also in that they proved to the planters that their prejudice against any disturbance of the soil and roots was unfounded. The beneficial results of "forking" obtained on River Estate are also substantiated by results obtained by de Verteuil, on the La Vega Estate. It appears that the determining factors as to whether or not forking is beneficial, depend very largely upon the environmental conditions.

In conclusion as regards cultivations, experiments have shown that the chief objects to be aimed at are:—

(a) Sufficient drainage.
(b) Adequate soil aeration.
(c) Encouragement of organic matter in the soil.
(d) Encouragement of the water-holding capacity of the soil, and a deeper root system.

Research on cacao has now been going on for approximately twenty years, and the results have been satisfactory in that they have shown us the courses that are open if cacao is to be continued in Trinidad. It must be remembered that cacao is not a short-lived crop, and that alteration in quality cannot
be made rapidly by varietal changes. Mature crops represent heavy capital expenditure, and therefore the planter is limited to the cacao he possesses. There are two courses open to the planter:

(1) To produce cacao of a quality for which the manufacturers are prepared to pay a high or premium price. This can be done by exercising greater managerial care in the production of the cacao beans.

(2) To increase his profits by producing larger crops on the same average, and to reduce the cost of production. This can be accomplished by the elimination of poor bearing trees, and by abandoning cacao where planted under unsuitable conditions.
It would be sheer waste of time to enter into a detailed discourse upon the present position of the cacao industry in Trinidad. One has only to pick up any newspaper, whether European or local, or to talk to any planter, to ascertain its condition. The condition of the industry is precarious.

I propose to deal with this section in the form of a summary, giving the causal factors for the present depression and a sketch of the existing conditions.

Apart from the following summary, it must be borne in mind that the existing depression is very largely aggravated by the collapse of the economic structure of Western Europe. Whether or not this structure will collapse into the unknown depths of anarchy, following the bankruptcy of the great nations, is beyond the power of man to predict.

It may be poor consolation to the cacao producer to realise that he is in a position similar to every other producer of agricultural raw materials, with the possible exception of the Citrus growers, and that whether he can last out until the tide of depression turns very largely depends upon his thrift in the past. In my opinion, the turning point will be distant, and it will be a question of the survival of the fittest as regards solvency. The tide must turn, as agricultural commodities cannot for long be grown for less than the cost of production, but until the economic stability of the consumers is reassured, such a turn will be retarded.

Summary of Causes, and Present Position of Cacao Industry in Trinidad.

1. The droughts of 1912 and 1926, and the fires that followed, were very largely responsible for the extensive damage to cacao properties. In some districts the cacao never
recovered, and the estates still remain in a chaotic condition.

2. The present low price of cacao. The abnormally low price of cacao at the moment makes it impossible to run an estate in accordance with the practices of good husbandry. If the price of cacao were to rise to 10 dollars per fanega, it would be possible to continue to run the suitable estates at a profit.

3. The average yields of cacao in many cases are too low to give satisfactory profits, and in consequence the standard of cultivation is falling. Cultivations are cut down to a minimum, in many cases to the detriment of the estate.

4. On good estates, however, the standard of cultivation is high, and the yields are high, and it is encouraging to see that the young plantations are being well looked after.

5. Extensive areas of cacao land, planted under unsuitable conditions, are gradually being abandoned. 35,000 acres of cacao land have been abandoned, and in the near future this figure will increase.

6. There remains in Trinidad only a very limited area of land suitable for cacao planting. This may be advantageous in that in face of the existing competition, the yield of the cacao estates will have to be increased rather than that capital expenditure should be incurred by the formation of new estates.

7. 50% of the cacao estates have inadequate buildings and equipment for the production of a high grade fermented cacao.

8. Bad management has very largely been responsible for the position in which the cacao planters now find themselves. They keep no records in many cases, and have been very lax in controlling their estates.
9. Exploitation of estates is another factor of importance.
   (a) No attempt has been made to maintain the fertility of the soil.
   (b) Upkeep of equipment in many cases has been neglected.
   (c) The payment of the mortgage principle, even when possible, has not been made in the vast majority of cases.

10. Speaking generally, there appears to be a lack of scientific knowledge among the planters, and in many cases the desire to learn seems to be dead.

11. Many estates are encumbered by mortgages of fictitious value, and cannot possibly continue under the heavy burden with prices such as prevail at the moment. In these circumstances it is often very difficult to obtain credit or money for working the estates.

External factors affecting the Cacao industry in Trinidad.

