A SAMPLE SURVEY IN BANANAS IN TRINIDAD.


D.T.A. Report.

Submitted in part requirement of the examination for the Diploma in Tropical Agriculture, Imperial College of Tropical Agriculture, Trinidad.

On 3 October, 1958, a group of seven post-graduate students of the Imperial College of Tropical Agriculture assembled under the chairmanship of Dr. A.L. Jolly, of the Economics Department of the College. This group assembled for the purpose of undertaking a sample survey to be completed by 14 June, 1959, as an academic exercise in part requirement of the examination for the Diploma in Tropical Agriculture.

As a group we were given freedom of choice in the selection of our subject matter for investigation. Preliminary examination and discussion extended until 31 October, 1958, when it was decided to adopt an investigation based upon the exporters of bananas from Trinidad.

Shortly after this decision three members of the group withdrew from the project, and the whole of the development of the subsequent investigation was the responsibility of the remaining four members. In effect there was very little division of individual responsibility among the four members of the group. We were all intimately concerned at all stages. Consequently this report represents a full account of the project rather than of one particular personal aspect. However, the background of the field problems and enumeration techniques are dealt with in rather greater detail in the hope that my personal experience in developing these aspects will be of value in the appreciation of the survey.

The report is presented in two parts.

Section A: An outline of the accumulated background information, and emphasis of the academic requirements of the report.

Section B: A report on the survey procedure and results.

To the other student members of the group I am indebted for
their co-operation, criticisms and assistance, more especially Mr. A. Denness for his leadership in designing and supervising the statistical procedure. Nor could I fail to acknowledge the great value of the advice and help of Dr. A.L. Jolly, whose great experience did much to overcome our many ignorances. Mr. G.E. Hodnett, the Regional Research Statistician, also gave us much valuable assistance. We were fortunate too in the generous co-operation extended to us by the various members of the Trinidad agricultural communities. I thank them for their help, encouragement and teachings. Finally, the enumeration of the post-graduate students of the college must be acknowledged. Such a survey depends on the enumerator's work, and their contribution was conscientiously and good naturedly given.

Gordon Farley.

May, 1959.

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SECTION A.

The limitations placed on this initial stage, the limitations placed on the scope, the imprecision, and incompleteness of statistical agricultural information, was inadequately comprehended and interpreted in the significance of research we were further complicated by our lack of working knowledge of agricultural processes within the island of Trinidad. We were not aware of the extent of agricultural surplus, unknowable to national or international legislation and policy, and had little experience of such local agricultural practices as we found. Further, we hardly assessed, in our early days, the existence of such structures as we saw. The wet field boundaries were of very identification.

Some early observations were a fortunate step of preliminary investigations that so fully defined the facts that we could never see any difficulty in the more detailed later investigations. Such early information was from very general survey. This was with the assistance of local marketing organizations, who made final decisions and recommendation and discussion on local evidence. These observations all became part of a reported inferences rather than a detailed economic analysis. From this we were able to obtain an impression of costs. So was the choice of subject for investigation.

The following subjects were considered in greater detail as offering scope for the medical demands of the survey:

1. Establishing the species and types of plants in the area.

2. Identifying the soil, climate, and potential for agricultural production.

3. The role and activity of supply of essential goods and services to farmers.
PART I

INTRODUCTION

It is essential to emphasize, at this initial stage, the limitations placed upon the group by our own ignorance, and inexperience, of tropical agricultural conditions. Our inability to fully comprehend and interpret the significance of facts on tropical agriculture was further complicated by our lack of working knowledge of agricultural communities within the island of Trinidad. We were unsure of the extent of agricultural services, unknowledgeable on national agricultural legislation and policy, and had little experience of such local farming communities as we found. Further, we tacitly assumed, in our early discussions, the existence of such utilities as maps, farm and field boundaries and ease of crop identification.

These initial limitations necessitated a definite first stage of preliminary investigations of a very general nature from which we could draw some definite line for a more intensive survey examination. Such early information came from very general sources. Discussion with the officers of local marketing organisations, introductory college lectures, and observation and discussion on local peasant farms and estates all formed part of a personal intercourse rather than a strictly academic enquiry. From this we were able to obtain an impression on which to base our choice of subject for investigation.

The following subjects were considered in greater detail as offering material suitable for the academic demands of the survey.

a. Investigation on recent plantings of clonal cacao under the cacao rehabilitation programme. Frame material was available from the Cocoa Board. This could quickly give the following information:

i. Name of farmer in the scheme.

ii. The address of the farmer.

iii. The time and quantity of supply of clonal cacao material to these farmers.
b. Examination of the increased orange acreage due to recent plantings.

The Co-operative Citrus Growers Association held ample frame material. For members of this Association, it could provide:

i. Name of farmer.

ii. The address.

iii. Number of orange trees supplied in each of the recent years.

iv. Individual contribution of oranges to the marketing organisation of the Association in each of the recent years.

v. Similar information on grapefruit acreage and production.

c. Investigation of some aspect of the banana production by those producers contributing to the Marketing Board Banana Export Scheme. This organisation could supply material for a frame only as follows, without further computation:

i. Contributor's name.

ii. Definition of the broad area in which the contributor supplied, e.g. Toco area.

iii. Number of banana stems supplied in any shipment.

Lack of suitable survey problems, and knowledge of the complex field conditions, precluded the cacao survey. The orange frame was thought, by other members of the group, to be an inadequate representation of orange producers on the island on which to base a survey. Consequently a banana investigation was adopted by the majority of the group. The investigation was accepted on the considered suitability of the frame material alone. No aim was given. The group chose to ignore the complexity of field problems involved, early indications of which I placed before them at this time as a result of my preliminary field enquiries. The wide limitations will be more apparent later in the report.

Our lack of tropical agricultural knowledge further handicapped us in that we were quite unable to define specifically an aim for a banana survey. The severe limitation of the frame material implied, with such a short period of time for the preparation of something more suitable, that we must fit any problem
to the frame, rather than frame to problem, the latter being more obviously
essential in a practical sample survey. Such an approach, i.e. of undefined
aim, is in conflict with practical statistical ideals. The need for an early
definition of exact aim is emphasised adequately by Yates, (1957a), and indeed
should be the basis of all work of an investigational nature. Data should be
collected with a clear purpose in mind. Not only a clear purpose, but a clear
idea as to the precise way in which it will be analysed so as to yield the
desired information. The group failed entirely to appreciate the significance
of a clear aim despite insistent comment.

Nor could we hope to carry out the procedure recommended, (Yates, 1957b),
when limitations and conditions in the field are not fully appreciated. A pilot
survey to establish the nature of field conditions and problems was ruled out
by shortage of time, due to other responsibilities and the need to enumerate
our main survey early in December.

Having elected to undertake an investigation into banana growing in
Trinidad, it was necessary thoroughly to investigate conditions under which the
crop exists, and is produced, on the island. This second stage of preliminary
investigation was designed not only to further our understanding of the banana
production, but also, more specifically, to observe features that offered them-
selves as fields of investigation. This investigation was approached from two
aspects, firstly that of cultivation practices in the fields, and secondly that
of marketing of the produce. This latter was approached through the officers of
the government marketing organisation. Knowledge of field practices and conditions
evolved from local enquiry and observation, Montserin, (1956), providing an
excellent introduction. After the conclusion of the field work, Evans, (1957),
was discovered to provide a very adequate account of the industry, although many
of his generalisations are open to much criticism and debate.

The information obtained by this second stage of preliminary investigation
provided a background from which to plan the details of the survey. Part II of
this report is devoted to an outline account of our findings and the development
of our problem.
It was not until we had completed this second stage of preliminary investigation that we could outline exactly the field of enquiry. The defined aim was eventually laid down as:

a. To estimate the density of Musa spp. on those estates, and holdings, contributing bananas for export through the marketing board scheme in Trinidad.

b. To obtain an estimate of the percentage of these Musa spp. suitable for export, by an identified "export" fruit and identified "non-export" fruit count.

c. An investigation of crop associations in which plants of the genus Musa occur.

d. An indication of the standard of cultivation of export banana varieties by a shoot per stool count.

The Land Utilisation and Agricultural Production Report, (1956), gives an estimate for total banana and plantain numbers on the island of 6,748,772. Of these, 301,581 are in pure stand, 639,466 dominant in mixed stand, and 5,570,725 as subsidiary area in mixed cultivation; thus 61% occur as subsidiary crop.

General observations in the field confirmed this widespread association of bananas with cane. In addition bananas were found along citrus, coffee, in pure stand and associated with a wide range of local food crops in peasant gardens holdings. On our own estates or holding, and even in one field within an area, one or all of these associated crops may occur, with or without bananas. Such the associated crops and bananas may occur, in any location, at different ages and stages of growth. Variable standards of cultivation and control of the crops within any one estate or holding added to the complexity of the picture.

It soon became apparent that our studies were not directed toward a very uniform type of banana stands, uniform field conditions. Rather, we were dealing with various phases of different ecological successions stemming from plantings of different crop associations. Now, on any one holding or estate, the crop
PART II

BANANA PRODUCTION IN TRINIDAD

1. Field conditions and their limit on survey aim.

The main characteristic of banana production in Trinidad is its intimate associations with other crops. These associations usually place bananas as a secondary crop. Farrell, (1958), regards the supply of export bananas from Trinidad and Tobago as coming from some 12,000 cocoa farms. On these farms he considers, in this report, that banana plants occur interplanted with cocoa in small concentrations of about 30 to 60 plants per acre. Further, only 10% to 20% of these plants are of Gros Michel or Cavendish types, which bear fruit suitable for export.

The Land Utilisation and Agricultural Production Report, (1956), gives an estimate for total banana and plantain numbers on the island of 6,748,372. Of these, 391,531 are in pure stand, 685,655 dominant in mixed stand, and 5,670,840 as subsidiary crop in mixed cultivation; thus 84% occur as subsidiary crop.

General observation in the field confirmed this widespread association of bananas with cacao. In addition bananas were found among citrus, coffee, in pure stand and associated with a wide range of local food crops in peasant garden holdings. On any one estate or holding, and even in one field within an estate, any or all of these associated crops may occur, with or without bananas. Both the associated crops and bananas may occur, in any location, at different ages and stages of growth. Variable standards of cultivation and neglect of the crops within any one estate or holding added to the complexity of the picture.

It soon became apparent that our studies were not directed towards a crop grown under simple, uniform field conditions. Rather, we were dealing with various phases of directed ecological successions commencing from plantings of different crop associations. Also, on any one holding or estate, the various
phases of different associations may be represented. Bananas are grown rather than cultivated, and the presence of fruit provides an incidental cash return to the grower.

The important function of bananas within associations is to provide shade, and the shade requirements of the primary crop is the basis of appreciating the significance of banana distribution. Young crops of cacao, coffee and often citrus, are regarded in Trinidad as generally requiring considerable shade. As these crops develop, less and less shade is required. The bananas are progressively thinned out and may be dispensed with entirely. Neglect of an area of crop, before the banana shade has been removed entirely, will lead to a seral succession through a condition of initial crop and bananas to dense undergrowth, and later/secondary forest. Not all banana shade is removed always from older crops, especially cacao. Small areas and pockets of bananas are maintained in spaces unfavourable to the main crop, or where the crop has died out, to prevent weed growth. Small nursery areas providing propagation material for further areas of shade replanting are also maintained. Thus on a large, mixed estate, with a regular programme of replanting, it was inevitable that we found a wide range of conditions including various conditions and associations of bananas. An estate, for example, may range from pure stand of Musa spp., through mixed areas of cacao with variable Musa spp. shade and fields of citrus, to areas of neglected bamboo. In addition, this range may occur in one field of an estate.

This variation in conditions under which bananas occur implied the first limitation to our field work. This wide variation over a holding or estate, and over a field, led to an inability to define a "banana area", and to lay out its limits in the field. Inevitably we had to consider the whole of the holding or estate as our ultimate units in the field, rather than individual fields.

This difficulty of definition became further apparent when we attempted to define "bananas" in such areas more specifically. With the basis of our frame built upon the names of exporters of bananas, we hoped to confine our survey to export varieties of bananas produced by these people. These varieties are defined in the Government contract as Gros Michel and the Cavendish types, (Farrell, 1958).
However, these varieties occur intimately mixed with other varieties of banana, fig and plantain. These other types are used as shade since they are more easily obtained, harder, provide better shade and are more resistant to disease. All these factors favour them, in preference to export varieties, as a reliable shade material.

The intimate mixing of banana varieties is complicated yet further by the difficulty of identification of the differences in varieties. This difficulty is emphasised by Simmonds, (1953 and 1954), and Reynolds, (1927). Without the presence of fruit bunches, it is difficult, unless one has years of first hand practice, to distinguish with any certainty the difference between varieties of plantain, figs and bananas. Even with fruit bunches present, we could only hope to train enumerators to distinguish export from non-export bunches in/short time at our disposal.

The suggestion that we should approach the individual growers for identification was considered to be beyond the scope of our work. Personal approach by enumerators requires much training to obtain uniformity, nor could we rely on the accuracy of the answers. Apart from the wide variation of the usage of the words banana, fig and plantain over the island, the estimates of peasant farmers, and estate overseers, are liable to considerable bias depending on his impression of the enumerator as a "for-his-good", or a "not-for-his-good" type of official.

Our chairman advised us also at this point that the value of the survey as an academic exercise would be greater to ourselves, and the postgraduate enumerators, if we confined our investigations to field problems lending themselves to direct measurement.

Our study was, by the very circumstances of cultivation, defined as an examination of all *Musa* varieties, but only on properties that exported some fruit; not a very realistic or satisfactory domain of study. It was these limitations which the majority of the group chose to ignore when selecting initially bananas as a field of study.

Field problems lending themselves to direct measurement in the field were considered under the following headings:
The pests and diseases occurring commonly among bananas and plantains in Trinidad are:

a. The Weevil Borer - *Cosmopolites sordidus.*
c. Moko Disease - *Pseudomonas solanacarum.*
d. Panama Disease - *Fusarium oxysporum* spp.
e. Leaf-Spot Disease - *Cercospora musae.*

These offered little scope for survey investigation. Due to varietal differences of susceptibility, an identified light infestation of any one area may be due only to the presence of resistant plantains, which we could not identify from others, and not the absence of the pest or disease. Additionally, weevil borers are confirmed only by the uprooting of stems, not a popular practice, and hard-back beetle occurs mainly in June, outside our period of enumeration. Moko and Panama diseases are characterised by rapid wilting, and the cultural practice is to cut down the stem at the first sign and chop it up into small pieces. Consequently, it is rare to meet infected trees in the field, only in the form of chopped stems, in which condition they resemble the remains of old harvested stems. Leaf spot occurs to a variable extent on different species of *Musa,* and with irregularity of spray practice, if any, it was thought that little of significance could be obtained by field observations.

Weeding practices and drainage conditions were also not suitable. They are too closely allied to the primary crop rather than to the *Musa* shade species, to give useful field data. Also, they are difficult to define and measure.
Stool pruning seemed at first to provide a suitable and important field of study, well suited to enumerator instruction. On well managed banana crops three or four shoots of progressive ages per adult stool are regarded as good practice, (Montserin, 1956). Under poor management up to ten or more shoots per stool may be recorded. Poor management of stools leads to the production of smaller bunches from plants with higher stool counts. Total bunch weight is reduced by smaller individual fingers and smaller number of hands per bunch. The difficulty of concentrating the study on this feature was that it is not a universal practice to prune fig and plantain stools, which are far less prolific in sucker production than bananas. Hence any judgement of cultivation standard based on shoot per stool count must be based only on those stools carrying identifiable export fruit. Confining stool counts to those with only identifiable export fruit ensures also that mature stools only are estimated.

The recording of associated crops seemed desirable. The tremendous variation within any estate, or holding, demanded an ecological approach, rather than one of mere classification, to obtain worthwhile results, and it was on this basis that the field enumeration system was developed. This is dealt with in Part VIII of this report.

General field sanitation offered no standard of measure, and we felt that it fell outside the scope of our requirements and our resources for a survey. Density of stools of *Musa* spp. was, however, something that we felt was very fundamental and could well be estimated. It affected incidence of pests and disease; dictated the economics of collection in the field; guided management practice and improvement potential; and dominated immediate potential production. As far as we could ascertain, no measurements of this kind have been previously undertaken in Trinidad, or under similar conditions.

Equivalent average figures were estimated for 1938 and 1944, purely on the basis of the opinion of area field officers over the island, (Marketing Board, 1944 and 1945). These figures were:
They show a remarkable increase over six years, due either to war-effort or poor estimation correlation. Montserin, (1956), suggests 444 plants per acre for average plantings of bananas, so that the 1944 figures suggest numbers of 2,877,000 banana plants and 563,880 plantain plants. This coincides with an untraced banana enumeration in 1945, (Report, 1956), estimating total banana type plants as 3½ million. A 1956 estimate, (Land Utilisation and Agricultural Production Report, 1956), gives total banana numbers as 6,314,630 and total plantain numbers as 433,742. A breakdown of these two figures is given in appendix I. These figures are much in excess of the previous estimates, and there appears to be lack of positive information. There is an uncertainty about the Musa population, and no reliable forthcoming information on the density of Musa spp. in Trinidad conditions. Farrell, (1958), claims a density in cacao for bananas in Trinidad, both export and non-export types, of from thirty to sixty plants. This guess is an opinion of personal experience, and not based on measurement.

