SUBJECTIVE NOTE

This dissertation is one of five students on a sample land utilization survey. Such a survey is considered an important exercise for postgraduates but is not in all respects novel. It is necessary to have a team (of five people this year) to undertake the field work, and second it is necessary to restrict the scope of the survey further artificially so that it can be completed in the time available.

In order to minimize the first difficulty certain steps were taken to minimize the possibility of an additional student. Each was required to turn his semen as though he was the senior officer responsible for the whole work. This is not the only remaining difficulty. The nature of the information collected and issued takes time for collection and some time in order to report on these facts even if the survey could be conducted in the usual manner.

In addition to the special restrictions on the survey no changes were made in the survey methods of the college. The total amount of research was assigned to the student that did most fairly according to the standards in the college that are most fairly recognized. In the case of this student the student was decided that no further steps need be taken.

The five students participating in this project have been limited to the simplest equipment and the standard types. They have not been allowed any outside labour to help them in the field or clerical assistants to help with mapping and other activities.
This dissertation is one of five reports on a sample land utilisation survey. Such a survey is considered an important exercise for Postgraduates but is not in all respects ideal project material. In the first place it is necessary to have a team (of five people this year) to undertake the field work, and second it is necessary to restrict the scope of the survey rather artificially so that it can be completed in the time available.

In order to minimise the first difficulty certain aspects of the whole survey were made the responsibility of an individual student. Each was required in turn to behave as though he was the senior officer responsible for the whole work. This student's particular responsibilities were determining and classifying the nature of the information collected and issuing "Notes for Enumerators", and he was required to report on these more fully than on others. The emphasis given to various aspects of the whole project is therefore intentionally uneven.

The supervisor imposed artificial restrictions on the survey in order to keep it within manageable bounds. The total area was restricted by him to the part of the Colony that was most easily accessible to the student; he decided that no Northern range land and none of the populous urban area along the Eastern main road should be included.

The five students participating in this project have been restricted to the simplest equipment and the standard maps; they have not been allowed any outside labour to help them in the field or clerical assistants to help with mapping and area measurements.
(I) INTRODUCTION.

(II) THE AREA SURVEYED.

(III) CHOICE OF FRAME.

(IV) CHOICE OF SAMPLING UNIT AND SIZE.

(V) TYPE OF SAMPLE.

(VI) NATURE OF INFORMATION COLLECTED.

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INTRODUCTION.

It is only in comparatively recent times, influenced by the effects of major world upheavals, the great increase in world population, and the rapid advancement of backward peoples, that the full importance of Agricultural Sample Surveys has been realized.

The events of this century have focussed attention on the ever present race between multiplying populations with their desire for higher living standards, and the ability to produce sufficient food to meet the increased demand. This has resulted in a desire to examine the major factors involved, such as, the area, yield, type and distribution of foodstuffs; the numbers of livestock; the number and characteristics of the people who secure their livelihood from agriculture; the number of agricultural holdings and their practical characteristics; the economics of food production; and the amount of extra foodstuffs needed to keep pace with the likely demands.

It was with these objects, among others, in view that the Food and Agriculture Organization of the United Nations initiated the World Food Survey (F.A.O. 1946), and a number of countries have been stimulated into carrying out Agricultural Surveys, partly as a contribution to the World Census, and partly as a basis for the furtherance of agricultural and economic development in the particular country concerned.

The recent awakening of interest in the field of Agricultural Surveys has led to the realization (Douglas and Tennant, 1952) that, although the mathematical principles of sampling surveys are well established, their practical application and the relevant field techniques in the more undeveloped countries still need considerable attention, moreover in such undeveloped countries, conditions vary so greatly, and interchange of information is often so limited, that any account of practical experience - skilled or unskilled, of failure and success - may help others engaged in the vital task of basic fact finding.

The objects of this Survey are to gain first hand practical experience in organizing a survey and supervising the work entailed, and to test some of the theories of sampling in survey work under the particular conditions...
conditions involved. As far as can be ascertained, no previous work of this type and on this scale has been carried out in Trinidad, so that this survey can claim to be unique as a first attempt in this field of land utilization.

The survey team consisted of five students under the guidance of Dr. A.L. Jolly, the project Tutor. Although the five members involved worked together as a team, as each problem was reached one of the five was detailed to supervise its solving and on these occasions the other four were treated as assistants and subordinates. The object of this was to give each person training and experience in supervising the work entailed in the survey. It was realized that the intelligence and integrity of the assistants in this case was probably much higher than would normally be the case, but as far as possible the supervision was carried out on the assumption that the assistants were of low intelligence. Hence every effort was made to explain each step as simply as possible so that even very unintelligent assistants would have no difficulty in understanding and carrying out the instructions.

It was realized from the beginning that the time available for carrying out a worthwhile survey was very limited, the only time available for the main field work being during the Christmas vacation, so it was decided that the survey should be planned in detail before that time so that everything would be ready for a few weeks concentrated field work during the vacation. With this end in view, frequent discussions were held to decide on policy and to organize the work.

The limited time available had an important bearing on many aspects of the survey which will be mentioned in due course, and at an early stage it was decided that this would have to be purely an experimental survey, that it should be carried out as accurately and extensively as the time allowed, but that the actual practical value of the final survey figures should take a position of secondary importance to the practice and experience in survey methods obtained. In any case absolute truth is seldom the object of this kind of survey, generally what are required are working estimates, although they must be sufficient and accurate in relation to the use made of them.
THE AREA SURVEYED.

One of the early questions to be answered was that relating to the possible scope of the survey, and this was one of the aspects of the problem that was largely limited by the time and money available.