1. Increased competition from West African Colonies.

Trinidad can produce cacao of a type superior to that of any West African colony, on account of its quality and flavour. The Trinidad Cacao Planters' Association cacao commands a premium on the London market, and up to a year or two ago the West Indian cacao had little competition. At the present time things have changed. The West African cacao has been improved in quality to a certain extent, but the process of manufacture has been so increased in efficiency that the poorer quality cacao, i.e. that obtained from West Africa, can be substituted in favour of the superior type for which the manufacturer has to pay a higher price. In addition, the production of cacao from the West African colonies is rapidly increasing, so that the general range in prices will not be so high.

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2. The General Demand.

At the present time there seems to be a demand for a different type of chocolate. The discriminating chocolate buyer and the Epicurean are rapidly dying out, and in consequence the first class type of chocolate is not in such demand. The demand now lies in the good middle class type of chocolate which, by the improved manufacturing processes, can be made from inferior qualities of cacao. The public prefer quantity, not quality.

It now remains to show that, by diversifying cacao with other crops, better conditions may be obtained.

The question which immediately presents itself is whether or not the condition of the industry in due, directly or indirectly, to excessive specialisation in Trinidad. The answer, as will be seen later, tends to show that it is a question of indiscriminate specialisation rather than excessive specialisation, and the basis on which I suggest my improvements is inspired by the principle of suitable crops for suitable climate and environmental conditions. There appear to be two methods by which the industry might be improved:

1. By increasing specialisation under suitable conditions.

2. By diversification.

Before giving these two methods, it would be relevant at this point to give the present position of cacao as regards diversification.

A. The position of Cacao relative to regards diversification.

The figures quoted are those obtained from the Cacao Survey, Department of Economics, Imperial College of Tropical Agriculture, and are those taken last year for the years 1929-1930.

Of the 176 cacao estates that were surveyed, 96 showed a credit return from intercultivated crops. This represents
I have attempted to explain the present condition of the cacao industry in Trinidad, and have given the chief reasons for its depressed condition. I shall next endeavour to offer some solutions whereby the position of the industry can be ameliorated. It is quite beyond the scope of this paper to give all the methods whereby improvements might be affected, but I shall hope to show that, by diversifying cacao with other crops, better conditions may be obtained.

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(ii) By diversification.

Before giving these two methods, it would be relevant at this point to give the present position of cacao as regards diversification.

A. The Position of Cacao Estates as regards Diversification.

The figures quoted are those obtained from the Cacao Survey, Department of Economics, Imperial College of Tropical Agriculture, and are those taken last year for the years 1926-1928.

Of the 176 cacao estates that were surveyed, 96 showed a credit return from intercultivated crops. This represents
54% of the total estates. The distribution of the estates was then studied, and the estates were placed in their respective areas for analysis. Table 1 gives the distribution of the estates in the island showing a credit return of more than half a dollar per acre from inter-cultivated crops. The estates are divided into eight areas. These areas are determined by the Department of Economics for ease and convenience in analysing the data. The areas are as follows:

(i) The Northern Range.
(ii) Montserrat.
(iii) Sangre Grande.
(iv) Siparia.
(v) Talparo.
(vi) Moruga.
(vii) Rio Claro.
(viii) Princes Town and Mayaro.

The following analysis was made, from which the table resulted:

1. The total number of estates with inter-cultivated crop returns was found.

2. The distribution of these estates into their respective area groups was made. The results were expressed as a percentage of the total number of cacao estates surveyed in each particular district.

3. The estates with inter-cultivated crop returns were analysed into those, giving Net Profits and Losses, the results again expressed as a percentage.

4. A further analysis was made to find the percentage of estates that had more than half a dollar per acre return from inter-cultivated crops.

The following table gives the data which were obtained from the survey with regard to inter-cultivated crop returns.
## TABLE I.