Thus our scope of survey investigation, and the extent to which our survey could proceed, was strictly limited by conditions under which bananas are grown in Trinidad. The most suitable and useful matter for investigation was therefore defined as follows:-

a. An estimate of the density of Musa spp. on those estates, and holdings, contributing bananas for export through the marketing board scheme in Trinidad.

b. An estimation of the percentage of Musa spp. suitable for export, by an identified "export" and identified "non-export" fruit count.

c. The investigation of crop associations in which plants of the genus Musa occur.

d. An indication of the standard of cultivation of export banana varieties by a shoot per stool count.
2. The background of the marketing organisation.

The wide range of conditions under which species of *Musa* are found in the field, and the range of varieties within the species, implies a difference of usages, and hence different channels of disposal. Apart from immediate producer utilization for both human and stock consumption which is usually small, the two main channels for disposal are through the local markets and through the Government export scheme. The local market handles all varieties of bananas, figs and plantains for distribution through Government and private local market facilities. In contrast, the Government export scheme is a highly selective channel taking only the fruit of specific export varieties, and standards, on limited days of collection.

From the previously quoted 1946 estimate of 3½ million banana and plantain plants, (Report, 1956), we can estimate a probable annual output of all bunches. A banana stool will normally yield two stems per year. If we allow for change of weather, new planting, loss in the field and other factors affecting yield, we may liberally say that the total annual output should be in excess of six million stems of all types. 3½ million pounds of bananas were exported in 1954, (Report, 1954), and, if we allow a low stem weight of 30 lbs. per stem for export bunches, this represents a total of under 200,000 stems exported, leaving a possible 5,800,000 stems for local consumption. This gives a clear idea of the relative importance of local consumption and export trade, the latter representing less than 4% of the market trade. Farrell, (1958), estimates this export trade as perhaps 10%, or more, but his estimate is based upon a higher export total of stems and a lower total tonnage of production.

The price of bananas in the local market depends on variety offered. The grower's price is from three to six cents per lb. and retail sale is at six to twelve cents per lb. The price paid by the Government for export bananas accepted is now 9½ cents to the grower, but until recent months was only four cents per lb.
The local market is supplied by personal producer delivery or by traffickers. The latter collect bananas regularly from producers on pre-defined days of the week and carry them into the local market or to vendors. They may even undertake to cut fruit for a producer. There is virtually no reject of fruit, and cash is paid on a bunch weight basis. Price range covers conditions and varieties offered. Any reject is either rotten or unfilled, which are rarely harvested. Fruit is carried naked and unpacked in the trucks, but distance of transit may be small. Any transit bruising goes unnoticed in the quick sale. The trucks are employed every day on banana collection. Any daily excess collected may be stored at the traffickers depot.

Essentially it is a service taking all types of bananas, figs and plantains paying cash for any quantity condition and collecting regularly and often. The producer is subject entirely to trafficker bargaining in return for lack of concern over harvesting. The export of bananas is governed by the contract between the Government and the Union International Company Limited, the company providing shipping from Trinidad to the foreign markets. The original terms of the contract stipulated that the company had the sole right to purchase from the Marketing Board, as the competent Government authority, all bananas of the Cavendish type collected for export for a period of fifteen years, from September 1955. The terms were later extended to include

a. Gros Michel bananas.

and b. Provision for a further period of fifteen years.

The Marketing Board is also committed to ensure, at the earliest opportunity, a minimum quantity of 300 tons fortnightly. There is also a clause providing for the loan of 500 acres of land in Trinidad to the Company for the development of a banana plantation, produce of which is exported direct by the Company.

Discussion of the implications of this contract are not within the scope of this report. However, it is perhaps pertinent to point out that the Marketing Board have not yet succeeded in raising and maintaining a fortnightly supply of 300 tons.

The Marketing Board relies for the supply of bananas upon a large number of small producers. Analyses of shipments in 1956 (Report, 1956)
indicate the importance of small producers. Between 90% and 87% of the suppliers accounted for 51-57% of the fruit shipped. 9 out of 10 suppliers, each supplying not more than ten stems, supplied an average of four stems each per shipment. Two out of three supplied an average of less than three stems per shipment. Analyses of the purchases of sixteen collectors, taken at random from over the island, show that, using the 1110 suppliers of the sixteen collectors on the first of the three shipments as a base list of names, 425 of these names recur on a similar list of the next shipment, and 471 of the names on the following shipment. The implications of these figures are that export bananas are being supplied on a very small scale, production is widely diffuse, and supplies are irregular.

These small producers are not in a position to deliver their own produce, nor would it be economic in competition with the traffickers. Consequently, to implement the terms of this contract, the Marketing Board set up a collection system. This system of collection formed the basis of our survey frame.

The days on which the Board will collect are notified by radio announcement, advertisement in the newspapers, and locally by notices on Marketing Board announcement boards, which are situated in local community centres. Time of collection is not notified, only the date, but collection usually commences at 8.00 a.m. The dates are not regular, they depend on the calling dates of the transport ships. A shipment collection is usually spread over two days, but only one collection is made in any one locality.

The basic units of the collection system are the truck routes. They consist of localised areas, or stretches of road, where producers offer for sale at the roadside sufficient bananas to make up a pay-load of about 210 stems. A truck route is not an absolutely defined area. On any collection date low contributions on one usual truck route may be augmented by overlapping collection onto another truck route. However, truck route areas are fairly constant from one shipment collection to the next. The routes are organised through the local depots of the Marketing Board in the banana producing areas. They are the responsibility of the banana officers at those depots. These officers
contract for local transport trucks, maintain records, organise routes on the basis of their own local information on expected production, and are responsible for paying producers in cash the day after delivery. The twelve local depots through which banana collections are organised in Trinidad are listed in appendix IV. There is an additional collection on the wharf in Port-of-Spain from producers delivering their own produce, and one from Tobago. Some depots organise one route, while Toco has as many as nine routes. In appendix IV, the letters used to define different truck routes in one area are not Marketing Board letters, but our own initiation.

On a collection day, previously notified, a locally hired truck proceeds through a defined area to collect from producers who bring their bananas to the roadside. Each truck is staffed by a driver, a banana inspector, a recorder, and two, or even more, handlers. All are part-time employees of the Board. At each point of collection the stems offered are either accepted or rejected on grade format, individually weighed, each packed in a polythene bag and loaded onto the truck in the presence of the producer, or his nominated representative. The bananas have been previously headed out from the fields, either the previous day or early that morning. In return for his bananas each producer receives a receipt slip giving the total weight and the number of banana stems, and the number rejected. This information is also recorded on a duplicate sheet, which is retained by the inspector.

A truck continues until it has collected a pay-load of about 210 stems. The load is then taken direct to the wharf in Port-of-Spain, not to the depot. On most routes it takes a full day to collect and deliver a load of bananas. Each load is again inspected at the wharf for further reject. It is not within the scope of this report to discuss the economics of this system. However, nearly all the problems of the industries economics are embodied, or related to, this system of collection. At one typical collection point, bananas were bumped on the ground, during packing and inspection, seven times before being finally placed on the trucks, prior to a day of journeying on
poor roads and wharf handling. Idle gossip during collection accounts for much of the subsidy.

In an area of large production, collection is spread over two days due to shortage of inspectors and trucks. Each truck team thus may complete two or more loads.

The receipt duplicates from each truck route are summarised by the inspectors onto sheets called Banana District Purchases, see appendix II. Onto these sheets the inspectors enter, for each producers on their route from whom they accepted stems, the purchase slip numbers, supplier's name, total weight accepted, stem number accepted, value in dollars, and stem number rejected. They also enter at the top of the sheet area name, shipment number, collection date, and then sign their names at the bottom. The sheets are made out in duplicate. One copy is retained by the depot banana officer, and the other, together with the receipt duplicates, are sent to head office of the Marketing Board in Port-of-Spain.

At Headquarters the route Banana District Purchase sheets are collected together for each shipment. Summary sheets are made out for areas of more than one route. The Tobago sheets are added and, together with a wharf loading record, complete a shipment file. Thus, within the headquarters shipment files, are lists of contributors for each shipment together with a record of their individual contribution. These names are divided into truck route groups. A route is identified by the area, the inspectors signature, and the date. These shipment files formed the basis from which our frame was drawn.

Producers are paid in cash by the banana officer who takes the calculated money to the producers or their nominated representative. This is usually during the following days.
PART III

THE INSTRUMENTS OF SAMPLING.

1. Random sampling error

Considering the scope and time available for the survey, it was apparent, in view of the total number of producers and their wide distribution, that we could obtain information from only a small number of these producers. By careful choice of this small number of producers, it is possible to obtain information which can be applied, within a measurable limit of accuracy, to all of the producers. The smaller number of producers is called the sample, and the original whole number of producers is the population. The sample is chosen from the population by random selection. A survey based on information collected from a sample of a population is called a sample survey, while a survey based on all members of a population is a complete survey or census. A complete survey in which certain members of the population do not respond is referred to as an incomplete survey, (Yates, 1957c). Sample surveys and incomplete surveys both return information from a fraction of the whole population, but the former has the sample members pre-selected at random.

Even with utmost care in choosing a sample from a variable population, the sample can never be exactly representative of the population. The inevitable error is referred to as the random sampling error when random selection has been adopted. The size of this error depends on:-

a. Variability of the material in the population.
b. Size of sample in relation to the population.
c. Sampling procedure adopted.
d. The computational procedure applied to the material collected.

It is possible, by considering these four aspects, to reduce the size of the random sampling error to a suitable minimum, and allow the sampling error
to be calculated. Random sampling error cannot be eliminated.

2. **Bias.**

A further error that may be introduced at the sampling stage is that due to bias in selection. Bias occurs when, in the selection of sample members of a population, the selection of sample units is always affected by a similar error. Thus, error at sampling can occur due to random sampling error or bias. The former is measurable, the latter is not. Consequently, it is of importance to eliminate, or reduce, the error due to bias. An understanding of how bias arises leads to its elimination by careful selection of the sample.

Bias may arise from:

a. A conscious selection of a representative sample. Units of a population chosen because they give an impression of being average units for that population are not units chosen randomly.

b. Any system of selection correlated to some characteristics of the units being sampled. In a survey of incomes of all householders in a city, a selection of all the householders owning cars as a sample is not an unbiased sample of the householders in the city. It is safe to assume that higher householder income bears a fairly significant relationship to ownership of cars, and such a sample would not include fair representation of the lower income groups.

c. Substitution due to difficulties in locating any member of the sample. Substituting another more convenient member may lead to bias, since non-response may be correlated to the enquiry.

and d. Non-completion of the sample due to the lack of thoroughness by investigators. Those not found may be representative of some group with a common factor correlated to the investigation.

In a sample survey bias may arise at all stages. Cause b, above can lead to a biased frame for the sample survey; a, and c, give rise to biased selection in the frame; and c and d, can give bias in the sample adopted. In addition, bias can arise in the enumeration processes in the field, and in the
computational procedures. Vegetation sampled always from the roadside may over-emphasise men's biotic effect on a natural community. Field records may be pattern totalled, always omitting certain values.

It is essential to randomise entirely at all stages. An honest randomization and careful sample design will eliminate as far as possible any bias. Random selection is best obtained by the use of random numbers. Systematic selection can be practiced in some cases when the interval of the selection is in no way correlated with the characteristics of the population being selected, or when the population does not carry the periodic recurrence of some population characteristic. However, systematic selection is random in that the first drawn sample unit is drawn at random. Systematic selection may in fact increase the accuracy in ensuring that all parts of a population are represented.

3. Reducing the sample error.

Care in random selection can hence remove bias. It then becomes necessary to reduce, or control, the random sampling error to achieve the accuracy required. This may be done by using the following modifications of sampling methods.

a. Increasing the sample size.

b. Stratification of the population.

c. Incorporation of multi-stage sampling.

d. Use of variable sample fractions.

e. Multi-phase sampling.

f. Adoption of interpenetrating samples.

g. Use of supplementary information.

Although these are now described separately, they may be, and usually are, used in conjunction with one another.

a. Increase of Sample Size.

The random sample error is approximately inversely proportional to the
square root of the number of units in the sample. The number of units, however, is frequently linked with the economics of the survey. In drawing a sample from a frame, i.e. list of the population, as large a number (and therefore a large a proportion) as possible is drawn within the limits of economy, and increased accuracy in relation to the amount of extra work. A heterogenic population requires more sample units than a homogenic population to give the same amount of error.

b. Stratification of the Population.

In a stratified sample the population of sampling units are sub-divided into groups, or strata, before selection of the sample. These strata may all contain the same number of units, or differing numbers of units. Thus a population is divided into a number of sub-populations, and each of these is then sampled independently at random. Each sub-population is equivalent to a stratum. The fraction by which the strata are sampled may be either uniform for all strata, or variable between strata.

The value of stratification is twofold. Firstly, it can increase the accuracy of the total population estimates by segregating variability in the groups. And, secondly, it ensures that sub-populations of particular interest in the survey are represented.

Increased accuracy is obtained when a heterogenic population is divided into natural sub-populations, the division being dependent on sample unit characteristics. In this way less variability can be obtained between the units of a sub-population than between units of the total population. This lower variability leads to reduced sampling errors within the sub-populations. Since error is measured within the strata, it is essential to ensure that all sub-populations contain sufficient units to provide, on sampling by the given fraction, at least two or more sample units.

Sub-population of particular interest can be emphasised by using a variable sampling fraction for each strata. In this way more intensive
examination, i.e. a greater number of sample units, of a strata can be made.

A variable sample fraction can also ensure that more heterogenic sub-populations are examined in greater detail than more homogenic sub-populations.

c. **Multi-stage Sampling.**

In general, the smaller the sampling units employed, the more accurate and representative will be the units. This need for small units drawn from the whole of the population conflicts much with the administration of a survey. Multi-stage sampling uses the natural divisions of a population units to permit concentration of field work into given areas.

The process consists of grouping the population list into natural divisions. A sample, the first-stage sample, is then taken of these natural divisions. These sample units of the natural divisions each may be sub-divided within itself into further natural divisions. A second-stage sample from each of the first-stage sample units is then taken, using a constant sample fraction in all first-stage units. One, two or more stages may be designed according to the material being handled.

Multi-stage sampling has the additional advantage, when it is necessary to spend time improving the frame, in that the second-stage frame detail need only be drawn up for the first-stage sample units, and not the whole population. This may reduce the amount of work considerably when frames are being constructed from complex material.

d. **Variable Sample Fractions**

This is means of discriminating between different stages or strata with a view to improving the overall accuracy. This technique permits a greater proportion of a more variable stage, or strata, to be taken with a consequent concentration of effort in reducing the greater random sampling error. It can ensure the inclusion of a greater number of the more variable units, or the larger units which constitute more of the aggregate.
Allocation of the sampling fractions to strata is made in two ways. If the within-strata standard deviation of the units are known, the sampling fraction of a population should be proportional to these standard deviations of the units in the population. Knowledge of the standard deviations of sections of a population are, however, not usually known. In this second event, general experience and knowledge of the population are used in allocating sampling fractions to the strata. More variable strata receive higher sampling fractions, and less variable strata lower fractions. With populations of equal variability, but of differing numbers of units, the use of variable sampling fractions can reduce work in the larger population of units, i.e. variable sampling fraction can be proportional to size. 

Multi-phase Sampling

This method consists of drawing a large sample to yield a few pieces of readily available data, and then sub-sampling these to make a more elaborate enquiry in a few of the units. Further phases may be added by further sub-sampling of the second phase sample. Variable sampling fractions obviously may be used between phases.

The main value of multi-phase sampling is in the collection of information from the same sample units, where the items of information are characterised by different variations. The first phase sample yields accuracy on heterogenic characteristics of the sample units, and second phase collects information on more homogenic characteristics of the sample units with less effort.

If the first phase information is collected before the second phase information, the former may be used as a basis for stratifying the second phase.

Multi-phase sampling differs structurally from multi-stage sampling in that in the former the same sampling units are used throughout, whereas in the latter a hierarchy of sampling units is used.
f. **Interpenetrating Samples.**

Two or more independent samples of a given population, drawn with the same sampling technique, are known as interpenetrating samples.

In this way independent estimates of a population characteristic can be obtained, as a measure of accuracy. Different investigators working on different samples can, if the variation between samples is known to be small, be compared. Interpenetrating samples give a means of obtaining more accurate information in successive stages, a useful means of confirming an originally hurried investigation.

It is essential to draw all interpenetrating samples by the same procedure, and to ensure that each one provides an adequate sample of the material.

The introduction of sampling techniques has developed such qualitative ecological studies into a quantitative instrument. Observations on plant species taken with good sampling techniques can become an assessment of plant importance.