It was decided to concentrate the work where the most work and information, per dollar spent and time occupied, could be obtained; and, moreover, to try and survey an area which would give some idea of as many aspects of agricultural land utilisation in Trinidad as possible. These stipulations limited the area chosen to the Northern half of the island, so as to be within easy reach of the survey team based at the College.

The Northern Range was excluded from the possible area involved, as being very expensive in time and money, less representative from the agricultural viewpoint than the plains, and because of the possibly greater difficulty of obtaining in it a representative sample. In any case it may generally be said that similar basic problems confront the upland agriculturalist as the lowland agriculturalist only in a more acute form.

The decision was also reached for similar reasons of agricultural interest, time and money, to avoid large townships, and in fact the final area was chosen so as to exclude the heavily built-up strips along the Eastern Main Road.

After considerable deliberation the area to be used for the survey was demarcated as being enclosed in an approximate rectangle bounded by the Churchill-Roosevelt Highway to the North; the Princess Margaret Highway, Madame Espagnole River, and coast line as far as the mouth of the Couva River, to the West; the road through Couva, Gran Couva, Flanagan Town and Mamural, to the South; and the road from Mamural through Mundo Nuevo, Talparo, Brazil, San Rafael and Guanapo, to the East. (Appendix A).

The area is about 112,650 acres or 176 square miles in extent.

With its Western edge bordered by the Caroni Swamp and the sea, about two-thirds of the area is flat and under 100 feet above sea level. The South East corner, however, rises towards the Northern face of the Montserrat Hills up to about 400 feet, and an isolated high point of 582 feet is reached at Pepper Village.
The soil is mostly humic gleys with impeded drainage and of low productivity, changing to non-calcareous perched gleys with the increase in altitude. There are also patches of alluvial soils and various podzols all of medium to low productivity, and there is a very small isolated pocket of Brown Forest Soil with a very high productivity grade, situated at Pepper Village.

The rainfall varies from about 50 inches per annum in the West of the area to about 90 inches per annum in the East, however the effective rainfall is more likely to vary between 40 and 70 inches per annum. The Western part of the area undergoes a marked, and sometimes intense, dry season of from 2 to 6 months, and the Eastern part undergoes a weak dry season of about 1 month.

The natural vegetation of the area varies from a strip of mangrove woodland in the North West through central strips of deciduous seasonal forest and semi-evergreen seasonal forest, to evergreen seasonal forest in the East, with a small area of natural savannah in the North.

As this is a land utilization survey it would be out of place at this point to discuss the crops grown, except to say that a large amount of the flat land is under sugar cane cultivation and cocoa occupies a position of importance on the higher land, both of these crops having the effect of greatly restricting visibility at eye level.

(III) CHOICE OF FRAME.

It is important that the sample units in a survey can be clearly and unambiguously defined, and in order to make this possible the existence or construction of some form of frame is essential. The whole structure of a sampling survey is to a considerable extent determined by the frame upon which that survey is based. Consequently, until particulars of the nature and accuracy of available frames have been obtained, no detailed planning of the survey can be undertaken.

Some suggestions as to possible frames were put forward only to be rejected as unsuitable for various reasons. For example, use of the latest official 1946 Population Census of Trinidad was suggested but rejected because it is out of date and because the difficulty of contacting the
people chosen at random from the census, and thus of obtaining their co-operation, would have been considerable. The use of a list of villages was suggested, and where one has to contend with literate but poorly trained staff for field work who are likely to be more familiar with villages than with map divisions used in the case of area sampling, the use of villages as first stage sampling units is probably better than the use of maps and areas. However the use of villages is completely unsuitable in Trinidad where land is cultivated without obvious boundaries, villages are not demarcated, and it is often impossible to decide to which village a particular individual owes allegiance and to assign every piece of cropped land, without question, to a particular village. There was the further difficulty that use of village lists would lead to the necessity of interviewing the inhabitants, and it was finally agreed that the construction of the frame should not require the contacting of the local population, but that it should be built on material facts that could be examined and measured on the ground by the surveyors.

It was finally agreed that the frame should take the form of a map of the area to be surveyed. The map used was the 1926 Official Government Map of Trinidad, with a scale of 1:50,000 or 1.27 inches to 1 mile. Some difficulty was encountered later because of the age and inaccuracy of the map and numerous corrections had to be made from field observations as discussed in section (VIII), but in spite of these faults, the map was definitely the best frame available.

(IV) CHOICE OF SAMPLING UNIT.

From the start it was decided that some form of sampling would be used in this survey, as that was the only way in which a survey of this size could have been undertaken with the personnel, time and money available. Moreover, a complete survey method for large scale survey work is scarcely possible in the Colonies where there are usually so few suitable staff members compared with the large areas to be covered. It may be said (Douglas and Tennant, 1952) that correct statistical sampling economises staff and resources, keeps down expenditure, adjusts the statistical work to the areas and distances to be covered, and enables relatively few trained ...
trained field officers to specialize in overcoming local ignorance and prejudice. The important fact about a scientific sampling survey is that, when completed, the results can be stated to be correct within a particular error.

The choice of a sampling unit was discussed and the following possibilities were examined: (1) A grid system or grid lines on the maps which, although theoretically possible, would be impracticable owing to the labour involved in the unproductive work of identifying the lines and points on the ground. (2) Line sampling was suggested but it was decided that it would be too difficult to accurately take a line on a given bearing through such things as dense high bush and sugar cane without having traces cut out, an extremely slow, expensive business, which in any case, would not be tolerated by the landowners. (3) It was finally decided to take land areas as the sampling units, the units being bounded by features shown on the map that could be recognised on the ground, and the division of the survey area into suitable units was undertaken.