<table>
<thead>
<tr>
<th>Division</th>
<th>No. of Estates</th>
<th>% of Total Estates with Inter-cultivated Crops</th>
<th>% of Estates inter-cultivated and showing a return of more than .5 dollars per acre</th>
<th>% of Total Estates with no Inter-cultivated Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Range</td>
<td>46</td>
<td>50</td>
<td>19.5</td>
<td>69</td>
</tr>
<tr>
<td>Montserrat</td>
<td>35</td>
<td>31</td>
<td>6.0</td>
<td>37</td>
</tr>
<tr>
<td>Sangre Grande</td>
<td>32</td>
<td>47</td>
<td>6.2</td>
<td>53</td>
</tr>
<tr>
<td>Siparia</td>
<td>18</td>
<td>39</td>
<td>16</td>
<td>55</td>
</tr>
<tr>
<td>Talparo</td>
<td>15</td>
<td>47</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td>Moruga</td>
<td>13</td>
<td>69</td>
<td>0</td>
<td>69</td>
</tr>
<tr>
<td>Rio Claro</td>
<td>9</td>
<td>33</td>
<td>11</td>
<td>44</td>
</tr>
<tr>
<td>Princes Town &amp; Mayaro</td>
<td>8</td>
<td>38</td>
<td>12</td>
<td>50</td>
</tr>
</tbody>
</table>
From the above table the following observations should be noted.

1. Re Intensity of Diversification.

(a). The Northern Range and Moruga both show that 69% of the estates in the area have returns from inter-cultivated crops. The Northern Range returns show that of these 69%, 50% of the estates show a profit and the remaining 19% show a loss, while in the Moruga area all the 69% of the estates with inter-cultivated crops show a profit. In the Moruga area all the credits were derived from coffee, with the exception of one estate, where oranges were grown. The Northern Range showed a wider selection of inter-cultivated crops, the chief, of course, being coffee, to which the area is admirably suited, but such crops as nutmegs, mace, Tonka beans and fruit were also grown.

(b). Siparia area is the third most intense area for diversification. Coffee again is the only inter-cultivated crop.

(c). The lowest area as regards diversification is that of the Montserrat district. Only 57% of the estates show any returns from inter-cultivated crops, and of these returns coffee again represents the principal crop. The returns are also very small, the coffee in most cases being planted along the traces and roadways.

2. Re Amount of Credit received from inter-cultivated Crops.

(a). Again the Northern Range heads the list of credits. Out of the 69% estates showing credits, 45% show a return of more than half a dollar per acre from the inter-cultivated crops.

(b) Moruga returns must be noted. Moruga showed that 69% of the estates were interplanted, but that of these only 15% showed a return of more than half a dollar per acre from the inter-cultivated crops.
the inter-cultivated crop. The area has therefore many estates which are interplanted, but the amount of interplanting is very small.

(c). Siparia, on the other hand, was third in the quantity of diversification (55%), but of this 44% show a return of more than half a dollar per acre from intercultivated crops. The area has, therefore, quite an appreciable amount of interplanting, indeed very nearly as much as the Northern Range 45%. Relatively, the returns are considerably more than those of the Northern Range. On analysing the estate books, the returns are observed to be exclusively from coffee, and from young interplanted coffee.

(d). Montserrat and Rio Claro show the least number of estates, the percentage of estates showing a return of more than half a dollar per acre from interplanted crops being only 11%. Both these areas also show a low percentage of diversification in regard to quantity.

Inferences which may be drawn from the above data:

1. Diversification is most marked in the Northern Range. The environmental conditions are such as to encourage diversification. The cacao estates are the oldest in the island, and were badly affected by a cloudburst in 1925. The yields have steadily fallen, and are now too low to give satisfactory profits. In consequence the standard of cultivation is very low. These remarks apply especially to the Toco area, where the cacao problem is acute. Specialisation on cacao will have to be modified to suit the present day conditions.

From Table 1 we see that the Northern Range leads the way in diversification. This is chiefly because of the ideal conditions that prevail for the growing of coffee. In this area there are several long, highly fertile valleys
extending into the Mountains. It is here that coffee is extensively interplanted, and will eventually oust the cacao. The diversity of opinion with regard to the interplanting of cacao with coffee is of great interest. There are three schools of thought. Firstly the planters who state that, given suitable conditions, coffee can be grown successfully with cacao, and that the yields of both crops are in no way affected. Secondly, the planters who say that, if cacao is properly managed the conditions are such that the coffee will not survive - there will be too much shade for coffee. Thirdly, the planters who state that cacao and coffee are specialised crops, and should be grown alone, and that if they are grown together a reduction in the yield of each crop will result. As far as the writer is aware, there is no literature on the subject nor any evidence to show which school of thought deserves preference. From the results in the Northern Range, there appears a tendency for the cacao yields to fall where interplanted with coffee, but whether this is due to the increased competition for food, or from the general deterioration of the cacao, it would be impossible to state. On many estates the coffee has not been planted for any length of time, and the affect upon the cacao has not been determined. A well conducted yield trial on this point would be very beneficial.