Measurement of plant importance within an ecological system can be obtained by the application of one, or more, of four fundamental criteria. These are:

a. Frequency of occurrence of plants.

b. Density of individuals per species.

c. Area covered by individuals.

d. Weight produced.

a. The frequency of occurrence is concerned with the distribution of species and individuals in a plant community. It is obtained by sampling vegetation at random points, with a given sample unit-area, and recording the presence or absence of species in the sampling unit. It gives an expression of uniformity or heterogeneity. Bannister (1937), gives a very full discussion of the concepts of this system. Care must be taken to distinguish this frequency of occurrence usually termed 'frequency', from 'percentage frequency'. In the latter, the total number of plants in the given random sample areas are recorded,
PART IV

THE MEASUREMENT OF VEGETATION

1. The four basic criteria.

As emphasised in Part II, Section A, we were confronted with the measurement of widely variable ecological conditions within individual holdings and estate units. These conditions involved a range of plant species of tree, shrub and herbaceous types. The main basis of our observations, it seemed, would involve plant identification and recording of species occurrence. The details of fruit identification and shoot per stool count were subsidiary to this main problem. Such recording of species occurrence and identification has been the basic method of ecological studies of a qualitative nature. The introduction of sampling techniques has developed such qualitative ecological studies into a quantitative instrument. Observations on plant species taken with good sampling techniques can become an assessment of plant importance.

Measurement of plant importance within an ecological system can be obtained by the application of one, or more, of four fundamental criteria. These are:

a. Frequency of occurrence of plants,
   b. number of individuals present,
   c. area covered by individuals,
   and d. weight produced.

a. The frequency of occurrence is concerned with the distribution of species and individuals in a plant community. It is obtained by sampling vegetation at random points, with a given sample unit area, and recording the presence or absence of species in the sampling unit. It gives an expression of homogeneity or heterogeneity. Raunkier, (1934), gives a very full discussion of the concepts of this system. Care must be taken to distinguish this frequency of occurrence usually termed 'frequency', from 'percentage frequency'. In the latter, the total number of plants in the given random sample areas are recorded,
not merely their presence or absence.

b. The number of individuals present is obtained by a direct or sample count, and is then expressed as:

i. abundance,

ii. percentage composition by number,

or iii. population density.

i. Abundance is a comment on the number of individuals of a species. It can be expressed in general terms of classes of abundance, or quantitatively on a count within sample units.

ii. Percentage composition by number is a relative figure expressing the number of individuals of a species as a percentage of all the individuals of all species present.

iii. Population density is the exact relationship between the number of individuals of a species observed or estimated on a certain area and the extent of that area. It is the number of individuals of a species per unit area.

c. In measurement of area covered by individuals the importance of a species is ascertained by a means of ground surface covered by the individuals of a species. It can be measured by two methods:

i. leaf projection from stem base,

or ii. total area covered at ground level.

The term is expressed as the relation of area covered to total area, or, when relative importance of species is required, it is expressed in relation to the total area covered by vegetation.

d. Weight produced expresses the importance of species according to the amount of weight produced. It is used predominately for smaller species, where there is only a small difference in the amounts of species. Weight analyses are known as percentage productivity, dry-weight composition, weight list and list weights. The requirements, application and limitations of these four criteria are now briefly discussed in relation to the conditions of the growth of bananas set out in Part II, Section A, and to the measurements we wished to make.
2. **Frequency of occurrence.**

Raunkiaer's original development of this concept, (Raunkier, 1934), has been widely adopted by ecologists, and has been further adopted to give a measure of density. There is a direct relationship between the frequency measurements of a species and the density of a species. It is a relationship between the density and frequency of absence, rather than frequency of occurrence. With this relationship, the taking of frequency readings becomes a rapid means for determining the density of a species in a given area. This is especially so when the species are distributed at random within the community.

Frequency measures are given by recording the presence or absence of species in small sampling units randomly scattered over the area. The frequency of a species can be regarded as the relation between the number of sampling units in which the species is present and the total number of sampling units. Normally it is expressed as a percentage of the total number of sampling units, but may be given as degrees of frequency on a pre-defined scale.

The size of sampling unit obviously influences the probability of the presence of a species. The smaller the sampling unit the less likelihood there is of a species being recorded in it. This can be overcome by using a larger number of sample units or the same number of larger units. Also, if the sampling unit is a large one, a lower number are required to include the species of lowest frequency. A heterogenous community will require more sampling than a homogenous one.

The shape of the sampling unit also has a considerable influence on the value of the measure. Shapes may be oblong, square or circular. Oblongs are better than squares because they have greater length, increasing the chance of cutting into natural communities. They have length that is more likely to cut across the circles of distribution in which species naturally occur, and encounter more species and greater variety. How far we could consider this of importance in our banana communities, developed from original plantings, is not
known. The square has advantage over the oblong in having a narrower ratio of border to area, and sampling error increases as the ratio of border to area increases. Considering natural plant communities, the circle is even less efficient than the square, but has advantage of having the lowest ratio of border to area. Using a larger sampling unit in all shapes reduces the sample error due to border sampling. Sampling plants easily defined as individual plants reduces the importance of border effect.

It did seem that by sampling within the area of our sample holdings and estates at random points, with a given sample unit, we could obtain a good estimate of the density of Musa spp. Size and shape of sampling unit would need careful consideration, as would sampling fractions. This method implied that we must be able to define the extent of the area to be sampled. This was required for two reasons. Firstly, to give a means of calculating the number of sampling units required in the area for a standard sampling fraction of that area. And, secondly, to pre-determine at random on a map of the area the points at which these sampling units were to be laid down.

Having done this we would be faced with the difficulty of locating these exact spots within the holding or estate area. This may be very difficult in large areas of untracked estate, and would inevitably require special survey equipment in sufficient quantity for all enumerators. This was not forthcoming.

A greater theoretical limitation, however, precludes the use of frequency counts to estimate density under conditions such as we required to measure. Brown (1957) quotes Blackman's demonstration of the relationship of the frequency of absence to density. It is reasoned on the Poisson series of discontinuous distributions, and only applies to populations distributed at random. The occurrence of Musa spp. is not completely at random, having developed from original plantings. With random removal of shade, death, replanting etc. we were unaware how far we could consider the Musa spp. as randomised. In young
plantings there is probably no randomisation, but the condition of an older community is probably effectively randomised. At least the positive distribution of vegetative parts from *Musa* spp. overcomes a limitation of contiguous distribution. But it seemed that any method involving samples within the holdings and estates pre-supposed a random distribution of species.

3. **Number of Individuals Present.**

Counting the number of individuals in our sample area, with the size of estates and holdings with which we were dealing, implied some form of sampling within these areas. This sample could be done using:—

a. Unit sample areas, or quadrates.

b. Point units.

c. Line transect.

The uses and limitations of unit sample areas within the large sample areas has been discussed under frequency concepts. Point sampling would also imply locating easily, and quickly, a number of random points within the area, and emphasise this difficulty by increasing the number of random locations per unit area to be found. The only difference in using point and quadrat sampling for number counts, as opposed to frequency counts, is that the total species individuals within the sampling units are recorded, not merely the presence or absence of any species.

Line or strip transect recording offered us a method of counting individuals in a sample area quickly. Hunt, (1952), recommends the method for tree crops, and there are numerous forestry techniques developed on this basis. Using stimulated plant communities, Beuer, (1943), compared the efficiency of quadrat and transect line methods. He showed that, when individuals were of various sizes, the normal natural condition, the transect gave decidedly more accurate results than the quadrat. Basically the transect line can be used for two purposes:—

a. as a line on which to count the occurrence of individuals, i.e. as a sample unit.

or b. as a line along which sample units are distributed.
Individuals of any one species, or all species, may be recorded. The former gives a total and density figure only and the latter a number, density or percentage composition by number figure. Of these two, the latter seemed preferable for our application, giving information on associated crops with little extra recording.

Most techniques adopt the principle of laying down a base line within the area to be sampled, and setting out transect lines, of a given length, at right angles to, and at regular intervals along, this base line. The transect lines may be of variable width, from wide strip to pure line, according to area and conditions. The number and length of transect lines can be adjusted in each sample area to give a constant, or known, sampling fraction.

4. Area Covered and Weight Production.

The necessity to harvest plants for weight production, excluded its use immediately. Essentially the method is developed for pasture analysis and has little application for perennial crops.

Nor was the method of area coverage estimates of application. All aspects of this work require a detailed botanical estimate, which was excluded by enumerator, training and availability. Although giving a better estimate of the relationship between species in a community, than a mere number count or frequency, the work lay beyond the resources of the survey.

These techniques may offer a valuable indication of the detailed use and importance of bananas for shade, but this would require detailed and localised work.
SECTION B.

In order to construct a list of current export contributors, it was necessary to take more than the rigid scheme to account for the irregularity of producer contributions to the export scheme. In view of this irregularity, it would have been desirable to construct a frame from a whole year of shipments, to extend only for as many producers as possible and the seasonality of banana production in Trinidad. The work involved in this would have been beyond our resources. We estimated that the firm of shipments would involve at least 2,000 members. This we considered a serious uneconomical matter.

The list of current contributors was taken so that only present contributors were included. It was also kept in mind that the frame of producer's names represented the total number of names to be handled. For shipments, that were not included in the alternative of a random sample of the membership than a non-random, may have included some producers as fewer contribute to our needs.

The names were extracted from the shipment lists and divided into:

a. The British Crown Possessions


b. These were processed immediately after being entered.
Five shipment files, see PART IIB, made available from the Marketing Board headquarters, were used to construct the frame for the survey sample. These shipments are listed in detail in appendix III. They were the five most recently available shipment files.

In order to construct a list of current export contributors, it was necessary to take more than one shipment due to the irregularity of producer contributions to the export scheme. In view of this irregularity, it would have been desirable to construct a frame from a whole year of shipments, to account fully for as many producers as possible and the seasonality of banana production in Trinidad. The work involved in this would have been beyond our resources. We estimated that the five shipments would involve at least 2,000 producers. This we considered a maximum manageable number.

The five most recent shipments were taken so that only present contributors were included. It was also hoped to maintain continuity of contributor's names to reduce the total number of names to be handled. Earlier shipments, that may have been included in the alternative of a random sample of the shipments over a year period, may have included some producers no longer participating in the scheme.

The names were extracted from the shipment files in the following stages.

a. The District Banana Purchase forms from the five shipments were each numbered to facilitate their recollection into the original shipment file order after handling.

b. These forms were then sorted by shipment files into truck routes. Each of the 33 truck routes was named and lettered. The Tobago forms and summary sheets in the files were discarded. Analogous route records in
different shipments were identified by the following means:

1. Area of truck route entered at head of the form.
2. Date entered at the top of the form.
3. Inspector's signature at the bottom of the form.
4. Comparison for the occurrence identical names.

c. The identified truck routes from each of the shipments were then combined to give 33 routes of 5 collections each.

d. A first-stage selection of these 33 routes was then taken, by allocating temporary numbers for each route and selecting 16 numbers between 1 and 33 at random. The 16 routes selected, and the order of selection, are shown in appendix IV.

e. The names of the contributors from the five shipments for each of the first-stage sample routes were extracted. These names were entered onto a punched card to facilitate subsequent handling. All names occurring in the five shipments of a route were allocated on card. Those names which were repeated from one collection to the next, or occurred on more than one of the five collections, had pooled information on one card. An illustration of card entry is shown in appendix V. The information collected onto the card of each name showed:

1. Contributor's name.
2. Number of collections of the five on which contributions were made.
3. Amount of stems contributed for each shipment.
4. Total number of stems contributed over the five shipments.
5. Truck route number to which the contributions were made.

This extraction was completed by a laborious search through the lists for each consecutive shipment.

On completion of extraction, the cards were grouped into truck route groups.
The cards were then sorted into the three strata according to total stem contribution over the five shipments. The strata division was as follows:

i. Contributors sending one to five stems in five shipments.

ii. Contributors sending six to fifty stems in five shipments.

iii. Contributors sending over fifty stems in five shipments.

These cards, now arranged in strata within routes, were now sampled by strata, to give the final second-stage sample. The sampling procedure is given in Part VI.

The cards drawn at this sampling represented the list of farmers to be visited. It provided us with the following information only:

i. Contributor's name and initial.

ii. Truck route to which contribution made.

iii. Total contributions over the five last shipments.

A list of sample truck routes showing the total number of producers per route, and sample number of producers per route, by strata and totals, is given in appendix VI. A list of the second-stage sample names, by strata and truck route, is given in appendix VII.

This frame has been retained in the Department of Economics at the College.
A two-stage sample was taken, with stratification of the second stage. The first-stage sample was taken of the truck routes, and the second-stage sample was taken of names within strata in routes. A differential sampling fraction was taken at the second stage.

This second-stage sampling, with a first-stage sample of truck routes, was accepted as giving a selection of groups of farms over the island. This geographical grouping of farms would aid in farm location and reduce travel to local areas.

1. First-stage Sample.

In drawing the first-stage sample the two following alternatives existed:

a. A first-stage sample of geographical districts, with a second-stage sample of routes within areas, leading to a third-stage sample of names within routes.

b. A first-stage sample of truck routes, irrespective of area, with a second-stage sample of names within routes.

The first alternative was rejected on the basis of the irregularity of these geographical areas as units. They were not of a comparable, uniform size or stem contribution, nor could we define the geographical coverage of the truck routes to locate different geographical districts.

A first-stage sample of truck routes would give, with almost equal probability, a sample of island wide distribution. There would be no advantage in introducing a further stage into the sampling.

A large first-stage sampling fraction was taken, half, in order to increase the probability of a widely representative sample over the whole island.
The sample was drawn by allocating temporary numbers, between one and thirty three, to the routes and drawing sixteen of these numbers at random.

The first-stage sample, and the order of draw, are shown in appendix IV. The distribution of these routes over the island, and their relation to rainfall and topography, are shown in Maps I and II.

2. Second-stage Stratification.

Before drawing the second-stage sample, the names in each of the first-stage sample routes were stratified into the following groups:

a. Those producers contributing a total of one to five stems inclusive, over the period of five shipments.

b. Those producers contributing a total of six to fifty stems inclusive, over the period of five shipments.

c. Those producers contributing a total of over fifty stems, over the period of five shipments.

These groups were chosen in consideration of the following points:

i. The numbers of producers on routes fell into natural groupings of about these sizes. This grouping showed the clear identification of the large number of very small contributors, a small number of large contributors, and a variable number of middle group contributors. This may be seen in the numbers of total producers per route, and their grouping, shown in appendix VI.

ii. It was thought that this grouping would represent approximately the three natural classes of banana production identified in the field. These were:

a. Peasant garden contributions, with bananas coming from a back-garden site.

b. Peasant holding contributions, with bananas coming from a mixed holding of about five to twenty acres.
c. Estate contributions, with bananas coming from large areas of over thirty acres showing much variation in condition of production.

iii. By using such a grouping, it was possible to sample these small number of large producers, accounting for a high proportion of total contribution, in greater detail. Similarly, a low sample would be taken of the less variable small producers.

3. Second-stage Sample.

The variable sampling fractions used in the second-stage sample were:

i. For contributors/1 to 5 stems, 1/45

ii. For contributors of 6 to 50 stems, 1/15

iii. For contributors of over fifty stems, 1/1

These fractions were chosen to give

i. intensive coverage of the small number of large producers.

ii. minimal coverage of the large number of small producers.

iii. a reasonable number of farms for a sample, with due consideration to the resources of the group for field work. Small contributors would require more time to find, and meeting the producer would probably necessitate pre-arrangement. By taking a larger number of larger contributors, we could obtain more information per stem contributed for a given number of contributors, and location of contributors appeared the major problem of the field work.

The second-stage sample was taken as a systematic sample as follows. The cards for each first-stage truck route were divided into strata groups. For each strata group within a route, a number was drawn at random. This number was drawn from within the limits of one and fifteen or forty-five, depending on strata. These strata group of cards were counted through until this random number was reached. This was withdrawn and every fifteenth or forty-fifth card after was drawn out. The withdrawn cards formed the sample.

A full list of sample names by strata and truck routes is given in appendix VII.
PART VIII

FIELD ENUMERATION

1. General

The outline of the limits inherent in the field problems and the development of the aim of our field investigation are given in Part II, 1. Field conditions, group resources, and the academic requirements of the survey had limited our aim to:

- an estimate of the density of *Musa* spp. on the second-stage sample holdings.
- an estimate of the percentage of export varieties on an identified "export" fruit count.
- an investigation of associated crops.
- a shoot per stool count of export varieties of *Musa* spp.

The frame provided only limited information. The second stage sample cards carried:

- the producer's name and initials.
- the truck route to which he contributed.
- his contribution of stems per shipment.

The requirements of the aim were to be measured directly in the field. Producer questionnaires were held to be without the scope of our survey. Only a sample area of any area of production of a producer could be examined. Time precluded a full examination of holdings. This implied a random allocation of sampling units within an area of production. To meet this requirement, in view of the limited information given in the frame, five stages were implied:

- the location of the producers in the second-stage sample.
- the definition of
  - the position,
  - the layout,
- the extent of the holdings, from which the
export bananas of these producers are drawn. This required an outline map of each producer's holding.

d. an allocation of sample units, at random, within this map outline, according to a standard sample fraction.

d. the identification of the position of these sample units in the field.

e. the taking of measurements in the field to give sufficient information to meet the requirements of the aim.