The method used was to divide the area to be surveyed, into as many sampling units as possible, with a minimum size of ½ square mile; if the units had been smaller then this it would have become difficult to draw sufficiently accurate enlarged maps of such small areas from the comparatively small scale map used for the frame. As far as possible, only features on the map that could be easily found in the field such as, 1st and 2nd class roads, and railways, were used as boundaries for sample units. Any doubtful boundaries were investigated in the field before being used.

(V) TYPE AND SIZE OF SAMPLE.

Multi-stage sampling was suggested in order to help reduce the sampling error (Yates, 1953) and, as it was considered to be rather a waste of time making a detailed map and survey of the first stage sample and then only using, say, 25% of it, it was agreed that a 100% sample of the second stage sampling units should be taken. This plan was however, difficult to put into practice because of the difficulty of dividing up the first stage.....
stage sample units in the field, and when this was tried in a sugar cane area it was found that the vegetation obscured all points on which sights might have been taken. Eventually the problem of dividing the sample units into sub-units was overcome on the enlarged unit maps in the office by taking, at random, a number of compass bearings, the first of these bearings giving the angle of the straight line which was to divide the unit equally in half, the second giving the line equally dividing each half, and so on until 16 sub-units, of roughly equal size, within each unit, were produced from each original sample unit.

The size of the first stage sample to be taken was the next question to be considered and in order to increase the accuracy of the overall estimates and ensure that subdivision of the area which were themselves of interest were adequately represented, a stratified sample (Yates, 1953) was taken, and the total sampling units were divided into two strata before the final sample was taken. After some deliberation the strata to be taken were laid down as being firstly cane and arable lands, and secondly bush and plantation lands. This stratification had the advantage of automatically giving an upland, lowland division, and some degree of sample unit size division, as the bush and plantation area tended to be on the uplands and composed of larger units than the others. The demarcation of the strata was fairly easily undertaken from the map and from the then rather small knowledge of the area, and it resulted in there being 16 units, a total of 31,460 acres, in the bush - plantation stratum and 92 units, with a total area of 81,186 acres, in the cane - arable stratum. Eventually 10 sample units to be surveyed were chosen, using tables of random numbers, out of the total 110, which resulted in a sample of 1/11th of the total. Of these, 6 were taken in the cane-arable stratum and 4 in the bush-plantation stratum. It was thought that the estimates of the bush-plantation area would be less accurate than those of the cane-arable area, because of the former's rough vegetation, terrain and larger sized units, and it was agreed that at least four sample units should be taken in this area because of this, and because of the likelihood of great variability between units. However, the greater number of sampling units, six as against four, was allocated to the cane-arable stratum because this
was considered to be generally the more productive area of the two and therefore of greater agricultural importance, and because of the very much greater number of units in this stratum than in the other.

In order to evenly spread the work and responsibility, two sample units were allocated to each member of the survey team and each member was then responsible for organizing and supervising all further work on those units.

The individual sample unit sizes were:

1. Cane-arable stratum.
   - Unit No. 49: 536.0 acres
   - Unit No. 71: 718.9 acres
   - Unit No. 13: 745.3 acres
   - Mean size = 917.1 acres

2. Bush-plantation stratum.
   - Unit No. 110: 1199.0 acres
   - Unit No. 76: 1575.0 acres
   - Mean size = 1916.2 acres

It is of interest to note that average size of the sample units in the bush-plantation stratum is over twice that of the sample units in the cane-arable stratum. The fact that the stratification chosen gave a sample unit size division has already been mentioned.

A summary of the information mentioned in the preceding section is as follows:

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Cane-arable</th>
<th>Bush-plantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area (acres)</td>
<td>81,186</td>
<td>31,460</td>
</tr>
<tr>
<td>Area of sampling units (acres)</td>
<td>5502.4</td>
<td>7664.9</td>
</tr>
<tr>
<td>Area sampling fractions</td>
<td>1:14.8</td>
<td>1:4.1</td>
</tr>
<tr>
<td>No. of units in stratum</td>
<td>92</td>
<td>18</td>
</tr>
<tr>
<td>No. of units surveyed</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Unit sampling fractions</td>
<td>1:15.3</td>
<td>1:4.5</td>
</tr>
</tbody>
</table>

This shows clearly that, although a fewer number of units were surveyed...
surveyed in the bush-plantation stratum than in the other, a greater sampling fraction was achieved in relation to both the number of units surveyed and their area. The reasons for this have been explained earlier.

(VI) NATURE OF INFORMATION COLLECTED.

As has been explained before, this survey was essentially experimental, and so was more important in itself than for the results obtained from the information collected. However, forgetting for a moment that this was an experimental survey, and taking a wider view, it is obvious that the detailed problems which arise in deciding what information is necessary and how it can best be obtained vary widely in surveys covering different fields of enquiry, but there are certain general points that cover almost all cases (Hunt, 1952). Basically the problem is essentially that of selecting the most relevant items of information from all those which it is practicable to collect and which might have a bearing on the matters under investigation.

The first step is to determine the details of the information required to deal with the problems originally propounded, then should be considered the possibility of important related problems on which this information, possibly supplemented to some extent, would throw light. The details would vary greatly in different types of survey, but the essential thing is to see that the items of information collected form a rounded whole covering a definite subject or coherent group of subjects.

It is important that the survey should have a clear purpose which is understood by the field investigators. If the field investigators are not imbued with a sense of the importance of their work, and are overloaded with the collection of miscellaneous data, they cannot be expected to give of their best, thus the collection of information unconnected with the main survey should generally be avoided.

It was the writer's duty to decide on the nature of the information to be collected in this survey, and it was decided, on account of the limited time available for field work, to obtain all the information required without having to rely on the information of the landowners. It was realized that anything requiring contact with the people and relying on their information
needs a great deal of time and patience, and even then is often inaccurate and unsatisfactory. On the rare occasions that local information was sought, for example, to find out if a particular piece of cane was estate cane or farmers cane, it was treated with the utmost scepticism, and checked before being used.