In this area there has been a very considerable reduction in cacao land. Large areas have been cut down and other crops substituted. Citrus has to a great extent taken the place of cacao where it had been planted in unsuitable conditions. The valleys of Caura, San Jose and Maracas are ideally suited for citrus growing, which at the moment is far more profitable than cacao. On the higher lands, Tonka beans have been planted, which afford excellent shelter as a windbreak and in addition produce valuable nuts.
2. In the Moruga area coffee has not been interplanted so extensively, as is shown by the figures in Table 1. There are relatively as many estates interplanted, but the percentage of estates showing a return of more than half a dollar per acre is much lower. The environmental conditions are not the same as those in the Northern Range, the rainfall being lower and the topography of a different structure. The coffee of Moruga is also younger: in most cases it is only just coming into bearing.

3. As would be expected, the Montserrat area lags far behind as regards diversification, the area, taken as a whole, being one of the finest cacao areas in Trinidad or, in fact, in the world. This area will profitably continue to specialise in cacao on the whole, with the exception of the South-Eastern parts and some of the very hilly districts of Montserrat, where the soil is too light for cacao and would be admirable for grape fruit and other citrus fruits. From the analysis of the estate books, the intercultivated crop returns are shown to be mainly coffee. This coffee is grown chiefly along the traces and roadways, and the opinion that prevails in the area is adverse to the interplanting of cacao with coffee.

STATISTICAL ANALYSIS OF ESTATES RE DIVERSIFICATION.

A statistical analysis of the estates was undertaken as regards the credits obtained from inter-cultivated crops, and a series of group distributions was made to ascertain if any direct correlations could be found. The following data were tabulated:-

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Acreage</th>
<th>Pickets</th>
<th>Bags</th>
<th>Cost per bag</th>
<th>Credits per bag</th>
<th>Credits per acre</th>
</tr>
</thead>
</table>

From this tabulated data, group distributions were made.
Two methods by which the Cacao industry might be improved.

1. By increased specialisation.
2. By diversification.

Improvements by Increased Specialisation.

As previously mentioned, Trinidad suffers from indiscriminate specialisation rather than excessive specialisation. The continued policy of specialisation of the industry under suitable conditions and on suitable soils is rational, and must continue, but a higher degree of supervision and intensity of work must accompany this policy.

Parts of Trinidad produce the world’s best cacao, chiefly because the factors of growth are ideally suited. Where cacao is suited both to the soil and to the environmental factors, it can still be produced at a profit. Estate efficiency must, however, be raised by improving the standard of management. This can be done in the following ways:

1. Accurate records will have to be kept, both of financial accounts and crop yields.
2. Closer supervision must be exercised.
3. Estate trials - both manurial and cultivation trials - must be made. The object of these trials must be a determined effort to increase economically the yield per acre.
4. Improvement in quality must be made by better manufacturing. Grading must be done.

Improvements by Diversification.

Improvement can be affected in the industry, and in the position of many planters, by overcoming indiscriminate specialisation, and by judicious diversification of cacao estates with other crops. The methods of diversifying cacao
are numerous, but for the convenience of explanation this section has been divided into two main sub-sections, A and B, with their respective sub-headings.

Methods of Diversifying Cacao.

A. The Diversification of Cacao Estates by interplanting the Cacao with other crops.

B. Complete Diversification of Cacao Estates by the substitution of other crops.

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A. Diversification of Cacao by interplanting.

It must be borne in mind at the start that cacao is essentially a specialist crop, and if grown under suitable conditions it should be grown pure. Owing to the present economic conditions, and the fact that in many parts of Trinidad heavy capital expenditure has been incurred by the formation of cacao estates upon unsuitable soils, the question of ameliorating existing conditions by inter-cropping has arisen.

Another point of interest is that cacao has no alternative diversified by-products, as have many other crops. Take, for example, the lime crop. When the price of lime, and its main products such as lime oil, fell, diversified by-products such as concentrated lime juice (a tarry residue) were utilised for the dye industry, and further, lime seeds were compressed and sold as cattle cake. The only product of the cacao crop, however, is beans.

Interplanting of cacao can be done in two ways.

(a) By interplanting cacao with a crop which is shade-tolerant, the object being to maintain the estate in cacao, but to increase the monetary returns by inter-cropping.
(b) By interplanting cacao estates with other crops, with a view to eliminating gradually the cacao in favour of the interplanted crop.

(a) Interplanting Cacao with shade-tolerant crops.