These five stages were covered in two phases:

a. Preliminary Survey.

and b. Field Enumeration.

These two phases were necessitated by the difficulty of locating producers in the sample, and their holdings; the extreme difficulty of defining the boundaries of the holdings without personal guidance; and the need to pre-allocate the sample units. Also, these two phases aimed at maximum field enumerator work in the field, with a minimum of their time spent locating areas. A preliminary survey permitted field enumerators to be placed immediately on their enumeration locations, without unnecessary loss of their time in finding the producers. This was essential in view of the limited time that field enumerators were at our disposal.

2. Preliminary Survey.

The preliminary survey was carried out by the four members of the survey team, working in pairs. It was designed to:

a. Locate the producers.

b. Investigate the position, layout and extent of the producers' holdings.

c. Allocate sample units to these areas of production.

The recording of preliminary survey information was carried out on Forms L, see appendix for completed example, designed to facilitate easy relocation of the holding, and illustrate by map the layout of the holding.
No list of addresses was available for the names of the producers in our second-stage sample. The Marketing Board did not maintain such information. The banana inspectors, buying bananas for the Board off the producers, were only temporary employees, and were not available to furnish this information. The district banana officers of the Board were able to indicate the addresses of some producers, but their other duties did not permit them to spend time out in the field locating them with us.

The two main methods of locating producers were:-

a. Through the local field assistants of the District Field Staff of the Ministry of Agriculture, Lands and Fisheries. A list of district staff and their locations was made available by the service.

b. Local enquiry in village stores, from local inhabitants and at local police stations. These last usually maintained an electoral list giving names, initials and addresses. But common duplication of names did not always make location simple.

Once a truck route area was located, by finding some of the producers, it was usually easy with initiative and local gossip to complete the list for that route. The greatest difficulty came in dealing with estates. Frequently the overseer's name was used instead of the estate name on the sample list, and was not known locally.

Having found the producer, a careful note was made on Form L, in the "Location Notes" section, as to how and where to find him. A comment was also added on his availability, i.e. if occupied by other work, and if not available at certain times.

The producer was then persuaded to indicate the position and extent, including the boundaries, of his holdings. This they did with goodwill and enthusiasm. Examination of the holding permitted a sketch map of the holding to be made. This sketch map showed:-
a. Outline of the holding, and indication of boundary marks.
b. Approach roads and prominent features.
c. A producer's estimate of acreage.
d. Approximate scale of the map.
e. The direction of north.
and
f. A few comments on the nature of the holding, to include topography, growth conditions and accessibility, so that an assessment of the amount of work could be made.

In obtaining these outline maps, estate producers could often provide a map of their estates. No reliable maps were available for other producers, and on some large holdings shortage of time made our maps very sketchy.

In allocating sample units to a holding, no measurement could be found to show the variability within the crop and vegetation associations that we would be measuring. Nor, with such a short time, could we undertake an investigation to ascertain this. Consequently, our sampling of holdings was not based on mathematical evidence. Basically, it was proposed to take 100 yards of sample line per acre, the sample line being 3 yards wide. This represented a sample of 300 square yards per acre, a fraction of approximately \( \frac{1}{14} \).

Sample lines were placed at random in the area. Randomization was on a combination of a system of random co-ordinates, and random compass directions, depending on the shape of the holding.

The total length of the sample lines was calculated from the acreage of the holding. The number and distribution of sample lines depended on the layout of the holdings.

4. Field Enumeration.

Line transect sampling was considered to be more practicable and speedy under the conditions we were to work in, than several sample units randomly
distributed within the area. The former requires only one location of a random point within the holding, and a direction from that point. Difficulty of locating the alternative of several points in such conditions was quite apparent.

We saw little advantage in measuring density by frequency of absence, rather than direct count. Lack of knowledge on the variability to be found within holdings would have necessitated a thorough preliminary investigation of sample unit sizes to obtain an adequate estimate by frequency methods.

A transect strip yields more information than a pure line transect of the same length, and can give as much information for a shorter length of line set out in the field. This was of considerable practical significance in view of some of the dense conditions of undergrowth we were likely to meet in the field.

Field enumeration consisted essentially of two processes. These were:

- a. Line delineation in the field.

   and b. Sample recording.

   a. Line Delineation.

   The method developed for laying out the transect line adequately fulfilled the pre-defined requirements.

   i. It required a minimum of equipment, of simple type.

   Only three standard survey poles were used.

   ii. One person could progressively lay out the line without assistance.

   iii. The routine was quick to perform and simple to learn, and fitted in with the sample recording.

   iv. Although the line was subject to slight curve, due to faulty parallax judgement, it fulfilled the purpose of laying down a line unbiased in relation to plant occurrence.

   v. It was workable in thick growth and open land.

   vi. It was practicable on variable slope.
The lines were laid in the direction indicated on the sketch maps on Forms L. Position and direction were indicated to field enumerators, by supervisors, in the field.

A line was laid out by placing the first pole, A, at the starting point and the second pole, B, three yards away in the direction of the line. The third pole, C, was then placed in line with poles A and B, three yards beyond B by the method of no parallax. While the line marker was placing C in position the sample recording was carried out from A to B. During the time the recorder worked from B to C, the line marker moved pole A to a point three yards beyond C, in line with B and C by the method of no parallax. Thus recorder and line marker worked stage by stage along the line together.

The placing of the pole as close as three yards was required to facilitate the ease of the sample recorder's work, and ensured accurate working in thick undergrowth. The sample recorder's measuring pole was used at first to measure the three yard distances, but practice soon developed accurate estimation by line markers.

b. Sample Recording.

The individual recording units were of one square yard. These were laid out by the sample recorders carrying a light, three yard measuring pole at right angles to the delineated sample line. Hence, between any two consecutive sample line poles, the recorders could quickly mark out mentally nine units of one square yard each. Accuracy in width of sample strip was ensured by use of the measuring pole. Division of the sample line into yards could be approximate. Any deficiency in recording, due to inaccurate within-strip unit definition, was corrected by recording in the previous, or following, unit.

The recorder's measuring pole also served as a periodic check of between pole distance in line marking.
The individual square yard units identified on the ground correspond
to the squares on the recording forms, Form F, see appendix IX. Each of
the four columns on these forms represented twenty-five yards of line, and
seventy-five square yards of recording, with a sheet giving one hundred yards
of recorded line.

By using a crop enumeration letter code, shown at the top of Form F,
it was possible to record on the sheets the occurrence of plants in any one
square yard. Occurrence of a plant within a square yard unit was defined by
the presence of shoot at ground level. If a plant occurred on a square yard
boundary line, it was placed on that side of the line in which most of the
shoot at ground level occurred. This definition applied between units within
the sample strips, and for inclusion of plants within the sample strip width.
The shoot of a *Musa* app. was defined as the whole stool.

Only the occurrence of a plant within the square was recorded, not
the number of plants. Any one plant was not recorded in more than one square.
Using only a square yard unit, meant that in effect a number count for shrub
and tree species was obtained, while small food crops were recorded on a
frequency basis. Recording of the number of individual species smaller than
shrub size would have increased considerably recording work, and have yielded
little further significant information.

The crop enumeration letter code used by recorders was designed to
cover the four categories into which crop enumeration fell. These were:

a. Recording the occurrence of individuals of genus *Musa*.
b. Recording the occurrence of associated crops.
c. Attempting a fruit type identification, to estimate
the percentage of exportable variety bananas.
d. Obtaining a shoot per stool count of identified
export varieties of banana, as an indication of cultural standard.
Code letters B, E and P gave identified and unidentified Musa spp. count. This gave information for categories a, and c. Category b, was covered by letters C, O, F, A and D. C, O and A are self explanatory. F covered crops such as cassava, tannia, rice and maize found on mixed peasant holdings. Letter D was used for other crop trees, as opposed to forest trees, such as bread fruit, tonka bean and coconut. M and N were incorporated to indicate non-crop associations, their management and density. M represented cut and cleared undergrowth, while N represented uncontrolled growth of weed and forest shrub. Bare ground was represented by a blank square on the recording form.

Shoot per stool recording, on identified export bananas, was carried out by entering the number of shoots per stool alongside the letter E on the Form F. Thus an identified export banana stool of seven shoots was recorded as "7E". All shoots of all sizes were counted.

4. Estate and Peasant Holding Enumeration.

On Form L the holding was defined, on an acreage basis, into Peasant Holding or Estate. This classification was only for recording methods, and was unrelated to the strata groups. A 'Peasant Holding' was under twenty acres, and an 'Estate' over twenty acres. The field enumeration technique was adapted for these two groups, to ensure adequate information for a minimum of field recording.

For a Peasant Holding the whole of the sample line, or lines, was recorded. Starting at the foot of column I on Form F, and working upwards with progress along the line, twenty-five yards of recording were covered. Having completed column I, the next twenty-five yards was recorded from the foot of column II, and so on until the one hundred yards was completed at the top of column IV. If a sample line was greater than one hundred yards, recording was continued on a second sheet, again working from bottom to top.
On any Peasant Holding the sample lines were numbered on Form L. Record sheets, Form F, were numbered for line number, and consecutively for sheet number on any one line.

The organization of the field work was planned to incorporate

On an Estate all of a sample line was not recorded. The first twenty-five yards were recorded as in a Peasant Holding, from bottom to top of column I on Form F. The enumerators then continued marking out the sample line in the given direction but did not record the crops until a distinct, visible change occurred in the vegetation. At the point of change a note was made at the foot of the next recording column of the unrecorded distance covered. Another twenty-five yards of the new vegetation type was then recorded in this next column. During movement through the unrecorded area of crop, the three yard spacing of the marker poles could be much increased, according to crop and topographical condition, to allow greater speed of work. Again consecutively numbered sheets made up a line, and a number of lines an estate.

2. Preliminary Survey.

At this stage the true routes were divided into ten divisions. Allocation of routes to the divisions was arranged to give an approximately equal number of farms within each division, and similar estimated travel distances. Two sectors of the survey group were allotted to each division to field supervisors. Each was wholly responsible for completing the preliminary survey within their divisions, according to the instructions and requirements explained to them. Distribution of these areas is shown in Map II.

Allocation of routes to divisions is shown in appendix VII A.
PART VIII

ORGANISATION OF FIELD WORK

1. General.

The organisation of the field work was planned to incorporate the two distinct phases of the field enumeration into one overall plan. This plan included certain requirements of the Department of Agriculture of the College. These were:

a. To instruct post-graduate students in the development of the survey, in relation to the concepts of sample surveys.

and b. To practice post-graduate students in sample survey field enumeration.

To facilitate these requirements the post-graduate students were assembled on the morning of Friday, December 12th, for instruction, and made available from 15th to 20th December, inclusive, for enumeration. Forty-five post-graduate students were available to participate.

2. Preliminary Survey.

At this stage the truck routes were divided into two divisions. Allocation of routes to the divisions was arranged to give an approximately equal number of farms within each division, and similar estimated travel distances. Two members of the survey group were allotted to each division as field supervisors. These supervisors were fully responsible for completing the preliminary survey within their divisions, according to the instructions and requirements explained to them. Distribution of these areas is shown in Map II.

Allocation of routes to divisions is shown in appendix XII A.
In addition to locating sample farms and completing the forms L, field supervisors were expected to thoroughly familiarise themselves with their divisions, to facilitate efficient organisation of the field recording. Also, supervisors were to allocate farm numbers from a nominated list, see appendix XII B, to individual farms. These numbers were prefaced by a truck route number, individual farm numbers being from 1 to 125 inclusive. Preliminary survey was to be completed by Thursday, 11th December, 1958.

Any problems arising were to be brought to the general notice of all field supervisors. I, myself, was available to assist in any particular problems.

2. Instruction of Enumerators.

The programme of the combined seminar group and instructional group is given in appendix X. There was insufficient time to hold the alternative of separate periods for these two aspects.

Denness dealt with the general principles, and also with the method of frame construction and sample drawing which we had used.

A general comment on the background of the banana industry in Trinidad was made by Bird.

The broad classification of fruit into "export" and "non-export" types, and the problem raised by immature state of fruit, was explained by Auckland.

I dealt, firstly, with the severe limitations of the field conditions and the definition of our survey aim, as dealt with in Part II of this report. Actual instruction in enumeration technique occupied my second period. This was covered by an instruction brief, see appendix XI.

The demonstration proved valuable, especially with reference to fruit identification.
The high standard of the enumerators led to a rapid grasp of enumeration technique, and discussion during this period was of a more academic nature.

3. Field Enumeration.

Four enumerators were allocated to each field supervisor each day of the enumeration. At least one car was ensured for each field supervisor's group each day. Post-graduate students' cars were used. Mileage allowance was paid at fifteen cents per mile, in accordance with the normal college arrangements.

Enumerators were ready to depart each morning at 8.00 a.m., packed lunches were carried. All enumerators had two days, and some three days, in the field.

The preliminary survey divisions were maintained for the enumeration. Field supervisors agreed mutually on which routes each were to supervise within a division. Supervisors worked only in the divisions in which they carried out preliminary survey.

Routine in the Red Division was as follows. Denness was fully responsible for Maracas and Talpero routes field enumeration. I was responsible for Montserrat route. Both areas had been thoroughly surveyed in the preliminary survey.

Each day we took our teams of enumerators to the locations, gave them the starting points and direction of lines, and allowed them to enumerate with only occasional supervision. Enumerators were allocated to lines to work in pairs. On completion of one farm the whole team moved to the next. Having both pairs of enumerators on one farm ensured minimum local travel and ease of supervision.

Farms on a route were worked in order of geographical disposition to ensure minimum travel. Familiarity with a route, obtained by thorough preliminary survey, aided planning at this stage.

The enumerators required little direction on recording technique once they had been started off on the basis of their instruction period. Separation of routes into Divisions for the preliminary survey, and further separation for the field enumeration, ensured that all members of the survey group bore direct responsibility in the important aspect of field work.
Each supervisor was responsible for producing, unaided, the results from his own routes/his Division, within the general overall plan of the survey.

In detailed and accurate accounts of the time and cost involved were recorded. Such accounts as are made are based on:

a. Personal survey diary records,

and b. travelaisal submitted by supervisors and field enumerators for travel.

1. TIMELINE

The investigation of each of the office work with other college duties provided a useful estimate of time used in this way. However, it may be of value to record the following periods of time occupied by the various stages.

a. The group assembled on 3rd October, 1939.

b. First and second stages of the preliminary investigations lasted until the method of frame construction and the form of the survey was decided on 1st October.

c. The writing of data for frame construction commenced on 3rd November, and was completed on 20th November, a period of 20 days.

d. The preliminary survey and mapping of farm was outlined to supervisors on 20th November and work commenced in the field on 1st December. This preliminary survey was due to be completed by 11th December, prior to enumerator instruction.

e. 12th December was nominated as the day for the post-graduate project seminar and enumerator instruction.

f. Enumeration was to be carried out from 15th to 20th December inclusive.

g. The months of February and March were held for the calculation and interpretation of results.

The period occupied by preliminary survey investigation could have been

was reduced by greater knowledge of the agricultural circumstances with which
No detailed and accurate accounts of the time and cost involved were recorded. Such comments as are made are based on:

a. Personal survey diary records,

and b. travel claims submitted by supervisors and field enumerators for travel.

1. TIME

The investigation of much of the office work with other college duties precludes any useful estimate of time used in this way. However, it may be of value to record the following periods of time occupied by the various stages.

a. Preliminary survey and mapping;

b. First and second stages of the preliminary investigations lasted until the method of frame construction and the form of the survey was decided on 31st October.

c. The sorting of data for frame construction commenced on 2nd November, and was completed on 26th November, a period of 25 days.

d. The preliminary survey and mapping of farms was outlined to supervisors on 28th November and work commenced in the field on 1st December. This preliminary survey was due to be completed by 11th December, prior to enumerator instruction.

e. 12th December was nominated as the day for the post-graduate project seminar, and enumeration instruction.

f. Enumeration was to be carried out from 15th to 20th December inclusive.

g. The months of February and March were held for the calculation and interpretation of results.

The period occupied by preliminary survey investigation could have been much reduced by greater knowledge of the agricultural circumstances with which
we were dealing, or by a more definite direction of survey aim. With such a short period to plan and carry out a survey this stage ought to have been considerably reduced.

Sorting and constructing frame data also occupied an unnecessarily long period. A more organised, positive and definite approach at this stage could have reduced this period easily to one week. This long period inevitably reduced the time available for the preliminary survey and mapping, which was to follow. This had to be completed in time for the field enumeration, by 15th December. This short period proved totally inadequate, in view of other college duties.

The preliminary survey and field enumeration in the Blue Division is reported by Auckland in his report of this survey. The following figures are quoted for Red Division:

a. Preliminary survey and mapping.

Maracas route took \(\frac{3}{4}\) days to find and map 7 farms out of 8.
Talparo route took 1 day to find and map 5 farms out of 7.
Montserrat route took 2 days to find and map 11 farms out of 15.