Having decided to obtain the information required by observation and physical measurement, a number of points had to be considered when reviewing the practicability of obtaining that information. Firstly it was necessary to be sure that the observations desired were within the competence of the enumerators; secondly that the information could be satisfactorily collected in the time available. Also to be considered were the best methods of making measurements and observations and whether the owner of the surveyed areas would permit the observations to be made.

One of the objects of the survey was to test the practicability of the methods used and so the first three considerations could not be answered until at least some experience in the field had been obtained. The last consideration was overcome by writing to all owners of private lands within the survey area, explaining the reason for the survey and that no damage to land or crops would result from it, and obtaining their consent. Luckily in the area chosen most of the private land was owned by a few large companies and estates, so that a minimum amount of writing had to be done.

Tentative suggestions as to the type of information that might be collected were put forward. The possibility of a housing survey was rejected as not being closely enough connected with agricultural land utilization; it was thought that questions of erosion and drainage would be too difficult to accurately observe and record; soil fertility was suggested but the lack of accurate standards made this unsuitable from the general survey point of view. Information on yields of crops and numbers of livestock was considered to entail too much work and time spent, for example, in measuring the yields or finding and counting the cattle; and for the same reasons it was considered important to avoid all subjects which vary at different times of the day, for instance, a survey of the use of the heavy digging fork might not be suitable because this implement might be used extensively in the cool of the early morning and not at all later ...
later in the day when the investigators were making their observations.

Finally the decision was reached to limit the information collected to actual areas that could be measured on the ground, and keeping strictly to this ruling the definitions of the classes of information to be measured in the survey were drawn up together with the instructions on measurement and recording to be followed in the field.

(VII) NOTES FOR ENUMERATORS.

It is considered that this section is one of extreme importance in the survey, and consequently, instead of placing a copy of the notes issued for the guidance of enumerators, in the appendix, it is proposed to insert them in this section and then to comment on them individually. It was the duty of the writer to draw up these notes and classifications, and each of the field enumerators was issued with a copy.

NOTES FOR ENUMERATORS.

1. For the purpose of this survey the land utilization divisions will be as follows: -

Cultivated land (1. Crops in the ground. 2. Obvious signs of crops having been in the ground during the last 4 months. 3. Obvious signs of cultivation and tillage of the soil): -

SE. Estate sugar cane.
SG. Good farmers sugar cane.
SB. Bad farmers sugar cane (less than 50% cane, rest bush & weeds).
R. Rice (stools showing rice has been planted this year).
F. Short term food crops (tannia, cassava, sweet potatoes, pigeon-peas, tomato, plantain, etc.)
CN. Coconuts (in stands of ½ acre or more).
O. Orchard crops (cashew nuts, tonka beans, pineapples, etc. in stands of ¼ acre or more).
C. Citrus (in stands of ½ acre or more).
CO. Cocoa, bananas and coffee (separate or mixed, cutlassed and generally looked after).
T. Pure stands of timber trees.

Uncultivated land (land not satisfying any of the requirements of cultivated ...
cultivated land):—

HB. High bush (majority of vegetation above 6' in height, including bamboo and abandoned cocoa fields).

LB. Low bush (majority of vegetation under 6' in height, including bush grazing).

W. Rivers (10' or more wide) and swamps (over 50% sedges, rushes or swamp plants, otherwise grazing).

G. Grazing (main stand of grass).

NA. Non agricultural use (roads, railways, factories, etc.)

U. Urban areas (lines of houses and gardens of less than ½ acre per house, with a density of at least 2 houses per 100 yds., also built up areas, villages, etc.)

2. As each portion of an area is surveyed the method in which the land is utilized should be recorded under one of the headings given above.

3. The area and shape of the recorded portion should be drawn on the map as accurately as possible.

4. Further detailed remarks and observations should be added beside the record or in the map margin, i.e. the type and mixture of short term food crops; the type of orchard crops; cocoa, bananas, coffee separated or mixed; roads; gravel surface or pitched.

5. If the enumerator is unable to decide under which heading to place a particular portion of land, the supervisor should be consulted, or, if the supervisor is unavailable, the portion of land in question should be measured, drawn on the map and an accurate and detailed description of it entered in the map margin.

6. For the purposes of recording in the field, enumerators should use the symbols given beside the headings in section 1. For a further division between, for example, different patches of short term food crops, the symbols should be numbered in order, i.e. F1 F2 F3. Further notes in the map margin can then be made with reference to these symbols.

7. All measurements should be recorded in either feet, yards or miles depending on the circumstances. In each case the measure used should be clearly indicated.
8. The boundary of each sample unit should be taken as the centre of the boundary road, river or railway. Thus if the boundary road is 25 feet wide, the entry made by the enumerator on the map will be half that, or $12\frac{1}{2}$ feet.

9. Isolated peasant holdings should be ignored if they are less than $\frac{1}{10}$ acre in size.

10. Enumerators should remember to make a record of everything they see that has any bearing on the actual utilization of the land. It is better to record too much than too little. All drawing and recording should be done legibly and with a sharp pencil.

Besides the "Notes", each enumerator was issued with a 9"x14" board with fixed paper clip. An abbreviated key to the coding letters used for the land utilization items and a diagrammatic scale to show sample sizes of areas on the enlarged working map, were stuck to the face of the board (Appendix D). A pencil, rubber, prismatic compass, protractor and surveyor's field note book was also provided, and each enumerator was given a letter (Appendix E) showing his authority and purpose for being on the land.

It is felt that the notes for enumerators are self-explanatory, and they were, in fact, purposely made very detailed in an attempt to cover all possible points of uncertainty or ambiguity.