The following crops can be interplanted with cacao:

- Coffee.
- Nutmegs.
- Figs, Chinese Bananas.
- Tonka Beans.

Ground Provision Crops:

(i) Tanias.
(ii) Cush Cush.
(iii) Yam.

The desirability of interplanting with coffee, and the varying schools of thought on this subject have already been given, and can therefore be dismissed without further comment. Coffee can be grown successfully under shade at altitudes below 3,000 to 4,000 feet, as has been shown by experience. The shade question as regards coffee is still a much debated point, but is outside the scope of this paper. It is sufficient to say here that, given suitable conditions such as prevail in parts of Trinidad, coffee can be grown successfully under cacao.

Varieties. There is some difference of opinion as to which is the best variety of coffee to grow when interplanted with cacao. Wherever possible, coffee arabica should be interplanted, on account of its superior quality and flavour and consequently higher value. It can only be grown successfully, however, at a considerable altitude. In Trinidad it has been grown successfully at an altitude of 700 to 800 feet. Arabica is more susceptible to disease than some of the other varieties, and excessive shade must be avoided. A normal amount is,
however, beneficial, as the blossoms are apt to get severely damaged by rain. At the present time coffee arabica is the only profitable type to grow, on account of the low prices fetched by the other species. In the Northern Range, arabica is the chief type of coffee grown, and each year more cacao land is being interplanted.

There are several disadvantages of growing arabica coffee. The crop is simultaneous, and unfortunately it ripens at the time when the labour force is most busily engaged, namely at the cacao picking time. If labour is scarce, this clash of harvests may result in the loss of a considerable amount of one or other of the crops. Diversification of this type is theoretically undesirable, as the labour distribution is upset. It increases the demand on labour at certain periods to a far greater extent than if cacao were grown pure. If extra labour cannot be called in, e.g. casual labour, the interplanting with arabica may prove uneconomic. In the Northern Range last year, when visiting an interplanted estate the writer was told that 50% of the coffee could not be picked on account of insufficient labour. With the present depression, however, there is an increasing unemployment roll, and labour should be obtainable.

Coffee Robusta. Where the interplanting of cacao is to take place in the lowlands of Trinidad, Coffee Robusta will have to be substituted for Coffee Arabica, on account of the altitude. Robusta is a very hardy plant, giving the highest yields of any species of coffee, but of the poorest quality. It has the advantage that it comes to bearing very quickly, and also that the berries do not shed. This latter advantage ameliorates the labour question as regards the time of picking. It can be picked when the labour is not engaged in harvesting the cacao.
In Trinidad robusta is frequently grown along the sides of traces and roadways, and under these conditions it does admirably. Robusta is not so tolerant of shade, but the chief disadvantage is that of the price; it is so poor that production is an uneconomic proposition.

Liberian Coffee. This type of coffee is totally unsuited for interplanting with cacao, on account of its vigorous habit of growth. If allowed to grow unrestrained it would reach a height of 30 feet or more.

Conclusions. If conditions are suitable and the cacao is on the decline, such as in the case in the Northern Range, coffee interplanting can be done profitably. It requires extremely efficient management at harvest time to prevent the loss of crop, and sufficient labour must be available. The planting of arabica will, in the opinion of the writer, help to solve the crucial position of some of the cacao planters.

2. Interplanting with Nutmegs.

Interplanting with nutmegs presents some difficulties. Either the cacao and nutmeg trees must be planted at the same time, or gaps will have to be cut in the cacao to allow light and air to penetrate to the young nutmeg trees. If this is done, there is a danger of upsetting the balance of light and shade in the plantation, with the result that diseases and pests may gain access. In practice, if this were done thrips and cacao beetles would attack the cacao trees, and the damage might prove very extensive. It is therefore an undesirable way of interplanting an existing cacao plantation. In addition, the nutmeg trees affect considerably the yield of the cacao trees, as has been proved in Grenada. De Verteuil, in a report on the Cacao of
Grenada, showed that the interplanting of nutmegs into cacao estates has caused a drop in yields of between 15% and 18%. He points out that the decrease in yield is not so important as the future effect of the nutmegs upon the cacao trees. In practice, the interplanting of nutmegs does not harm the cacao for several years, until they attain the height of the cacao trees and start to outgrow them. In Grenada, where this has happened, the nutmegs have killed out the cacao to a distance of fifteen to twenty feet around each tree.