This is a total of \(\frac{3}{4}\) days to locate and map 23 farms out of 30. We considered we could locate the remaining farms whilst enumerators were working in the areas. This subsequently proved possible. One day was spent in Toco. This area is fully reported in appendix XIII.

b. Field enumeration in the Red Division.

Montserrat took 5 days using 4 enumerators per day.
Maracas took 2 days using 4 enumerators per day.
Talparo took 2 days using 4 enumerators per day.

This represents a total of thirty-six man days, excluding field supervisors, and including travelling time.

Preliminary survey time could have been little reduced. Location of producers within the area took by far the greater part of the time. Time
travelling to the area and time mapping were considerably less.

Field enumeration could have been more rapid only by taking more teams to an area at one time. However, we were limited in the number of enumerators, and loss of close supervision would have resulted. Nor would field enumeration have been more rapid with trained teams. Although we took out new enumerators every two days, the field technique was quickly appreciated, once the teams were placed on their survey lines. Having previously located the producers and mapped areas of production, we were able to organize our individual areas to obtain the most returns from our enumeration teams.

2. COST

The group commenced the survey without previous indication of monetary resources available for the project. Consequently, we were unable to make a budget estimate.

It was not until the end of December, after the period of main field enumeration, that it was indicated to us that we had reached our allowance limit. This led to the non-completion of the Blue Division reported by Auckland in his report of this survey, and the abandonment of the Toco area, as accounted in appendix XIII.

Students were allowed to claim fifteen cents per mile for the use of their cars. From examination of the claims submitted, it was found possible to allocate them to Divisions. This allocation showed:

- Blue Division expended $234.90 for 1566 miles - 59.36%
- Red Division expended $160.85 for 1072.3 miles - 40.64%

Total of $395.75 for 2638.3 miles

These claims represent the cost of travelling only. Without details of individual journey mileage, it would be unjustifiable to break these down further. The higher expenditure in Blue Division is perhaps related to its greater distance from the college, although a more methodical concentration of effort to complete
the survey of one truck route at a time would have resulted in more valid results for such a high proportion of the total expenditure. This is dealt with in Auckland's report on the survey.

The travelling costs can be regarded as being made up of two mileage groups.

a. Travelling to the area.
b. Travelling within the area.

The latter could only be reduced by methodical approach, working progressively through an area. This was difficult in the preliminary mapping survey. Location of farms often necessitated 'wandering' in an area with general enquiries. Methodical working in an area was quite easy for the field enumeration, and was desirable and logical to maximise enumerators' return of work.

Travelling to an area could only be reduced by going to an area less frequently. This would necessitate a longer working day to complete the required field work in less time. This was not possible for field enumeration. Their day was from 8.00 a.m. to about 5.30 p.m. During preliminary survey a longer day would have been possible, reducing our 'to-area' travelling time. However, preliminary survey work, of necessity, was fitted in with other college duties, and several half-days were taken rather than a reduced number of whole days.

Within the Red Division expenditure it was possible to break down claims into:

a. Toco preliminary survey $20.50
b. Maracas route enumeration
   Talparo route enumeration $63.57.
   All preliminary survey in the Division)
c. Montserrat enumeration. $76.60.
Section b, was completed using one large vehicle to carry both enumeration teams under Mr. Denness, whereas Section c, was completed using one vehicle per team, *i.e.* two vehicles per day. This accounts for the high cost.

A pre-budget would have helped in reducing these costs. However, travelling and mileage arrangements would have required detailed location of farms, and details of the amount of work needed on each farm. This should have been forthcoming from the preliminary survey. It can only be regretted that personal differences, lack of determined effort and failure to grasp an overall appreciation of the survey implications prolonged the routine construction of the frame to the detriment of the preliminary survey field work especially in the Blue Division.

The deficiencies are now discussed, as they arose, at each stage:

1. INITIAL

In preliminary decisions to adopt the tense implication, acknowledging the quality of work likely to be involved, we took upon the basis established of these people. The withdrawal of these members after this decision, was followed by a revision of plan. Consequently, the remaining four members found
In any discussion of the deficiencies of this survey a report cannot fail to mention difficulties arising from personal differences within the survey group, in addition to the errors of judgement which arose. Any analysis of particular personal differences cannot be reported impersonally by any one member of the team. However, it is of value to stress that, in such a study group, absolute co-operation must be forthcoming from all members. While a considered decision of the whole group should be followed in detail by all members, initiative in developing particular aspects of the work is desirable.

During the work of this survey group absolute co-operation from some members was rare; there was an unwillingness by individuals to abide by the considered decision of the group; at times there was refusal by individuals to accept leadership in aspects of the work developed by others; and a pathetic inability to grasp and comprehend the full implications, responsibilities and urgency of the work of the survey as a whole at one particular time. Such a background does not produce good results, and the poor achievement of this survey to produce complete results in no small way reflects on the attitude of individuals of the survey team.

The deficiencies are now discussed, as they arose, at each stage.

1. GENERAL

In preliminary decisions to adopt the banana investigation, acknowledging the quantity of work likely to be involved, was taken when the team consisted of seven people. The withdrawal of three members after this decision, was not followed by a revision of plan. Consequently, the remaining four members found
themselves unable to cope adequately with the amount of work involved.

The lack of budget estimate in the early stage is emphasised in Part X, and a planned utilisation of financial resources from this stage would inevitably have resulted in a more satisfactory return. It may also have brought a sense of responsibility to certain individuals' judgement.

Vague terms of reference adopted by the group as an aim in the early stages were most misleading. The essential definition of aim in any problem of inquiry can lead to much saving of effort. Although much was learnt of the Trinidad agricultural background in searching for this aim, few technicalities of sample surveying were assimilated.

2. FRAME

Yates, (1957d), states that a frame can be subject to various types of defect. He classifies these defects as:

a. Inaccuracy.
b. Incompleteness.
c. Duplicity.
d. Inadequacy.
e. Out of date.

The inaccuracy of our frame was in listing units which did not exist. For example, Doobal, G., a second-stage sample producer in route 5 contributing over fifty stems, was discovered to be an employee of the Esperanza Estate, also listed in the same route and strata sample. His name did represent a unit of contribution, but merely the occasions he had been responsible for supervising the sales of the Esperanza Estate.

Since we took only five shipments from the twenty during a twelve month period, our frame was inevitably incomplete and inadequate. Seasonality of production of bananas meant that in the months of April to June, the period covered by the frame, many banana producers were not contributing, especially in the drier areas. Subsequent contact with unlisted estates showed that all
producers, who contributed at other times of the year in a range comparable to over fifty stems per five shipments, were not included. The Santa Maria Estate, in Montserrat, was not included, due to non-contribution during the five shipment frame period, yet contributed considerable numbers of stems at other times of the year.

Duplication was common. This arose from the lax definition, and overlapping, of truck routes from one shipment collection to the next. Even in our second-stage sample of names, see appendix IV, two names occurred on two different routes. Urich, F.C., occurs in routes 2 and 13, and the El Reposo Demonstration Station occurs on routes 13 and 15.

It is difficult to see how we could have got a more up-to-date frame, with the inevitable delay in shipment file assembly. Nevertheless, the withdrawal of contributors, between the last shipment in June and our enumeration dates in December, could have been considerable. De Matos of Maracas, and Sookal of Montserrat, both second-stage sample contributors, no longer considered themselves contributors to the scheme.

An improved frame of the exporters of bananas could only have been obtained by using a full year of shipments files. This would have been beyond our resources. Other general frame sources since examined have prompted the following brief comments. The source of the list of addresses used in the Land Utilization and Agricultural Production Report, (1956), is unknown. The Trinidad Department of Agriculture does not maintain such a list. The Survey Department maintains a full set of aerial photographs of the island. I found that I could not distinguish banana plants on the photographs, but they would form a good basis for locating and measuring citrus acreage, which appeared quite distinct.

The frame cards were clipped without reference to the group as a whole. During the period of clipping, some four months, the frame cards were not available to the group. The clipping proved totally inadequate. It gave the following information:
a. Total stems contributed over 5 shipments.

b. Strata group

c. Truck route number

d. Sample or non-sample contributor.

It was not possible to break down a contributor's five individual contributions from this system, a point on which evidence would have been valuable. The refusal to make the clipping code available to the whole group added to our difficulty.

3. Sample

A more thorough sample of the island could have been produced by a first-stage sample of geographical areas, with a second-stage sample of truck within the sample areas. This would have necessitated an investigation to ascertain the limits of each truck route to enable definition of the geographical areas. We could reasonably have expected the district banana officers to give this information.

However, within the limits of our knowledge of the truck routes and time, our plan of two stages of sampling seemed adequate. But within this plan the sampling fractions and stratification were totally inadequate.

We were unjustified in believing that the three producer types identified previously in the field corresponded to the three producer groups apparent in the five shipment stem contributions. The inadequacy, duplication and incompleteness of our frame led to the interference of seasonality of production in recorded contributions, with a consequent unsatisfactory stratification. Most of the 1-5 and 6-50 stem groups in Red Division were over twenty acres, although showing considerable division between strata in the sample. Stratification did not lead to intensive investigation of large producers, and less intense investigation of small producers.

Nor were the sample fractions adopted at all adequate. We did not know the variability to be expected between stages or strata, but it was inexcusable to proceed with the survey allowing only one unit in several of the strata of the second-stage sample.
4. **Field Technique.**

This appeared to be generally adequate. To the crop recording code should be added a group for non-food forest trees.

In view of the wide variety of conditions under which the recording technique was worked, the results, taking for example the density of cacao, are surprisingly adequate.

A more critical testing of the system should, however, have been adopted before its use in the field. The use of artificial communities was considered, but time precluded any action. It has since been recognised that a scale test model on communities of discs could have been used effectively, (Bauer, 1943).

5. **Instruction.**

We were fortunate in that we were dealing with post-graduate students. In view of their academic interest in this subject a more distinct division should have been made into seminar and instruction periods. Students expressed the opinion that a longer discussion of the principles would have been of greater value. They felt that the hand-out of instructions was sufficiently adequate, on this occasion, as to cover the instruction in field technique.

Lack of enumeration practice prior to commencing field work was overcome quickly by supervisor direction in the early yards of field work.

6. **Field Organisation.**

The overall plan seemed adequate. Preliminary survey work was, of necessity, hurried due to the waste of time on frame construction. Red Division completed all except the Toco routes, the abandonment of which is reported in appendix XIII. Red Division also completed their enumeration comfortably within the week.

The lack of results in Blue Division in the preliminary survey and field enumeration is reported by Auckland in his report of this survey. An inability
to organise, on a methodical basis, the work within the division seems to have been the major shortcoming. However, the field work was planned to give each supervisor direct responsibility in the field to produce results.

Time could have been saved in the field by using a longer working day. Had student enumerators have departed at 6.30 a.m., work could have commenced in the field much earlier. For preliminary survey in distant areas use should have been made of sleeping in the area to reduce loss of time in travel. It was planned to use the Government Rest House at Toco, and camping equipment could easily have been borrowed.

7. Computation

Every assistance was given by Mr. Dennis to the other group members. However, much of the simple mathematics of computation proved beyond some members of the team. Much time was wasted in re-checking other people's work, and instructing in computational procedure. Even at this final stage of report the cacao densities for Tamana have not been produced by one member.

It is pertinent to point out that a thorough familiarisation with the mathematics of the computations allowed one member to compute all values for B's, E's, P's, and B+E+P. On the other hand two individuals adopting a purely mechanical computation procedure, completed only C's, A's and O's over a much longer period.

It is to be regretted that so many deficiencies arose, but such mistakes are the basis of academic experience, and it is to be remembered that this alone was one of the major aims of this survey.
PART XI

THE DERIVATION OF COMPUTATIONS AND ANALYSES.

The general analysis of field records was carried out in three stages. These stages were:

1. Raising the recorded field sample totals to holding values of total number of each recorded species, and density for each recorded species.
2. Derivation of the standard errors for total numbers of each species.
3. Derivation of the standard error for density of each species.

For stage one the sample farms were divided among the group members for computation. For stage two, group members derived standard errors for given species throughout all strata and truck routes.

1. Raising the sample values to holding totals and densities.

This was a simple proportion carried out in the following stages for individual farms. A full example is given in appendix XIV.

i. For the given recorded area of each line, the number of individuals recorded were totaled from Forms F. These totals are given in row 1 of the computation.

ii. These totals were raised by the first raising factor, $g_1$, to represent a distance measured for each type of vegetation on the line. This $g_1$ factor was derived by dividing (total distance measured in yards per type of vegetation x 3) with (area recorded). The first raised totals for each part of line are given in row 2. $g_1$ for a peasant holding records was automatically 1.

iii. The first raised individual species totals were then totaled for each holding in row 2.

iv. The density raising factor, $g_2$, was then derived by dividing 4840 by (total area surveyed), the divisor being obtained from a total of column 3.

v. The total raising factor, $g_3$, was obtained by (total holding area x $g_2$).
vi. The density raising factor then gave individual densities in row 3, from the first raised totals of row 2.

vii. The total raising factor then gave individual totals in row 3, from the first raised totals of row 2.

viii. The total and density of Musa spp. were then given by adding the B, E, and P row 3 values.

All row and column numbers in this account refer to the example in appendix in appendix XIV.

2. Derivation of standard errors for total number of each species.

Considering a whole strata, i, within a truck route, t.
Let estimated number of trees on one holding = y
number of square yards sampled per farm = a
number of trees measured = tr
total acerage of holding = A
If suffix i = within strata
   t = within truck route
   ' = first stage sample
   " = second stage sample

Then
\[ y_{it} = \frac{tr \times A}{a} \]

If \( y_{it} \) = total estimated number of trees on all holdings within strata i, within truck route t.
\( \varepsilon_{it} \) = exact second stage raising factor.
and \( S(y_{it}) \) = sum of the estimated number of trees on holdings within strata i, on truck route t.

Then
\[ y_{it} = \varepsilon_{it} \times S(y_{it}) \]

But since
\[ y_{it} = \frac{tr \times A}{a} \]
\[ y_{it} = \varepsilon_{it} \times S_i(\frac{tr \times A}{a}) \]

\[ \varepsilon_{it} = \frac{1}{F_{it}} \]

If \( F_{it} \) = exact second stage sampling fraction.
Variation of $Y_{it}$ is given by

\[
V(Y_{it}) = g_{it}^n V(S_i(y_{it}))
\]

but

\[
V(S_i(y_{it})) = n_{it}^n S_i^2(1 - f_i^n)
\]

where

\[
V = \text{variance}
\]

\[
S_i = \sqrt{V(Y_{it})} \text{ in strata } i, \text{ on truck route } t.
\]

\[
n_{it} = \text{number of units in strata } i \text{ on truck route } t.
\]

Therefore

\[
V(Y_{it}) = n_{it}^n S_i^2 g_i^n (1 - f_i^n)
\]

\[
= n_{it}^n S_i^2 g_i^n (g_i^n - 1)
\]

Computation to derive $Y_{it}$ is based on formula i.

Computation to derive $V(Y_{it})$ is based on formula ii.

A full computation example is set out in appendix XV.

3. Derivation of standard error for the density of each species.

Let $e = \text{number of trees as measured on holding}.$

\[A = \text{total acreage of the holding}.
\]

\[a = \text{number of square yards sampled per farm to give the number of trees } e.
\]

Then

\[y_{it} = \frac{e \times A}{a}
\]

and

\[e = \text{density } = d.
\]

Now

\[
S_{it}(Ad) = \text{mean ratio for strata } i \text{ within truck route } t, \text{ represented by } \bar{F}.
\]

\[
S_{it}(A)
\]

Hence

\[
\bar{F} = \frac{S_{it}(A \times e)}{a}
\]

\[..............................\text{iii}.
\]

\[
S_{it}(A)
\]
Now $\bar{r}$ is a weighted mean.

The general formula for a weighted mean is given by Yates, (1953), 7:5, as:

$$\bar{y} = \frac{w_1 y_1 + w_2 y_2}{w_1 + w_2}$$

In our example $y$ values are total trees,
and $w$ values are acreages.

Further, $\bar{r}$, the weighted mean, is derived from weights which are in the nature of supplementary information; the quantities $y$ and $w$ being determined from the same individual sampling units, with the variances of the $y$'s related in some way unknown to the values of the $w$'s.

Since

$$\bar{r} = \frac{S_{it}(A \times \frac{y}{x})}{S_{it}(A)}$$

and

$$\frac{(A \times \frac{y}{x})}{A} = \frac{y}{x}, \text{ the total number,}$$

$$\bar{r} = \frac{S(y_{it})}{S(x_{it})}$$

Yates, (1953), 7:5k, gives the approximate formula for the standard error of the ratio of two estimates, whose sampling errors are independent. This is:

$$V\left(\frac{y_1}{y_2}\right) = \left(\frac{y_1}{y_2}\right)^2\left[\frac{V(y_1)}{y_1xy_1} + \frac{V(y_2)}{y_2xy_2}\right]$$

If the estimates $y_1$ and $y_2$ are not independent, the concept of covariance is introduced. In this survey the acreages are not independent from the densities. Hence into Yates' formula the following expression must be introduced:

$$\frac{2 \text{ cov.}(y_1 y_2)}{\left(\frac{y_1 y_2}{y_2}\right)}$$
Hence, to get the variance of $\bar{r}$, the following formula is derived from Yates, (1953), 7:5k, allowing for covariance and fixed populations:

$$V(\bar{r}) = \frac{1 - \frac{T^2}{n_i^2}}{r^2} \left[ \frac{V(y)}{y^2} - \frac{2 \text{cov}(xy)}{\bar{x} \bar{y}} + \frac{V(x)}{x^2} \right]$$

If we were to plot the values of $y_{it}$ and $x_{it}$ against each other, we could get a representative figure for a strata in a truck route:

![Diagram showing scatter plot of $y_{it}$ and $x_{it}$ with line OMD through the origin and the mean representing the ratio of $\frac{\bar{y}_{it}}{\bar{x}_{it}}$.]