It was not possible to subject the classification rules to a preliminary trial in the field and indeed the first day of field work was approached with a feeling of trepidation, being in effect a trial in itself, however, although all the planning and classification work had been done in the office and with only a little knowledge of possible obstacles that might be met in the field, it proved practicable and successful in all cases.

There are a number of possible limitations in the classification chosen that may be pointed out, and the method as a whole might be said to require field enumerators with some degree of intelligence. Examples of the limitations of the land utilization divisions are, firstly, that only good pure stands of coconuts, grown as a definite crop, were included under the heading of coconuts, and this resulted in the exclusion of a great many coconut palms on abandoned estates, and the like, which were doubtless...
regularly relieved of their crop of nuts by the local population but which were only of secondary importance, the majority of the land being cropped with, say, annual crops or bananas, or simply left to revert to high bush. Secondly, it is obvious that by limiting the orchard crops recorded to those of ½ acre stands or more, and likewise citrus in at least ½ acre stands, there were a number of orchard and citrus trees left out of the survey figures. In each case the limitation was set so as to include all land growing the trees in question as a definite crop and exclude the rest. Thirdly, isolated houses and peasant holdings covering less than 1/10th of an acre of land were considered insignificant enough to be ignored. Fourthly, the fact that cocoa, bananas and coffee were placed under the same heading; this was done because of the common practice in Trinidad of growing these three crops in mixed stands and the difficulty and time necessary to divide them up. Lastly, it may be argued that the estimate of grazing is inaccurate because it lumps together true pastures and roadside grazings, and, in some cases, grass that is not used for grazing, and ignores bush grazing, which, for convenience, is included under the heading of low bush. These criticisms may be met by pointing out that this survey covers a wide field, taking as it does, the whole of the land utilization in the area examined. Definitions have to be made in all surveys and consequently there is always bound to be a minority that is left out of the survey.

It was considered profitable to give the field investigators an opportunity of making general remarks on special points, and it was for this reason that the fourth note for enumerators was included. It was thought that, although such extra observations would not easily lend themselves to exact analysis, they might be of considerable value in drawing attention to relevant facts not covered by the main divisions of classification.

The fifth note was probably one of the most important, as occasions arose when the field worker could not decide on the exact designation of an item, and a second opinion from the supervisor, either on the spot or later from the written and verbal description, was extremely useful.
It was originally intended that all additional notes should be made in the map margins of the enlarged maps that were used in the field, but some workers preferred to use the surveyors note books that were also provided, and this was not discouraged although it meant that the pages had to be torn out as each unit was completed, and carefully filed with the appropriate map of the unit.

On account of the map scale used, it was found convenient in practice to use yards as the most common measurement of distance, and this was normally done by pacing.

It is possible that note number ten should have been reworded, because although it was perfectly satisfactory for the field workers used in this survey, it is thought that a certain class of enumerator might interpret it incorrectly and spend too much time making careful, detailed records on subjects of minor importance and not enough time dealing with the main items of the survey.

(VIII) MAPPING.

As has been mentioned earlier, it was decided to use the Official Government Map of Trinidad as the frame for the survey, and the first mapping task was to plot in the Churchill-Roosevelt Highway which formed the Northern boundary of the area to be surveyed, and also the new Princess Margaret Highway leading South. The Official Map has a scale of 1.27 inches to the mile, which meant that it was necessary to draw enlarged maps of each of the sample units chosen at random for the survey. This enlargement was done in the office before the field work began and sufficient copies of the enlargements were made to allow one to be given to each of the field enumerators. The Government Map was enlarged 6.3 times, by use of dividers, and plotted onto graph paper, producing a final working map with a scale of 8 inches to the mile. This scale was purposely chosen to allow easy plotting of distances and areas in the field, as it meant that each of the smallest squares on the graph paper represented 22 square yards or 1/10th of an acre, and so ten of them represented an acre of land.

The sample unit outline and main features only, were plotted onto the working maps, the rest being added by the enumerators in the field.
Even then a number of changes had to be made due to the original Government Map, which was the result of a field survey carried out in 1920-25, being out of date, and often apparently inaccurately surveyed in the first place. In particular, the course of the Caroni River was found to have altered considerably in the last thirty years.

Originally the decision was reached to only allow the use of the Official Government Map and such enlargements as could be made from it, for the survey work, as it was thought that this would simulate conditions in the more undeveloped Colonies. Later, this ruling was altered, and although the frame, the main work of the survey and all the work on the majority of sample units, was undertaken from the Official Map, in a few cases aerial and sugar estate maps were examined and this actually afforded a means of gaining much useful experience. The estate maps, in particular, were never used for the survey work without their accuracy being carefully checked on the ground, and it was remarkable just how inaccurate these maps were in some instances.

The aerial photographs were found to be extremely useful for reploting the altered course of rivers, but otherwise tended to be slightly outdated and rather difficult to translate for the purposes of this survey. However, on account of the increased attention shown to aerial surveys in recent years, it is of interest to note the following (Hunt, 1952).

"Speaking generally, an aerial survey will give more information about vegetation types, their distribution and topography generally, per pound spent, than any other method of investigation, however, (1) under present conditions much of the information may not be of immediate use; (2) for large areas absolute costs are high; (3) the equipment required is expensive, specialized and capable of operation only under comprehensive organization of ground and air operations; (4) accurate ground or radar control is necessary, the former demands considerable resources, the latter, specialized equipment and organization. The work must be so planned that such equipment is used to capacity whenever it is in operation, thus limiting the scope of ad hoc studies of critical areas and favouring full coverage of the whole area in sequence at constant scale." Thus, it is unlikely that aerial surveys will lessen the importance of ground surveys for some considerable time to come, if ever.
(IX) FIELD PROBLEMS.