**Conclusions.** Where a cacao estate has reached such a state of dilapidation that it will eventually go out of cultivation, the planting of nutmegs under suitable conditions may prove a satisfactory solution. If, however, the cacao estate is intended to remain as such, with an interplanted crop, the planting of nutmegs is to be deprecated.

3. **Interplanting with "Figs". Cavendish Bananas.**

The interplanting of cacao estates with "figs" or bananas is not done on a commercial scale, neither is it likely to become a commercial practice on account of the inconvenience of harvesting the figs. Where gaps have occurred in the cacao, due to damage by falling immortelle trees or other factors, it will be noticed that bananas are frequently planted. This is done to eliminate the gap quickly, so as to prevent an excess of light and air into the cacao plantation, and in order to obviate the risk of thrip infection.

Where an estate might adopt the interplanting of cacao with bananas, the following conditions should prevail:

(i) The condition of the plantation should be such that gaps had to be filled in quickly in order to save the cacao.
(ii) Given the above condition, it should also be possible to absorb the bananas produced into a local market economically.
Some estates grow Cavendish bananas and Succrine varieties profitably among the cacao, but the advisability of recommending such a practice in general seems unsound.

4. **Interplanting with Ground Provision Crops.**

This is possible, provided the shade is not excessive. On a well-managed estate it would be impossible to grow ground provisions except where gaps in the cacao occurred. If, however, the conditions are suitable, the following crops can be recommended:

(i) Tanias.  (ii) Cush cush.  (iii) Yams.

The method of planting would be between the rows of cacao trees, and on account of their tuber-like products they should be grown well away from the cacao tree roots. Much damage to the cacao trees would result if the ground provision crops were planted too close, as the harvesting of these crops necessitates forking and digging.

The limiting factors to the growing of these crops, given suitable conditions, are:

(a) They are of very little economic value.
(b) They are essentially peasant produced commodities, and are not very suitable for estate production.
(c) Marketing and transport of these goods often makes them uneconomic, owing to their low value.

(b) **Interplanting of Cacao Estates with other crops, with the object of gradually eliminating the cacao in favour of the interplanted crops.** Gradual diversification.

Such crops as citrus, nutmegs, and coffee, grown pure, are suitable for interplanting with cacao trees when there is to be a gradual change over from cacao to an alternate crop. The methods of working will be dealt with later, when describing the existing transition that is taking place in Trinidad.
B. Complete Diversification of Cacao Estates by the Substitution of other Crops.

Whether complete diversification or gradual diversification be adopted depends very largely upon the type of crop to be substituted, and upon the condition of the land at the time. It also depends upon local environmental conditions.

In many cases the crops may be the same as those of the gradual method, i.e. citrus, etc., but in some cases when cacao is being substituted for sugar and coconuts, the change over is complete at one time. If the land is so impoverished or so unproductive, it may be necessary to clear away the cacao and resort to restorative crops prior to the permanent change over. Whatever the substitute crop is to be, the determining factors of the new crop are:

(i) Suitability to soil and environmental conditions.

(ii) Economic value; such limiting factors as transport, proximity to market, etc., have all to be studied.

Here again the methods that are being adopted will be given when describing the change over that is being carried out in Trinidad.
The above methods of diversification will, in the writer's opinion, be adopted in the near future where cacao estates have been established on unsuitable soils. Much experience has been gained at the expense of the early planters as to the result of indiscriminate planting of crops, and now, owing chiefly to economic pressure being brought to bear upon the planters, diversification of their crops has been found necessary. In suggesting new crops, great care has to be exercised to prevent a repetition of failure due to unsuitability. I shall, therefore, in the following section endeavour to explain how diversification can be applied, and the working methods that are being employed in Trinidad.

In Trinidad the soils may, for the purpose of explaining the application of diversification, be divided into three classes according to suitability for cacao production.


The figure given below represents in a general way the writer's conception of the range of suitability of soils under cacao in Trinidad at the present time, and the economic possibilities of the future:
The lines AB, BC, CD, represent the suitability of the soils under cacao at the present time, and the lines AF, BT, CT, DF, represent what might be practicable in the future as the result of scientific research, improved management, and suitable diversification.

It has been seen that cacao was indiscriminately planted during the boom, and that a comparatively large area was planted on unsuitable soils. From the above figure it will be seen that some of the areas now considered indifferent soils for cacao can be made good, and that what are good can be still further improved. Moreover, a section of the soils which are now definitely unsuited to cacao can be improved, and made into indifferent soils on which economic, although not good, crops could be grown.