In this figure,

$$M = \text{sample mean} = (\bar{x}_{it}, \bar{y}_{it})$$

the line OMD through the origin and the mean represents the ratio of $\frac{\bar{y}_{it}}{\bar{x}_{it}}$.

If $Q$ denotes the sum of squares of the deviations of $y$'s from the value given by the ratio line OMD, we have:

$$Q = S\left( y_{it} - \bar{r}x_{it} \right)^2$$

$$= S(y_{it}^2) - 2\bar{r} S(x_{it} y_{it}) + \bar{r}^2 S(x_{it}^2) \ldots \ldots \text{iv.}$$

Now, if $Sq^2$ represents the estimated mean square deviation from the true ratio, we have:

$$Sq^2 = \frac{Q}{n - 1}$$
Then

$$\frac{1 - f_i''}{n'' \cdot x_{it}^2} \cdot \text{Sq}^2 = \frac{1 - f_i''}{n'' \cdot x_{it}^2} \cdot n'' \cdot \text{Sq}^2 \ldots \ldots \ldots \ldots \ldots \ldots \ldots$$

Computation for $\bar{r}$ and $V(\bar{r})$ were based on formulae iii, iv and v.

A full computation example is given in appendix XVI.

In addition to these general computations undertaken by all members of the group, Mr. Denness has furthered the analysis by individual effort beyond this point. Although his results are quoted in this report, his mathematics are reported only in his own report on this survey.

********
PART XII

RESULTS

As outlined in Part IX, only the second-stage sample on five truck routes were in any way completed. These routes were:

- Maracas of eight farms
- Montserrat of fifteen farms
- Talpero of seven farms
- Rio Claro of three farms
- Tamana of seven farms

of Red Division.

of Blue Division.

Only the results for these five completed routes were analysed.

The mathematical background and procedure of the three stages of general analysis are given in Part XI and appendices XIV, XV and XVI.

These three stages were:

a. Raising the recorded field sample totals to holding values of total number of each recorded species, and density for each recorded species.

b. Derivation of the values and standard errors for total numbers of each species by strata and truck routes.

c. Derivation of the densities and standard errors for densities of each species by strata and truck routes.

The crops recorded in the field were:

B - Unidentified Musa spp.
E - Identified export variety Musa spp.
P - Identified non-export variety Musa spp.
C - Citrus.
O - Coffee.
A - Cacao
F - Food crops.
D - Other food trees.
D was not present significantly, and, since F was recorded on a frequency of occurrence and not total number, these two were not analysed in the general analysis. Any analysis of F must be carried out in accordance with the concepts laid down by Raunkier, (1934), on the basis of frequency of absence. We felt the amount of computation involved to be beyond the usefulness of the information obtained, in view of our shortage of time.

No use was made of the M and N records in classifying the standard of management, and any investigation of the shoot per stool counts of identified exportable varieties of Musa spp. was precluded by time.

Of the three general analyses only stage C, the density figures, are published, in appendix XIX. The total numbers, by truck route and strata, are of little significance, the wide differences of acres between holdings giving the figures very large standard errors. However, the results were combined to give a total number of each species for all routes and strata. This table is given in appendix XVII, and is a useful indication of tree potential on the holdings contributing to the export scheme.

The densities are also combined by strata within routes, to give a comparison of densities in the areas that we were able to complete. These figures are given in appendix XVIII.

---

The figures for the density of species, combining strata within the routes, is appendix XVII, which only has potlao.
PART XIII

CONCLUSIONS

In view of the deficiencies outlined in Part X, and the incompleteness of the survey, any conclusions drawn from the results of the survey must be of a very general nature.

1. In considering the total numbers of each species, in combined strata and truck routes, three points are evident.

   a. The predominance of cacao as the associated crop is emphasised.

   b. The number of export variety bananas, $2,952,652 \pm 1,140,000$, is high in relation to other available estimates. Farrell, (1958), states that export of bananas from Trinidad are 250,000 per year. This is confirmed in Report (1956) which states that the export of bananas in 1954 was 200,000 stems. Even with a low production of one stem per year per plant, our estimate would seem to promise, at least $1,812,652$ per year. With an allowance of one third for reject, unweight and non-production, present export still falls remarkably short of potential.

   c. The Land Utilisation and Agricultural Production Report, (1956), totals banana and plantain trees as $6,748,372$. This estimate is lower than our estimate of $12,074,186 \pm 3,986,000$. However, the former estimate is based on tenant opinion of numbers of trees on their holdings, and not a sample count. It would seem that total banana and plantain trees are higher than expected, especially in view of the fact that our estimate is for exporters of bananas only and not the whole of the island.

2. The figures for the density of species, combining strata within truck routes, in appendix XVIII, raise only two points:

   a. There is considerable variation between values of total Musa spp. in different areas. However, all values are high in comparison
with the previous opinions. Farrell, (1958), considers bananas as occurring at a density of thirty to sixty plants per acre in cacao. In all areas, except Tamana with a value of seventy-eight, the density of total Mussa spp. was estimated as being over ninety. This higher figure for density may be an important factor in any planned expansion of the industry.

b. Density figures for cacao seem to suggest a reasonable estimate of plants. They coincide with a density one would expect in mature cacao, after death and selective thinning during the early years.

3. The density of species, for strata within truck routes, merely confirm the impression of a higher density of Mussa spp. than expected. The variability between strata and routes however, warrants further investigation. It may be related to more favourable conditions for expansion of an export banana industry in certain areas.
An account is given of a sample survey carried out by a team of four students from the Imperial College of Tropical Agriculture. The survey was developed to obtain a measure of the density of *Musa* spp. on holdings contributing export bananas to the Trinidad export scheme. Supplementary information was collected on associated crops, and the population of exportable and non-exportable varieties of *Musa*.

The background of the development of the survey from the conditions of cultivation of *Musa* spp., and the construction of the frame from the Marketing Board records, are accounted fully.

A two-stage sample was taken, with stratification of producers, in the second-stage, on their total contribution over a period of five export shipments.

The development of a line transect technique for field recording is outlined, and the field organisation of the survey is described in detail.

The estimates are presented with the standard sampling errors, which are high.


BIBLIOGRAPHY:


BIBLIOGRAPHY.


Montserin, B.G. (1956). "The Cultivation of Bananas in Trinidad and Tobago." Trinidad and Tobago Department of Agriculture, Port-of-Spain.


...
MAPS.

MAP I. Trinidad: sketch map of land form and rainfall.

MAP II. Trinidad: sketch map showing the distribution of sample areas and main communication roads.
MAP I.

TRINIDAD.

Sketch map of land form and rainfall.

- Land over 200 feet.
- Land under 200 feet.
- Rainfall margins.

Sketch showing distribution of main roads.
MAP II.
Sketch showing the distribution of sample areas and main communication roads.

Main roads.

Area of sample routes.
## APPENDICES

### HOLDINGS OVER 100 ACRES

<table>
<thead>
<tr>
<th></th>
<th>E.</th>
<th>L.</th>
<th>N.</th>
<th>S.</th>
<th>P.</th>
<th>P.</th>
<th>T.</th>
<th>E.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of holdings.</td>
<td>20.</td>
<td>12.</td>
<td>3900.</td>
<td>300.</td>
<td>3900.</td>
<td>312.</td>
<td>544.</td>
<td></td>
</tr>
<tr>
<td>Total acreage</td>
<td>658.</td>
<td>74.</td>
<td>6638.</td>
<td>800.</td>
<td>3334.</td>
<td>834.</td>
<td>5164.</td>
<td></td>
</tr>
</tbody>
</table>

### NUMBER OF TREES ON 100 ACRES

- 1605000. 26145.472630. 407500.631690. 433732.674652.22
- *Possibly stands.*

### ACREAGE, STANDS

<table>
<thead>
<tr>
<th>Acreage</th>
<th>E.</th>
<th>L.</th>
<th>N.</th>
<th>S.</th>
<th>P.</th>
<th>P.</th>
<th>T.</th>
<th>E.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>per acre</td>
<td>478.</td>
<td>28.</td>
<td>400.</td>
<td>3.</td>
<td>978.</td>
<td>22.</td>
<td>933.</td>
<td></td>
</tr>
<tr>
<td>per six acres</td>
<td>216.</td>
<td>12.</td>
<td>3000.</td>
<td>400.</td>
<td>3418.</td>
<td>918.</td>
<td>4430.</td>
<td></td>
</tr>
</tbody>
</table>

### NUMBER OF TREES

- 260390. 4722. 126400. 3900. 361192. 10332. 391331.

### NUMBER OF TREES AS

- 81952. 700. 231900. 81400. 795586. 85100. 256205.

### COLUMN B
- Figures for bananas.

### COLUMN C
- Figures for plantains.
APPENDIX I.

Extracted figures from 'Land Utilization and Agricultural Production Report, 1958'.

<table>
<thead>
<tr>
<th>HOLDINGS OVER 100 ACRES</th>
<th>HOLDINGS UNDER 100 ACRES</th>
<th>TOTALS ALL HOLDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.</td>
<td>P.</td>
<td>B.</td>
</tr>
<tr>
<td>Number of holdings.</td>
<td>29. 12</td>
<td>3900. 500.</td>
</tr>
<tr>
<td>Total acreage of pure + mixed stands.</td>
<td>696. 34. 3638. 800.</td>
<td>4334. 834.</td>
</tr>
<tr>
<td>Number of trees on pure + mix stands.</td>
<td>1582000. 26142. 4732630. 407600. 6314630. 433742. 6748372.</td>
<td></td>
</tr>
<tr>
<td>Acres pure stand.</td>
<td>478. 22. 400. 3. 878.</td>
<td>25. 903.</td>
</tr>
<tr>
<td>Acres mix stand.</td>
<td>218. 12. 3200. 800. 3418.</td>
<td>812. 4230.</td>
</tr>
<tr>
<td>Number of trees pure stand.</td>
<td>255099. 6732. 126100. 3900. 631199. 10332. 391531.</td>
<td></td>
</tr>
<tr>
<td>Number of trees mix stand.</td>
<td>61755. 700. 531800. 91400. 593555. 92100. 685655.</td>
<td></td>
</tr>
<tr>
<td>Number of trees as subsid. crop.</td>
<td>1265130. 18710. 4074700. 312300. 5339830. 331010. 5670840.</td>
<td></td>
</tr>
</tbody>
</table>

Column B. --- figures for bananas.
Column P. --- figures for plantains.
Marketing Board banana collection record form for individual routes, showing a sample entry.

<table>
<thead>
<tr>
<th>SUPPLIERS</th>
<th>STEMS</th>
<th>WEIGHT in Lbs</th>
<th>STATE</th>
<th>RATE</th>
<th>REASONS</th>
<th>SCARRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAMCHARAN, S.</td>
<td>3</td>
<td>92</td>
<td>New</td>
<td>4</td>
<td>3</td>
<td>68</td>
</tr>
<tr>
<td>HENRI, T.</td>
<td>5</td>
<td>123</td>
<td>Ripe</td>
<td>&quot;</td>
<td>4</td>
<td>92</td>
</tr>
</tbody>
</table>

Signed: D. STEWART.
### APPENDIX III.

List of shipments used in the frame construction.

<table>
<thead>
<tr>
<th>Market Board</th>
<th>Name of Ship</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipment Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>S/S Boswell</td>
<td>18 April, 1958</td>
</tr>
<tr>
<td>72</td>
<td>S/S Hilary</td>
<td>17 May, 1958</td>
</tr>
<tr>
<td>73</td>
<td>S/S Boswell</td>
<td>28 May, 1958</td>
</tr>
<tr>
<td>74</td>
<td>S/S Hubert</td>
<td>10 June, 1958</td>
</tr>
<tr>
<td>75</td>
<td>S/S Canadian Star</td>
<td>26 June, 1958</td>
</tr>
</tbody>
</table>
## APPENDIX IV

List of total routes sampled, drawn sample and order of draw.

<table>
<thead>
<tr>
<th>Route Designation</th>
<th>Order of Draw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biche A.</td>
<td></td>
</tr>
<tr>
<td>&quot; B.</td>
<td></td>
</tr>
<tr>
<td>&quot; C.</td>
<td></td>
</tr>
<tr>
<td>Blanchisseuse.</td>
<td></td>
</tr>
<tr>
<td>Cedros.</td>
<td></td>
</tr>
<tr>
<td>Maracas.</td>
<td></td>
</tr>
<tr>
<td>Mayaro and Guayguayare.</td>
<td></td>
</tr>
<tr>
<td>Moruga.</td>
<td></td>
</tr>
<tr>
<td>Montserrat A.</td>
<td></td>
</tr>
<tr>
<td>&quot; B.</td>
<td></td>
</tr>
<tr>
<td>&quot; C.</td>
<td></td>
</tr>
<tr>
<td>Rio Claro X.</td>
<td></td>
</tr>
<tr>
<td>&quot; Y.</td>
<td></td>
</tr>
<tr>
<td>&quot; Z.</td>
<td></td>
</tr>
<tr>
<td>Sangre Grande A.</td>
<td></td>
</tr>
<tr>
<td>&quot; B.</td>
<td></td>
</tr>
<tr>
<td>&quot; W.</td>
<td></td>
</tr>
<tr>
<td>&quot; X.</td>
<td></td>
</tr>
<tr>
<td>&quot; Y.</td>
<td></td>
</tr>
<tr>
<td>&quot; Z.</td>
<td></td>
</tr>
<tr>
<td>Talparo.</td>
<td></td>
</tr>
<tr>
<td>Tamana 0.</td>
<td></td>
</tr>
<tr>
<td>&quot; Q.</td>
<td></td>
</tr>
<tr>
<td>&quot; S.</td>
<td></td>
</tr>
</tbody>
</table>
### Route Designation

<table>
<thead>
<tr>
<th>Route</th>
<th>Order of Draw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toco E</td>
<td>9</td>
</tr>
<tr>
<td>&quot; F.</td>
<td>6</td>
</tr>
<tr>
<td>&quot; G.</td>
<td>16</td>
</tr>
<tr>
<td>&quot; H.</td>
<td>-</td>
</tr>
<tr>
<td>&quot; I.</td>
<td>14</td>
</tr>
<tr>
<td>&quot; J.</td>
<td>11</td>
</tr>
<tr>
<td>&quot; K.</td>
<td>-</td>
</tr>
<tr>
<td>&quot; L.</td>
<td>-</td>
</tr>
<tr>
<td>&quot; M.</td>
<td>-</td>
</tr>
</tbody>
</table>

Total of 33 routes.

Sample of 16 routes.

---

*Note: Total delivered stems out of five shipments.*

- **Column 1**: Number of shipments out of five on which stems were not distributed.
- **Column 2**: Contributor's name and initials.
- **Column 3**: Truck route number.

Column 1 records individual shipment totals.

Box 1: Total for shipment on 19 April, 1968.

Box 2: Total for shipment on 17 May, 1968.

Box 3: Total for shipment on 10 June, 1968.
APPENDIX V.

Details of the frame cards.

Column 1.

a. = total delivered stems over the five shipments.
b. = number of shipments out of five on which stems were contributed.
c. = contributor's name and initials.
d. = truck route number.

Column 1.- records individual shipment totals.

Row 1.- stem total for shipment on 18 April, 1958.
" 2.- " " " " " 17 May, 1958.
" 3.- " " " " " 28 " .
" 4.- " " " " " 10 June, 1958.
" 5.- " " " " " 26 " .
APPENDIX VI.

List of sample truck routes showing the total number of producers per route and sample number of producers per route by strata and totals.