It has been found (Hunt, 1952) that in the Colonies, partly because their agriculture is less standardized and partly because direct contact with cultivators is less easy, the work of the field enumerator plays a much more prominent part in agricultural statistical studies than in more highly developed areas. For example, there is the difficulty of accurately recording crop acreages where practically all crops are grown mixed in plots with very ragged edges, and under a system of shifting cultivation.

The recording technique used in this case, as has been explained previously, was to provide the enumerator with an enlarged map of the area, upon which he made notes and plotted the outlines of the cropped patches. When completed these were returned to the person in charge of the unit, for the compilation and interpretation of the data collected.

For the purposes of this thesis it is proposed to discuss the particular problems that were encountered in the two sample units which were surveyed under the supervision of the writer, and it is felt that the field problems met with on these units give a good idea of the general field problems encountered during the full course of the survey.

Taking each unit in turn. Unit 49 was a flat, triangular area of 536 acres, with roads on two sides and a railway on the third, and fairly well broken up internally by traces which were not shown on the initial map.

This was the first unit to be surveyed, and in the absence of a pilot survey, was consequently very much of a test case. There was always the possibility that the method of surveying would prove impracticable, and after the first day of surveying, when only about two-thirds of this comparatively small unit had been covered, it was seriously thought that this later possibility might be true. However, it was realized that in spite of its small size this unit represented very much more work than many of the larger units. The reason for this was the nature of the land utilization in the unit.

The main time consuming problems of the unit were as follows. As can be seen from the map (Appendix B), the unit, particularly at its north
end, is highly and haphazardly subdivided into small irregular sized plots of different crops, and even the southern end, which is mainly taken up with bush, has an irregular pattern of plots all round its edge; this particular portion was made more difficult by the numerous paths leading from roads and the railway into the bush, all of which had to be followed to their end, and all of which led to such objects as a single wild orange tree, a few abandoned coconut palms, or were simply paths to allow firewood and building materials to be collected. All this led to a great deal of time spent in carefully covering the ground, and also a great deal of time spent in positioning and sketching the individual plots on the map.

The question of accurately positioning and sketching the classification items was a considerable problem in this unit, where mapped landmarks were few, and it was soon realized that the use of a prismatic compass and protractor for drawing in the major paths, traces and field edges was essential. For example, after the first day it was found that some overlapping of work had occurred and it was interesting to note that without the use of a compass and protractor a major trace had been plotted as running directly North-South in one case, and 20° East of North in the second case, while in actual fact the trace should have been drawn at an angle of 35° East of North. At the time these errors led to great inaccuracy of all the other plotting in that area, being as it was, based on this trace. Following this lesson, the protractor, and more particularly, the prismatic compass were used continuously.

A further time consuming problem of this unit was due to the amount of urban area it contained, and the measurement of urban areas generally, was found to be a tedious job, particularly as their presence tended to result in there being a great number of small food plots in the vicinity.

Initially the four enumerators were split into two pairs for field work, with one sketch map per pair, but it was soon realized that this was not the best method of working, and after that each of the enumerators and the supervisor, five in all, were provided with a separate map and piece of the sample unit to plot, meeting either at midday, or at
the end of the day to compare notes. It was found that this method increased the speed of working considerably, and in any case, as they gained experience, the enumerators were able to increase their speed of working a great deal.

Unit 56 (Appendix C) was a complete opposite to the unit just described. It was twice as big, being 1147 acres in extent, flat as before, but covered by a single crop - sugar cane, in large, fairly regular fields. Its problems were also very different ones to those of the previous unit discussed. In the first place the only accurate boundary of the unit that was shown on the Official Government Map, was the railway line along its shortest side. The position of the Caparo River was found to have altered considerably since the map was produced, and its course was eventually re-plotted from an aerial photograph of the area. The traces shown on the Official Map, forming the western and southern boundaries of the unit, were found to be extremely inaccurate, and had to be re-plotted from an estate map and an aerial photograph, followed by a visit to the area itself.

The next problem encountered was that in spite of the size of the unit, the only place it could be directly reached by road was at its extreme eastern tip; this meant that, while the survey work itself was comparatively easy, a great deal of time was spent simply walking to the various sections of the unit.

It was necessary for the supervisor to make two or three visits to the unit before the actual surveying started, in order to accurately plot the unit boundaries, and during the course of these visits it was found that the whole unit was under sugar cane, with, apart from the grass on the traces, little else to enumerate. On account of this, it was decided that nothing would be gained by spending time mapping all the traces and fields in the unit, and so a complete map showing all the traces in the unit was drawn from the estate maps, and the supervisor and one assistant spent a day on the unit checking the accuracy of the estate map data. A number of inaccuracies were found, the main ones being that the estate maps gave no indication of the amount of land taken up by traces or bush; the plotting of the Caparo River and the area of some of the cane fields
was inaccurate; and the estate maps frequently showed full traces where, in fact, there was only a division of fields. These facts were corrected by the enumerators concerned, and they were undoubtedly saved a great deal of routine mapping work by being able to refer to the estate map.

(X) COMPILATION OF DATA COLLECTED.

The individual maps and notes of the enumerators were collected by the supervisor for the particular unit in question, and a completed map of the unit was plotted from the various sections, graph paper again being used. The areas under the various land utilization divisions were then added up by simply counting the number of small squares occupied by each division and dividing by ten to give the answer in acres. In the case of roads, traces, rivers, railways and grass verges, this technique was not possible, and the acreages under these items were calculated separately from the notes, showing widths and lengths, made by the enumerator.