Finally, the section AF will remain totally unsuited to cacao, on which no paying crop of cacao will ever be grown.

1. Good Soils. Increased specialisation will be carried on in the future. The chief object will be to increase the yield per acre by economic means.

2. Medium Soils. It is upon the indifferent and medium type of cacao soils that the problem of improvement becomes difficult. Here personal judgment and local knowledge play a very important part. The following are some of the alternative methods of improvement:

(i) If the inherent capabilities of the soil are good, and the cacao estates have been badly run, it may be an economic proposition to bring the estate back into profitable production by intensive methods of management and cultivation.

(ii) Upon this medium type of soil, interplanting may be the most profitable method. Interplanting with shade-tolerant crops - with the exception of coffee - is not to
be recommended, but interplanting with the object of gradually eliminating the cacao in favour of the interplanted crops, may be a sound plan.

In Trinidad the interplanting of cacao estates with citrus, given suitable conditions, is to be recommended. Diversification with citrus, as I have stated before, can be done in two ways, (a) the cacao may be cut out in places and the citrus interplanted, or (b) the cacao may be cut out altogether and citrus planted on the cleared land. The choice depends upon local conditions. Several advantages may be obtained from adopting the first method. The citrus will, in its young stages, be protected from excessive sunlight and from the wind. If the cacao is thinned out suitably, it affords first-class protection. The remaining cacao would gradually be improved by cultivation and pruning, etc., and should be considered as a temporary investment from which economic returns should be obtained.

The type of citrus that should be planted depends upon local conditions, but the writer recommends the planting of grape fruit and limes where possible. As soon as the gradual diversification is adopted, the management must be based upon the alternative crop, which in all cases should receive the maximum amount of attention.

If the cacao trees are to remain for a short period, say five or six years, as would be the case with grape fruit, ring barking of the trees may increase the yield very considerably for that short period, and is to be recommended. Where grape fruit is to be planted, care should be exercised in the selection of the plants. In Trinidad, where gamosis is prevalent, the writer wishes to stress the importance of selecting grape fruit plants with the following characteristics. The stock should be of the sour orange type, the scion
of a recognised high yielding, good quality grape fruit, 
and the plant should be worked high, at least 8" from the 
ground level.

The chief grape fruit areas which are being developed 
in the island are in the Northern Range: the valleys of 
karacas, San Jose, and Verdant Vale are developing rapidly. 
Similar remarks also apply to the areas of Diego Martin and 
Macaripe. Diversification in these areas will ameliorate 
the present conditions very considerably.

In the Toco area, coffee is gradually being substituted 
for cacao. Where the cacao has become derelict, portions 
have been cut out and coffee has been interplanted. When the 
coffee comes into maturity, the remaining cacao will be cut 
out.

3. Bad Soils, unsuited for Cacao. From Map 11 it will be 
seen that a large area in the island is under cacao. The 
shaded portions of the cacao land represent bad cacao areas, 
areas which form a considerable amount of the total cacao 
land, and upon which, speaking generally, diversification of 
crops will have to be made.

It must be remembered that when generalising there are 
exceptions to be borne in mind, i.e. the Toco area is 
represented as a bad cacao area, but even here there is found 
an occasional good cacao estate, due either to a pocket of 
good land or to the skill of a planter. Wherever bad estates 
cover any considerable area, it is almost invariably due to 
bad soil.

The outstandingly bad areas in the island, where the 
cacao is failing fast, or has been already abandoned on account 
of the soil conditions, are as follows:-

(1) A large area of land South of the River Caroni,
including the West of San Rafael, and the Eastern parts of Cunupia and Changuanas. It should be mentioned here that (ii) The Southern part of Savana Grande and the South-West of Ortoire. The valleys, the name has been cut out and grapes. (iii) The higher lands of Eastern Pointe à Pierre, and the South-Eastern parts of Montserrat.beans have been planted. (iv) Parts of the Toco district. How can diversification ameliorate the conditions that exist in such areas? In many cases the soil is either too heavy to work satisfactorily, or else it is so worn out by exploitation that under the present circumstances its ground utilisation would be uneconomic, with the result that part of the area under bad cacao will fall back into bush, or be cut up into peasant holdings. On the heavy clay lands such as exist in the San Rafael district around Talparo, cacao will have to be diversified. The soils are too heavy for cacao, and are quite unsuitable. The land becomes water-logged in the rainy season, and in the dry season very often cracks out badly, to the detriment of the cacao. On such lands, before new crops can be grown successfully research work will have to be undertaken by the soil chemists. There has been comparatively little work done on the improvement of such soils in the Tropics, and there is much room for such research.