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>NO.</th>
<th>TOTAL NUMBER OF PRODUCERS/ROUTE</th>
<th>SAMPLE NUMBER OF PRODUCERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>a.</td>
<td>b.</td>
</tr>
<tr>
<td>Tamanas.</td>
<td>1.</td>
<td>131</td>
<td>49</td>
</tr>
<tr>
<td>Maracas.</td>
<td>3.</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Mayaro &amp; Guay.</td>
<td>4.</td>
<td>44</td>
<td>23</td>
</tr>
<tr>
<td>Montserrat.</td>
<td>5.</td>
<td>77</td>
<td>57</td>
</tr>
<tr>
<td>Talparo.</td>
<td>8.</td>
<td>57</td>
<td>33</td>
</tr>
<tr>
<td>Rio Claro.</td>
<td>10.</td>
<td>67</td>
<td>18</td>
</tr>
<tr>
<td>Biche.</td>
<td>12.</td>
<td>112</td>
<td>46</td>
</tr>
<tr>
<td>Toco F.</td>
<td>6.</td>
<td>72</td>
<td>80</td>
</tr>
<tr>
<td>&quot; E.</td>
<td>9.</td>
<td>48</td>
<td>70</td>
</tr>
<tr>
<td>&quot; J.</td>
<td>11.</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>&quot; I.</td>
<td>14.</td>
<td>33</td>
<td>61</td>
</tr>
<tr>
<td>&quot; G.</td>
<td>16.</td>
<td>56</td>
<td>61</td>
</tr>
<tr>
<td>Sangre Grande Y.</td>
<td>7.</td>
<td>124</td>
<td>49</td>
</tr>
<tr>
<td>&quot; A.</td>
<td>13.</td>
<td>128</td>
<td>55</td>
</tr>
<tr>
<td>&quot; B.</td>
<td>15.</td>
<td>69</td>
<td>46</td>
</tr>
<tr>
<td>&quot; X.</td>
<td>2.</td>
<td>112</td>
<td>49</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td>1208</td>
<td>773</td>
</tr>
</tbody>
</table>

Column a. --- 1 to 5 stem contributors.
" b. --- 6 to 50 " " "
" c. --- over 50 " " "
" d. --- total contributors.
## List of second-stage sample names by strata and truck route

<table>
<thead>
<tr>
<th>Route Number</th>
<th>1-5 stem group</th>
<th>6-50 stem group</th>
<th>Over 50 stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>de Matos, T.</td>
<td>Lutchman, N.</td>
<td>Metamora, A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vialva, A.</td>
<td>Jardine, E.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mendoza, A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jardine, O.B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Zamora, S.</td>
</tr>
<tr>
<td>5.</td>
<td>Kaloo, J.</td>
<td>Santa Maria Est.</td>
<td>Doobal, G.</td>
</tr>
<tr>
<td></td>
<td>Sookal, A.</td>
<td>Hardial.</td>
<td>Lacaille, H.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duprey, R.</td>
<td>Santa Servera</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Batchasingh, C.</td>
<td>Est.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boodoosingh, S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>San Antonio Est.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>San Juan Est.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ramjasingh, B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Khan, S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Esperenza Est.</td>
</tr>
<tr>
<td>8.</td>
<td>Williams, E.</td>
<td>Navas, C.</td>
<td>Costineda, R.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simon, P.</td>
<td>Oudi, C.</td>
</tr>
<tr>
<td></td>
<td></td>
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### APPENDIX VII cont.

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APPENDIX VIII

BANANA SURVEY

Thompson, Tucker, Palmer, Wong Chen Ta.

Enumerator: Thompson, Tucker,
Palmer, Wong Chen Ta.

Form L.

Location: JOSEPH KALOO.

Form L.

Date: 16/12/1958.

District: MONTSEAN.

Farm Number: 5/9.

Type: Peasant Holding.

Location Notes: Easily approached from Pepper village. Sign posts at the unsurfaced junction very distinct. Farmer very co-operative. Holding of mixed cocoa and bananas, with food crops in patches.

Sketch of Area.

Approx. area: 16 acres
# Appendix IX

## Banana Survey

**Farm:** 5/11  
**Line:** 3  
**Sheet:** 2  
**Form F.**

### Crop Enumeration Code

- **B.** Unidentified banana/plantain.
- **E.** Identified export variety banana.
- **P.** Identified non-export banana, fig or plantain.
- **C.** Citrus trees.
- **O.** Coffee.
- **F.** Ground provision/food crop.
- **A.** Cocoa.
- **D.** Food tree not otherwise designated.
- **M.** Cleared under-growth, NON-CROP.
- **N.** Thick undergrowth, NON-CROP.

### Grid

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<td>M B M</td>
<td>F F M</td>
<td>F F M</td>
<td>M M M</td>
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</table>

- + 25 yds.
- + 50 yds.
- + 65 yds.
- + 90 yds.
Shortage of time will not permit both a seminar group and an instructional group to be held separately. Consequently, the aim of this period is twofold. Firstly, it is to instruct in the problems that have arisen in the planning of the Banana Survey, and, secondly, to provide instruction for those who will be enumerating on the survey.

Items will be covered in the following order by the instructors indicated.

(a) The Principles of Survey Sampling in General.  
A. Denness.

(b) The Background of the Banana Industry in Trinidad, and Problems Arising.  
J.R. Bird.

(c) Drawing the Sample for the Survey.  
A. Denness.

(d) The Limitations of the Problems in the Field.  
G. Farley.

(e) The Identification of Bananas and Plantains by their Fruit.  
J.N. Auckland.

(f) The Method of Field Enumeration and Recording.  
G. Farley.

In addition there will be a demonstration, arranged by J.N. Auckland and J.R. Bird, of classes of crop other than bananas and plantains which enumerators will need to identify.

Enumeration instructions will be handed to those taking part in the field work.
INSTRUCTIONS FOR FIELD ENUMERATION

1. GENERAL.

The general and statistical background of the survey will be fully covered in the lectures given on Friday, 12th December, 1958. It should, however, be remembered that the primary aim of the survey is to estimate the density of all the plants of the genus MUSA on those estates and holdings contributing bananas for export through the Marketing Board Scheme in Trinidad.

Information is also required on other associated problems. These may be summarised as:

(i) An estimation of the percentage of Musa plants suitable for export, by an identified "export" fruit and an identified "non-export" fruit count.

(ii) An investigation of crop associations in which plants of the genus MUSA are found.

(iii) An indication of the standard of cultivation of export banana varieties, by a shoot per stool count.

2. ALLOCATION OF ENUMERATORS.

Field enumerators will be informed of their days for field recording at least 24 hours beforehand. At the same time they will be allocated a field supervisor who will arrange personally the time of daily departure and collection of meals from the Hostel. Packed lunches will be ordered centrally. All enumeration should be completed during the period of December 15th - 20th inclusive.

3. LOCATION OF SAMPLE FARMS.

Field enumerators will be taken in pairs to the sample farms by their field supervisors, who will also arrange the detail of the day's work. Although field supervisors will not be present continuously during field enumeration at any one place, periodic visits to each working site will be made by them. This should ensure that any practical problems can be dealt with in the field.

The shape of the farm and its location will be given by notes and sketch on Form L. This form also gives the farm number, district and type to identify it exactly. In addition the sample lines to be taken will be nominated.

4. FIELD ENUMERATION.

Field enumerators will work in pairs in the field, and, although their duties fall into two district types, familiarity with both duties will facilitate interchange and maintain interest. These two duties are:

(a) Line delineation by the line marker.

(b) Sample recording by the crop enumerator.

5. METHOD OF LINE DELINEATION.

This method may appear cumbersome at first, but has been developed to minimise equipment, simplify method and provide a system which will be practicable under the wide range of conditions to be found in the field.
Equipment to be used consists only of three standard survey poles. This equipment will be provided each day by the field supervisors.

The line will be laid in the general direction nominated by the field supervisor on Form L, and which he will indicate in the field.

This is done by placing the first pole, A, at the starting point and the second pole, B, 3 yards away in the direction of the line. The third pole, C, is then placed in line with A and B, 3 yards beyond B, by method of no parallax. While the line marker is placing C in position the crop enumerator will be recording from A to B. During the time he enumerates from B to C the line marker removes pole A and places it 3 yards beyond C in line with B and C by the method of no parallax. Thus enumerator and marker work stage by stage along the line together.

The placing of the poles as close as 3 yards is required to facilitate ease of the crop enumerator's job, and to ensure working accurately in thick growth. The enumerator's measuring pole may be used at first to measure the 3 yards, but practice will soon develop accurate marker estimation.

6. METHOD OF SAMPLE RECORDING.

Crop enumeration falls into four categories:

(a) Recording of genus MUSA occurrence.
(b) Banana/plantain fruit type identification.
(c) Associate crop record.
(d) Shoot per stool count of identified export variety bananas.

All recording will be done on Form F.

The sample line will be laid out as in section 5, with poles at 3-yard intervals. Carrying the 3-yard measuring pole at right angles to the line, it will be possible to record a 3-yard width, so that between two adjacent poles there are 9 squares of 1 square yard area each. It will be easy after practice to estimate mentally the division of the between-poles 3 yards into yards, but for accuracy the width of the sample line must always be measured with the measuring pole.

These squares on the ground correspond to the squares on Form F, so that each column of squares on Form F represents a sample line length of 25 yards, and the whole sheet of four columns 100 yards of sample line. By using the crop enumeration code given at the top of Form F, it is possible to record the occurrence of plants in any one square yard. Occurrence of a plant within a square yard is defined by shoot at ground level. Should a plant occur on a line it should be placed in that square in which most of the shoot at ground level occurs. A similar definition is to be applied in case where doubt arises as to whether the plant occurs in the sample width. Occurrence of the plant within the square yard is to be recorded only, not the number of such plants. Any one plant must not be recorded as being in more than one square.

7. USE OF CROP ENUMERATION CODE.

A copy of the code will be found on the attached Form F. It is a letter code designed to simplify the categories (a), (b) and (c) of crop enumeration.

For bananas and plantains, E and P should only be used if the plant carries identified fruit of an export banana variety (E) or an identified non-export banana or plantain (P).

Letters C, O and A are self explanatory. F covers such crops as cassava and tannia commonly grown in peasant holdings, and D for other food trees such as tonka bean and bread fruit.

In the case of non-crop association M and N are given to indicate undergrowth density and management. M indicates cut and cleared undergrowth, while N represents uncontrolled growth of weed plants.

Bare ground is represented by a blank square on the recording form.

8. SHOOT PER STOOL RECORDING.

This is carried out on identified export banana stools only. Where E is entered on Form F to represent such a plant the number of shoots is counted and entered alongside the letter E. Thus an identified export banana stool of 7 shoots is recorded as "7 E".

9. PEASANT AND ESTATE RECORDING.

On Form L the holding will be defined, on an area basis, into Peasant Holding or Estate, under the heading TYPE. To avoid much arduous work on estates the system of using Form F has been adapted for the two types of holding.

For a Peasant Holding the whole of the sample line, or lines, are recorded. Starting at the foot of column I and working upwards with progress of the line, 25 yards are covered. Having completed column I, the next 25 yards is recorded from the foot of column II, and so on until the 100 yards is completed at the top of column IV. Should the sample line be greater than 100 yards, it is continued on a second sheet, again working from bottom to top. On any Peasant Holding the sample lines will be numbered, and this number must be entered at the top of Form F. If any line requires more than one Form F these must be numbered with a sheet number consecutively for each line. So that on any Peasant Holding, sheet and farm numbers (from Form L) should be entered on all sheets used.

An Estate type does not require all the sample line, or lines, to be recorded. The first 25 yards are recorded as in Peasant Holding, from bottom to top of column I on Form F. The enumerators then continue marking the line in the given direction but not recording the crops until a distinct change in vegetation type occurs. At this point a note is made at the foot of the next column of the unrecorded distance covered. Another 25 yards of the new vegetation type is then recorded in this next column. During movement through the unrecorded area of crop, the 3 yard spacing of line poles can be much increased, according to crop conditions, to allow greater speed of work. In a similar way to the Peasant Holding lines a number of sheets make up a given line, and number of lines a given farm number. Consecutive numbers must be maintained.
10. FORM F AND L COLLECTION.

At the end of a day's work the line and sheet numbers should be sorted into order and all recorded work handed to the field supervisor.
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<thead>
<tr>
<th>CROP ENUMERATION CODE</th>
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<tbody>
<tr>
<td>B. Unidentified banana/plantain</td>
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<tr>
<td>E. Identified export variety banana</td>
<td></td>
</tr>
<tr>
<td>P. Identified non-export banana, fig or plantain</td>
<td></td>
</tr>
<tr>
<td>C. Citrus trees</td>
<td></td>
</tr>
<tr>
<td>O. Coffee</td>
<td></td>
</tr>
<tr>
<td>F. Ground provision/food crop.</td>
<td></td>
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<td>A. Cocoa</td>
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<td>D. Food tree not otherwise designated</td>
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<td>M. Cleared under-growth. NON-CROP</td>
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<td>N. Thick undergrowth. NON-CROP</td>
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</table>
A. Allocation of truck routes to enumeration divisions.

Red Division consisted of the Maracas route of 8 farms,
" Montserrat " " 15 ",
" Talparo " " 7 ",
and all 5 Toco " " 38 ".
A total of 68 farms.

Blue Division consisted of the Rio Claro route of 3 farms,
" Biche " " 6 ",
" Tamanas " " 7 ",
" Mayaro and Guaygayare " " 7 ",
and the 4 Sangre Grande " " 34 ".
A total of 57 farms.

Red Division was supervised by Denness and Farley.
Blue Division was supervised by Auckland and Bird.

B. Allocation of farm numbers to truck routes.

Red Division.

<table>
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<td>Montserrat.</td>
<td>9 to 23</td>
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<td>Talparo.</td>
<td>24 to 30</td>
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<td>&quot; J.</td>
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<tr>
<td>&quot; I.</td>
<td>56 to 62</td>
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<tr>
<td>&quot; G.</td>
<td>63 to 68</td>
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Blue Division.

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<td>Biche.</td>
<td>73 to 78</td>
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<td>Tamanas.</td>
<td>79 to 85</td>
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<td>Mayaro &amp; Guay</td>
<td>86 to 92</td>
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<tr>
<td>Sangre Grande Y.</td>
<td>93 to 101</td>
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</table>
APPENDIX XII cont.

Blue Division cont.  Route Number.  Farm Number.

" " B.  15.  117 to 125.

** *** *

The purpose of this report is twofold. Firstly, it outlines the development of the survey work in relation to the foco area. Secondly, it explains the reasons for the abandonment of the foco area.

1. The Land Area.

The area is situated in the extreme north-east of the island, some distance from the college. There is only one approach road from the college, and no alternative means of access. This road is via Danguo, and the latter half of the journey is over a narrow and steep road which necessitates driving slow. The journey from the college to the village of Danguo is at least two hours.

The area lies to the north of Danguo, and the Northern Range is to the south and south-west. The swampy plains and high hills of this area contrast with the flatland, sandbank east of Danguo, leading to Calero South. The low area of this land is devoted mainly to peasant gardening. The Western Range is heavily Government Forest Reserve, only the lower slopes, up to 900-1200 feet, being cultivated. West of Tome, along a narrow coastal strip, conditions for farming are difficult.

In following facilities are available in the town: radio, telephone, post-office, police station, adequate general store, and the usual offices of police, armed and marketing boards.

Additionally, there is a Government Hospital.
APPENDIX XIII.

BANANA SURVEY.

Report on the non-inclusion of the Toco routes.

On 13 January, 1959, the survey group accepted the recommendation of the Toco area supervisors to abandon attempts to include the Toco area in the survey.

The purpose of this report is twofold. Firstly, it outlines the development of the survey work in relation to the Toco area. Secondly, it emphasizes the reasons for the abandonment of the Toco area.

***

A. The Toco Area.

Toco is situated in the extreme north-east of the island, some 57 miles from the college. There is only one approach road from the college, and no alternative means of access. This road is via Sangre Grande, and the latter half of the journey is over a narrow twisting road which makes driving slow. The journey from the college to Toco takes at least two hours.

The sea lies to the north of Toco, and the Northern Range to the south and south-west. The steep slopes and high hills of this area contrast with the flatter headland east of Toco, leading to Calera Point. The low area of this headland is devoted mainly to coconut growing. The Northern Range is mainly Government Reserve Forest, only the lower slopes, up to 200-300 feet, being cultivated. West of Toco, along a narrow coastal strip, conditions for farming are difficult.

The following facilities are available in the town; radio-telephone to Port-of-Spain, petrol station, adequate general stores, and the usual offices of police, warden and marketing board. Additionally there is a Government Rest House.
B. First and Second Stage Sample.

Five of the nine Toco truck routes were drawn in the first-stage sample of truck routes. These were lettered E, F, G, I and J.

Second-stage sampling of names on these five routes gave a total of 38 farms, out of a total sample of 125 names, on 16 routes. In the second-stage sample all strata of producers were represented on all truck routes.

A summary of the distribution of numbers of total and sample names within strata is given in the following table:

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<th>STRATA</th>
<th>SAMPLING FRACTION</th>
<th>ROUTE 1</th>
<th>ROUTE E</th>
<th>ROUTE F</th>
<th>ROUTE G</th>
<th>ROUTE I</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1:45</td>
<td>A</td>
<td>52</td>
<td>48</td>
<td>72</td>
<td>56</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6-50</td>
<td>1:15</td>
<td>A</td>
<td>50</td>
<td>70</td>
<td>80</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>51+</td>
<td>1:1</td>
<td>A</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Row A --- total of route names.
Row B --- total of sample names.