At this point it was decided that in order to provide a greater number of samples, and thus reduce the sampling error, each of the units should be further divided. It was decided that, as it had been impossible to have the original units of equal size, there was no point in having these further divisions of equal size, and so it was agreed to make an equal number of divisions per sample unit, the divisions or sub-units within each sample unit being roughly the same size, but different in size to the sub-units within other sample units. The method by which the sample units were divided into sub-units has been described in Section (V), and when this division was completed the areas under the various utilization divisions were calculated, as before, for each of the sub-units.

The results obtained for units 49 and 56, and their sub-units are given in Appendix F.
It was first of all necessary to estimate the totals, and then the sampling error for each of the land utilization divisions. The variability in size of the units was obvious, but the variability of land utilization within the units was not immediately apparent, and the Ratio Method of estimating crop totals (Yates, 1953) appeared satisfactory. However when tried, it was found to be unsatisfactory because the unit ratios varied so widely, and another less laborious method was eventually used to estimate both the utilization totals and the sampling errors. This method is described by Yates (1953) as an example of the estimation of total areas and sampling errors when there is a stratified random sample with possibly unequal variances within strata, and it may be briefly described as follows. The method consists of determining the variance of the sample total by adding the variances of the strata totals. These variances being obtained by multiplying the sum of squares by $n_1(I - f_1)$ - where $n_1$ = the number of units in the stratum, and $f$ = the sampling fraction - and by the square of the raising factor. Then the square root of the sum of the variances gives the Sampling Error.

The determination of the best method of analysis was based on calculations using the Estate Sugar acreages, as it was considered that this was the most prominent and probably most important crop in the district.

Using only the original 10 sampling units, the Sampling Error for Estate Sugarcane was calculated to be $\pm 15870.0$ acres in a total estimated acreage of 38,660.9 acres, this being an error of 35.7%, which was considered too large an error for the acreage estimate to be at all reliable. In an effort to reduce the Sampling Error, the number of sample units was increased by artificially dividing at random, each of the 10 original sample units into 16 sub-units, by the method explained in Section (V). This meant that the total number of units was 160 instead of 10.

With 160 sample units, the Sampling Error for Estate Cane was found to be 9.4%, which meant that the estimate, although still not highly accurate, was accurate enough for many purposes.

Each of the survey team members was then given three land utilization divisions in order to work out their Sampling Error (Appendix G ...
G) and the results obtained, given to the nearest whole number, were as follows:

<table>
<thead>
<tr>
<th>Land utilization division</th>
<th>Estimated Total (acres)</th>
<th>Sampling Error + or -</th>
<th>S.E. as percentage of Est. Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Cultivated Land:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estate Sugar cane</td>
<td>38,661</td>
<td>3,643</td>
<td>9</td>
</tr>
<tr>
<td>Good farmers cane</td>
<td>7,385</td>
<td>4,699</td>
<td>64</td>
</tr>
<tr>
<td>Bad farmers cane</td>
<td>1,114</td>
<td>266</td>
<td>24</td>
</tr>
<tr>
<td>Rice</td>
<td>3,783</td>
<td>826</td>
<td>22</td>
</tr>
<tr>
<td>Short term food crops</td>
<td>2,509</td>
<td>398</td>
<td>17</td>
</tr>
<tr>
<td>Coconuts</td>
<td>22</td>
<td>21</td>
<td>98</td>
</tr>
<tr>
<td>Orchard crops</td>
<td>242</td>
<td>90</td>
<td>35</td>
</tr>
<tr>
<td>Citrus</td>
<td>1,140</td>
<td>355</td>
<td>31</td>
</tr>
<tr>
<td>Cocoa, bananas and coffee</td>
<td>3,083</td>
<td>549</td>
<td>18</td>
</tr>
<tr>
<td>Pure stands of timber trees</td>
<td>7</td>
<td>14</td>
<td>218</td>
</tr>
<tr>
<td><strong>2. Uncultivated Land:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High bush</td>
<td>36,966</td>
<td>4,421</td>
<td>12</td>
</tr>
<tr>
<td>Low bush</td>
<td>4,914</td>
<td>1,058</td>
<td>21</td>
</tr>
<tr>
<td>Rivers and Swamps</td>
<td>1,480</td>
<td>327</td>
<td>21</td>
</tr>
<tr>
<td>Grazing</td>
<td>7,100</td>
<td>727</td>
<td>10</td>
</tr>
<tr>
<td>Non-agricultural use</td>
<td>972</td>
<td>154</td>
<td>14</td>
</tr>
<tr>
<td>Urban areas</td>
<td>3,168</td>
<td>660</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total area</strong></td>
<td>112,646</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From these results it is clear that insufficient accuracy was obtained with the method used, and more effort should have been made, when planning the survey, to devise means of reducing the sampling error due to the high degree of variability between the sample units.

These results do however, show a number of interesting points, for instance, the surveyed area has turned out to be almost half made up of land coming under the heading of uncultivated, the area estimates being 58,046 acres cultivated land and 54,600 acres unclutivated land, a finding which may show that there is no land shortage in the area surveyed, and on the other hand may show that much of the land cannot be economically cultivated.
Sugarcane, about 77% of which is Estate cane, is shown to be the main crop grown, and in fact takes up about 79% of the cultivated land area, while the next largest crop grown, which is rice, only covers about 6% of the cultivated area. It is interesting to note that the crop - rice, covers a greater area than all other short term food crops put together, showing perhaps the importance of rice as a carbohydrate food in the diet of the people.

The figures show that the amount of land taken up by exportable commercial crops rather than direct consumer crops is considerable, for instance, the two main export crops - sugar cane and cocoa - cover about 84% of the cultivated land in the area, while the short term food crops and rice between them only cover 10% of the area.

It is perhaps encouraging to find that only about 12% of farmers cane has been marked down as bad cane, and it seems likely that many of the farmers have copied the example in cane growing and management shown by the estates.