In order to simplify the explanation and actual diversification recommended in Trinidad, it will be advisable to take the island by counties. With the exception of the Toco area, the Northern Range has already been dealt with. It has been seen that conditions suitable for interplanting with Coffee Arabica exist in some parts, and that conditions also prevail for
the gradual diversification of cacao into citrus plantations. Grape fruit has been planted. It should be mentioned here that complete diversification has also been adopted in this area. In some of the valleys, the cacao has been cut out and grape fruit and limes have been planted. At the higher elevations, considerable areas of Tonka beans have been planted. The cacao was, in many cases, insufficiently protected, and was cut out in favour of these hardier trees. Good returns are being made from Tonka beans at the present time. They do not hinder the management of an estate in any way, as even if the nuts are shed, they can lie on the ground for a considerable length of time without deteriorating. Moreover, they form a very effective windbreak. Given suitable conditions, the writer recommends the planting of Tonka beans en bloc rather than interplanting with the cacao trees.

The Toco area represents one of the most difficult problems to solve. With the exception of a very few estates, the cacao growing in this area is in a chaotic state. It is the oldest area, it has been very badly managed, and in many cases the soils are totally unsuited to cacao. In addition, its position is so remote that the transport of suggested commodities would be excessive. It is clear that the area cannot remain under estate cacao for much longer.

The diversifying of the cacao may improve the situation, but transport of the crops would, in all probability, take the edge of the profit. On some of the estates patches of cacao have been cut out, and Coffee Arabica has been interplanted. These coffee plantations are intended to be pure, and the remaining cacao will be cut out in the near future.

Suggested Diversification. In parts of this area are several valleys running into the mountains, which are well
protected from the sea blast. Also on the leeward side of the mountains there are some fine valleys which could be restored to fertility. In such places the complete removal of the cacao would be suggested, and the planting of bananas and nutmegs advocated. In the more exposed areas planting of timber, supervised by the Department of Forestry, seems to be the only solution. The variety of bananas recommended would be either the Dwarf variety, on account of its hardiness, Governor or Succrine varieties.

In the writer's opinion, the following will happen to the cacao land.

(a) The estates in many cases will be split up into small holdings, and where cacao can be grown it will be continued.

(b) Diversification will take place to a small extent, the limiting factor being transport costs. Coffee, bananas and nutmegs will be grown. Timber will also be planted.

(c) A large quantity of land will go back to bush.

2. St. Andrew. - Sangre Grande, Manzanilla, Tamana and Turere. In this area there are some first-class cacao estates, where the cultivation is high and good yields are obtained. Specialisation will continue. There are, however, some very bad areas where complete diversification will have to come. The areas of Matura and Valencia are examples of alienation of land entirely unsuited to cacao. Cacao is being grown on sand, with deplorable results. Complete diversification from cacao to coconuts is to be recommended, especially near the sea coast.


Some excellent cacao is grown around Rio Claro, but complete diversification from cacao to coconuts is going on in bad areas. Much of the cacao around Ecclesville has been
irretrievably ruined by drought and fires, and coconuts are being planted in lieu.

4. Mayaro. Cacao in many places is being completely diversified by coconuts. In the San Rafael area around Talparo, coconuts are a possible recommendation.

5. Victoria. Princes Town. In parts of this area the cacao is being diversified in areas unsuitable for cacao. In Pointe à Pierre and Savana Grande, the cacao is being cut down and canes planted. In areas near the sea, coconuts are being planted. Whether the substitution of canes is to be advocated, in view of the present prices of sugar, seems doubtful.

6. St. Patrick. Siparia. Around Siparia there are some very good cacao estates. These will continue, but in the county the area under cacao is falling. Around the Orapa-che Lagoon cacao is in competition with rice and with sugar, and its diversification in favour of these two crops is gradually being brought about.

In the South-West part of the area, the newly established oil industry has stimulated the growing of coconuts and the cutting out of much of the cacao.


With the exception of a few small areas in this district, the cacao estates will continue and specialisation will be satisfactory. There are, however, places in the Montserrat Hills where the soil is too thin for cacao, and where diversification with grape fruit would be profitable. The cutting out of cacao and the subsequent planting with grape fruit would have to be done judiciously, or extensive damage to the cacao might result from the introduction of thrips and beetles. By causing gaps in the cacao indiscriminately, these pests are very likely to be introduced in