One point only needs emphasis in this report arising out of the sample figures. This is the high proportion, over 50%, of names falling in the stratum of the 6-50 stem group of contributors. 55% of the second-stage sample was from this stratum, whereas in all the other districts 34% of the second-stage sample fell in this stratum. The significance of these figures is that plots in this stratum were usually difficult to find and identify: they were neither large, well known estates, nor garden plots near the peasant houses. Such plots are away from the road and most difficult to identify.
C. **Preliminary Survey Visit.**

For preliminary survey and enumeration Toco was included in the Red Division. Personal contact was made with the agricultural service field officers by myself on 8 December, 1958, with the object of commencing the preliminary survey. Out of this initial visit the following points arose.

i. **Distribution of routes.**

The five selected truck routes covered not only Toco, but the whole of the coastal strip from Toco west to Matelot. The area was served by a narrow, twisting road ending at Matelot. All these routes collected to the Toco Marketing Board office. Truck routes overlapped, in what appeared to be an arbitrary fashion. There were, however, concentrations of collection points at Matelot, Monte Vido, Sans Souci, and Toco. The distance from Toco to Matelot is only 17 miles, but an hour's drive by car.

ii. **Conditions in the area.**

Apart from the main coast road from Toco to Matelot, there are very few roads in the area. The land rises steeply from the sea to heights of between 200' to 1500'. Government Forest Reserve dominates the higher slopes of the Northern Range; only the lower slopes, up to 200' to 300', are cultivated. Rainfall is high, 90'' to 100'', and the main area of cultivation is devoted to permanent tree crops, mainly cacao.

iii. **Types of holding in the area.**

The large number of peasant holdings suggested in the sampling was confirmed by impression and discussion with the field officers. The majority of the farms are tenant farmed, and consist of areas in the range of from 30 to 120 acres approximately. There is much fragmentation. Out of the 4 farms visited on this day 2 were in 2 or more fragments. Holdings in the area are devoted predominately to cacao, with bananas as general shade, or as pockets of pure stand.
iv. Location of farms.

Of the sample names for the area, the field officers could only locate immediately 80%. They could not, however, point out on their maps of the area the extent of these identified holdings belonging to each name. The maps gave 1948 and 1953 owner names for the plots only, and none of the sample names occurred on these maps as owners. Little further assistance could be given by the Marketing Board Officer.

The field assistances could take me to where the identified names lived. This was not always on the coast road, and, of the 4 names visited on this day, 3 residences lay at least \( \frac{1}{2} \) mile off the road. It was easy enough to locate the owner, or his relatives, with the help of the field assistants. The difficulty lay in finding and defining the holdings. The residence was not always on the holding. Distances between them and the holdings were often \( \frac{1}{2} \) mile or more. In the absence of the holding tenant, locating the holdings, and defining the extent, was found to be impossible. Holdings often lay in, and mixed with, the forest fringe.

Four names of the second-stage sample were visited on this day of preliminary survey. One was located, the tenant being at his residence on the holding, and mapped to satisfaction. A second residence was visited, the tenant was absent for the day, but it proved possible to map a 3 acre fragment of his holding near the house and road. The unidentified remainder of the holding occupied some 57 acres higher in the hills. The other two farms were not mapped due to the absence of the tenant from his residence with the consequent non location of the extent of the holding, despite intensive local enquiry.

v. Accessibility.

Farms were difficult to get to. Hill paths leading from the coast road were the only means of access. These were narrow, steep and slippery. One farm of the sample could only be approached by boat.
vi. Estimate of time required.

Time was likely to be consumed in:

a. Travelling to the area.

b. Travelling in the area and locating the occupiers.

c. Moving from occupier's residence to holding, and between fragments.

d. Working on the holding.

At this time it was estimated that, with daily travel from the college, it would take 7 days to complete the preliminary survey using two people. This would require a day of from 6.0 a.m. to 7.0 p.m., less would not justify daily travel from the college. Such a day is equivalent to a time of 8 hours in the field, completing 5 or 6 farms per day. In view of location, accessibility, fragmentation of holdings, location of unknown names etc., this is not a liberal estimate.

Time travelling to the area could have been cut down by using the Government Rest House in the area. This would have given us another 2 to 3 hours each day in the field, and would have reduced the preliminary survey time to 4 or 5 days.

vii. Conclusions of the preliminary survey visit.

As a result of this information it was obvious that this area could not be included in the general enumeration, which was to be commenced on the following Monday, 15th December, 1958. Apart from the insufficiency of time to complete the necessary preliminary survey before enumeration, it would have been uneconomic to transport enumerating students each day to the area. Little hope was held of persuading any of these enumerators to stay over in Toco for several days.

Consequently it was decided to omit the Toco area from the main survey enumeration.
D. The alternative of a sub-sample.

After completion of the main survey enumeration, it was found that expenses had been high, and that further funds that could be raised would be low. The possibility of the enumeration being completed by the supervisors for the Toco area on a daily travel basis from the college was ruled out on cost alone. The possibility of using the Government Rest Houses was considered, to reduce travelling costs and increase potential hours of work in the field. It was estimated that, using all four members of the group, at least ten days in the Toco area away from college would be a necessary minimum to complete the preliminary survey and the field enumeration. Such a period away from college could not be afforded, and two members of the group were themselves still concerned with the other Division.

Results in the Blue Division had not been very satisfactory. Consequently, over the whole survey, only four of the truck routes, out of a first-stage sample of 16 routes, had been satisfactorily completed. It seemed necessary to get as many more results as possible for the minimum cost. The alternatives for obtaining information more cheaply from the Toco area, the original second-stage sample being too costly and time consuming, were as follows.

i. Take a sub-sample of the five second-stage sample routes in the area.

ii. Take a sub-sample of the total names for the area.

The first alternative could not be accepted. We had drawn the five routes in a first-stage sample from 32 routes over the whole island. Toco area in our survey was not a statistical sample unit consisting of five routes. Having drawn randomly these five routes which fell in the Toco area, we could not interfere with this sample. We could only add to the sample at the last stage, that is the list of names at the second-stage. A sub-sample of the Toco names, from the second-stage sample, would only be a further breakdown of this part of the structure to a further stage, not an interference within the sample structure. Analysis could
build our sub-sample results back to significance for the original sample names. Also a sub-sample of the whole area offered to give us more information than a sample of individual routes. It would be less accurate than the original second-stage sample of 38 names, but cheaper than this original larger sample. It was thought that, with an apparent uniformity of conditions in this area, such a sub-sample would give a fairly accurate estimate of the Toco area, whereas individual truck routes completed in the area would not.

It was estimated that two people staying in the area could survey and enumerate 10 farms in 3 or 4 days. Accordingly the second-stage sample of names of the Toco routes were pooled and a sub-sample taken from the whole.

E. Results of the sub-sample.

Arrangements were made for Mr. Denness and myself to commence this sub-sample on the 9 January, 1959, The field officers were met at Toco at 8.15 a.m.

Again we encountered the difficulties of locating the residences of the sample names. On location of residence we were confronted by the absence of the holding tenant. Holdings were not near these residences, being up to 1 mile off the road and in the hills. Fragmentation of holdings, mixture in the forest and with neighbours, indistinct access paths and poor directions made location of the holdings almost impossible without the personal guidance from the tenant.

Added to this, enumeration would take longer than estimated on experience in previous areas. The relief of the ground was not helpful, steep slopes, wet conditions and thick growth made the going difficult.

It became apparent that we must increase our estimate of the time required even for the sub-sample. This was due to two major considerations.
i. More time would be needed for field enumeration.

ii. Special arrangements must be made to meet the occupiers of holdings at specifically arranged times to facilitate accurate and definite location of holdings.

We considered that five days in the area would be required to complete the sub-sample.

F. Review of the survey at this stage.

We now considered the value of the sub-sample, and the work and time involved, in relation to the results so far obtained for the whole survey. The position was briefly as follows. The Red Division had completed the Montserrat, Maracas and Talparo routes. Blue Division had completed only one route, and conditions did not allow them to complete more. Out of the original 125 sample farms on the 16 first-stage sample routes over the island, only four routes of some 34 farms had been significantly completed. Shortage of money for completion of the Blue Division meant that the survey would remain incomplete. Rather than a full sample survey, interpretation on only four routes would give the survey a character more of that of a pilot survey. We considered that the further time, energy and expense necessary to complete the Toco area would not add to the value of a survey in this pilot form. Completion of a sub-sample in Toco area would provide information on 10 producers out of the 2,000 or more included in the first-stage sample of 16 truck routes. Little extra information would be obtained by using 4 farms rather than the 34 already completed.
### APPENDIX XIV.

Example of raising field records to holding values.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farma number</td>
<td>5/12</td>
<td>375</td>
<td>621</td>
<td>255</td>
<td>10</td>
<td>123</td>
</tr>
<tr>
<td>Line number</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Area recorded</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total area measured</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total acreage</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Notes:**
- Column 6 -- total acreage.
- Column 3 -- total area measured.
- Column 2 -- area recorded.
- Column 1 -- Line number.
APPENDIX XV.

Example of the computation to derive $Y_{it}$ and $V(Y_{it})$.

<table>
<thead>
<tr>
<th>COLUMN NUMBER</th>
<th>MATHEMATICAL EXPRESSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>$r_i^n$</td>
</tr>
<tr>
<td>2.</td>
<td>$n''_{it}$</td>
</tr>
<tr>
<td>3.</td>
<td>$s(Y_{it})$</td>
</tr>
<tr>
<td>4.</td>
<td>$\overline{Y}_{it}$</td>
</tr>
<tr>
<td>5.</td>
<td>$\epsilon_i^n S_{it}$</td>
</tr>
<tr>
<td>6.</td>
<td>$Y_{it} = \epsilon_i^n S_{it}$</td>
</tr>
<tr>
<td>7.</td>
<td>$n''_{it} - 1$</td>
</tr>
<tr>
<td>8.</td>
<td>$S(Y_{it} - \overline{Y}<em>{it}) = S(Y</em>{it}) - S(Y_{it})^2$</td>
</tr>
<tr>
<td>9.</td>
<td>$S_{1}^2 = S(Y_{it} - \overline{Y}_{it})$</td>
</tr>
<tr>
<td>10.</td>
<td>$n''<em>{it} S</em>{it}^2 = a.$</td>
</tr>
<tr>
<td>11.</td>
<td>$\epsilon_i^n(\epsilon_i^n - 1) = b.$</td>
</tr>
<tr>
<td>12.</td>
<td>$V(Y_{it}) = a \times b.$</td>
</tr>
<tr>
<td>13.</td>
<td>Standard Error $Y_{it} = \text{sq. root of } V(Y_{it})$</td>
</tr>
</tbody>
</table>
**APPENDIX XVI.**

Example to show the computation of $\bar{r}$ and $V(r)$.

<table>
<thead>
<tr>
<th>COLUMN NUMBER</th>
<th>MATHEMATICAL EXPRESSION</th>
<th>COLUMN NUMBERS FROM WHICH DERIVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>$S(y_{it})$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>$S(y_{it}^2)$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>$S(x_{it})$</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>$S(x_{it}^2)$</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>$S(x_{it})^2$</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>$\bar{r}$</td>
<td>1/3</td>
</tr>
<tr>
<td>7.</td>
<td>$\bar{r}^2$</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>$\bar{r}^2S(x_{it}^2)$</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>$S(y_{it}^2) + \bar{r}^2S(x_{it}^2)$</td>
<td>2+8.</td>
</tr>
<tr>
<td>10.</td>
<td>$S(x_{it}y_{it})$</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>$2\bar{r}$</td>
<td>6+6</td>
</tr>
<tr>
<td>12.</td>
<td>$2\bar{r}S(x_{it}y_{it})$</td>
<td>11x10.</td>
</tr>
<tr>
<td>13.</td>
<td>$Q$</td>
<td>9-12</td>
</tr>
<tr>
<td>14.</td>
<td>$n''_1 - 1$</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>$S_{q^2}$</td>
<td>13/14</td>
</tr>
<tr>
<td>16.</td>
<td>$n''_{1q^2}$</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>$(1 - f''_1)$</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>$(1 - f''<em>1)n''</em>{1q^2}$</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>$V(r)$</td>
<td>18/5</td>
</tr>
</tbody>
</table>
Table showing the total numbers for each species combining all strata and truck routes.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>TOTAL TREE NUMBERS</th>
<th>ERROR</th>
<th>± ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.+B.+P.</td>
<td>12 074 186</td>
<td>3 986 000</td>
<td>33</td>
</tr>
<tr>
<td>B.</td>
<td>8 396 366</td>
<td>1 378 000</td>
<td>16</td>
</tr>
<tr>
<td>E.</td>
<td>2 952 652</td>
<td>1 140 000</td>
<td>38.6</td>
</tr>
<tr>
<td>P.</td>
<td>692 037</td>
<td>1 000 000</td>
<td>191</td>
</tr>
<tr>
<td>A.</td>
<td>16 456 477</td>
<td>5 416 000</td>
<td>32.9</td>
</tr>
<tr>
<td>O.</td>
<td>7 500 507</td>
<td>2 234 000</td>
<td>29.7</td>
</tr>
<tr>
<td>C.</td>
<td>764 276</td>
<td>176 000</td>
<td>23</td>
</tr>
</tbody>
</table>

B. = unidentified *Musa* spp.
E. = identified export variety *Musa* spp.
P. = identified non-export variety *Musa* spp.
B.+E.+P. = total *Musa* spp.
A. = cacao plants.
O. = coffee plants.
C. = citrus plants.
Table showing the densities of recorded species, and standard errors, by truck routes.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>MARACAS</th>
<th>TALPARO</th>
<th>MONTSERRAT</th>
<th>RIO CLARO</th>
<th>TAMANA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>16±1</td>
<td>61±1</td>
<td>211±18</td>
<td>73±29</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>23±2</td>
<td>65±1</td>
<td>32±5</td>
<td>57±18</td>
<td>101±42</td>
</tr>
<tr>
<td>P</td>
<td>51±1</td>
<td>2±0.12</td>
<td>11±55</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B+E+F</td>
<td>91±1</td>
<td>135±10</td>
<td>256±25</td>
<td>129±10</td>
<td>101±23</td>
</tr>
<tr>
<td>C</td>
<td>3±2</td>
<td>1±0.2</td>
<td>13±58</td>
<td>210±26</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>10±5</td>
<td>88±9</td>
<td>18±0.42</td>
<td>33±60</td>
<td>232±36</td>
</tr>
<tr>
<td>A</td>
<td>292±8</td>
<td>244±9</td>
<td>259±43</td>
<td>260±54</td>
<td>7±6</td>
</tr>
</tbody>
</table>

Species code as in appendix xvii.
Table showing the density values, by truck route and strata, with standard errors.

<table>
<thead>
<tr>
<th>Route</th>
<th>B.</th>
<th>E.</th>
<th>P.</th>
<th>B+E+P.</th>
<th>C.</th>
<th>O.</th>
<th>A.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-5 stems. *</td>
<td>0</td>
<td>19</td>
<td>60</td>
<td>79</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>MARACAS</td>
<td>6-50 stems.</td>
<td>0</td>
<td>573±233</td>
<td>54±26</td>
<td>626±73</td>
<td>0</td>
<td>11±11</td>
</tr>
<tr>
<td></td>
<td>51+ stems. #</td>
<td>83</td>
<td>36</td>
<td>18</td>
<td>136</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1-5 stems. *</td>
<td>72</td>
<td>54</td>
<td>0</td>
<td>126</td>
<td>0</td>
<td>92</td>
</tr>
<tr>
<td>TALPARO</td>
<td>6-50 stems.</td>
<td>61±6</td>
<td>0</td>
<td>0</td>
<td>61±2</td>
<td>0</td>
<td>226±34</td>
</tr>
<tr>
<td></td>
<td>51+ stems. #</td>
<td>60</td>
<td>117</td>
<td>7</td>
<td>185</td>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>1-5 stems. *</td>
<td>201</td>
<td>32</td>
<td>0</td>
<td>233</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>MONTSERRAT</td>
<td>6-50 stems.</td>
<td>192±3</td>
<td>76±7</td>
<td>7±3</td>
<td>275±59</td>
<td>2±0.7</td>
<td>3±2.6</td>
</tr>
<tr>
<td></td>
<td>51+ stems. #</td>
<td>224</td>
<td>15</td>
<td>18</td>
<td>256</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>1-5 stems. *</td>
<td>92±39</td>
<td>46±26</td>
<td>0</td>
<td>13±3</td>
<td>311±178</td>
<td>489±175</td>
</tr>
<tr>
<td>RIO CLARO</td>
<td>6-50 stems.*</td>
<td>81</td>
<td>0</td>
<td>1/0</td>
<td>113</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>51+ stems.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1-5 stems.</td>
<td>0</td>
<td>103±47</td>
<td>0</td>
<td>103±47</td>
<td>=</td>
<td>319±50</td>
</tr>
<tr>
<td>TAMANA</td>
<td>6-50 stems.</td>
<td>0</td>
<td>102±10</td>
<td>0</td>
<td>102±10</td>
<td>=</td>
<td>79±42</td>
</tr>
<tr>
<td></td>
<td>51+ stems. #</td>
<td>64</td>
<td>51</td>
<td>0</td>
<td>115</td>
<td>=</td>
<td>140</td>
</tr>
</tbody>
</table>

# = no standard error since all farms taken in the sample.

* = "" "" "" sample taken was a one farm sample.
"This is the end of tears: No more lament."

Sophocles.