In the uncultivated land area the results are perhaps more as one might expect; the division high bush covers about 74% of the area, a considerable amount, and the next largest division, grazing, covers 14%; urban areas cover about 6%, rivers and swamps 3%, and the division non-agricultural use, 2% of the uncultivated area.

(XII) CONCLUSIONS.

It may be said that the practical value of the results of this survey is not great for two main reasons; firstly, the area surveyed, while being fairly representative of the northern cane-lands, is not representative of the bush and plantation lands, because the whole Northern Range has been excluded, and only a comparatively small section of the bush and plantation lands have been included, and so it cannot be said to be truly representative of Trinidad as a whole; and secondly, the sampling errors are too high for all but the most general purposes. It must be remembered however, that this survey was not undertaken for the actual...
value of the final figures, and some very valuable information has been obtained from it.

The two-fold objects of the survey were, firstly experience, and secondly, the practical testing of sampling survey theories, and it is felt that these objects have been fully achieved. As will be realized from reading the preceding pages, a great deal of basic practical and theoretical knowledge, coupled with actual experience of the more intimate problems of sampling surveys, has been gained, and it is felt that this knowledge will be of inestimable value if the members of the survey team are ever called upon to organize or take part in future surveys.

The work has shown that the area sampling method of survey is basically simple, as all records can be made by direct observation, and is suited to dealing with conditions of shifting agriculture, and in areas where land goes in and out of cultivation with changing economic conditions. The disadvantages of the method have come to light as being, a demand for accurate mapping and dependency on the scale and reliability of the detail of available maps; the difficulty of using the method effectively to for sample/agricultural features where mapped land forms only a small proportion of the total land area; the accuracy also depends on the accuracy with which the total area of the country is known.

(XIII) RECOMMENDATIONS.

1. Improvement of the frame, by spending more time before the actual surveying started, improving the accuracy of the available maps, with a view to dividing the frame up into more uniform and perhaps smaller sampling units. The trouble with this is that it costs valuable time and money and may not always be worthwhile for the extra accuracy obtained.

2. Reduction of sampling errors involved, so as to obtain results that are more representative of the whole aggregate. This might be achieved by increasing the size of the sample taken, or by increasing the stratification to reduce the variability between sample units, the object being to obtain as accurate a survey as can be afforded and the smallest sampling error possible.
3. An initial study of the variability between sampling units, either by a pilot survey or from previous survey data, if it is available.

4. It is recommended that this type of survey should be used to form a nucleus of knowledge from which accurate information could be speedily and cheaply collected at intervals by simply selecting a suitable sample. The only upkeep being that of maintaining a well defined, up-to-date frame.

(XIV) SUMMARY.

1. An experimental land utilization survey was carried out on an area of land in the North West of Trinidad.

2. The objects of the survey were to gain firsthand practical experience in organizing a survey and supervising the work entailed, and to test some of the theories of sampling in survey work under the particular conditions involved.

3. The area sampling method of survey was used, with a map as the frame, a stratified sample was taken and a two stage sampling process used.

4. A method for the estimation of total areas and sampling errors when there is a stratified random sample with possible unequal variances within strata, was used.

5. It was concluded that the objects of the survey were achieved, that the methods used were well suited to the conditions involved, and that valuable information was obtained.

6. Recommendations were made.
(XIV) REFERENCES.


APPENDIX A.
MAP OF TRINIDAD SHOWING AREA
SURVEYED AND INDICATING POSITION
OF SAMPLE UNITS.

KEY:
Ca = Caroni
Ch = Chaguanas
Co = Couva
G.C. = Gran Couva
P.V. = Pepper Village
F.T. = Flanagan Town

--- = MAIN ROADS
--- = MAIN RIVERS
---------- = GOVT. RAILWAY.

For detailed map showing division of frame
into sampling units and stratification
APPENDIX B.

 Sansc Unit 49. Land utilization and Division into sub-units.

 S.J. Cunningham Junction

 Scale: 8 inches = 1 mile.
APPENDIX D.

ABBREVIATED KEY AND DIAGRAMMATIC SCALE ISSUED TO ENUMERATORS.

SE  ESTATE SUGAR CANE
S6  GOOD FARMERS CANE
S8  BAD FARMERS CANE
R   RICE
F   SHORT TERM FOOD CROPS
CN  COCONUTS
O   ORCHARD CROPS
C   CITRUS
CO  COCOA, BANANAS, COFFEE
T   TIMBER IN PURE STANDS
HB  HIGH BUSH
LB  LOW BUSH
W   RIVERS, SWAMPS
G   GRAZING
NA  NON AGRICULTURAL USE
U   URBAN AREAS
APPENDIX E

The Imperial College of Tropical Agriculture,
Trinidad, B.W.I.

7th December, 1954.

TO WHOM IT MAY CONCERN

Sir,

The bearer, Mr. M.J. Hannagan, is a Postgraduate student of the Imperial College of Tropical Agriculture who is engaged in surveying land use in selected areas in Trinidad. As his supervisor, I would appreciate facilities being allowed him to measure up any crop area which he requires.

(A.L. JOLLY).

Lecturer in Economics.
# APPENDIX P

Areas of Land Utilization divisions in sample units 49 and 56 and their sub-units.

## 1. Sample Unit 49 (in acres)

<table>
<thead>
<tr>
<th>Sub-Unit No.</th>
<th>SE.</th>
<th>SG.</th>
<th>SB.</th>
<th>R.</th>
<th>F.</th>
<th>CN.</th>
<th>O.</th>
<th>C.</th>
<th>Co.</th>
<th>T.</th>
<th>HB.</th>
<th>LB.</th>
<th>W.</th>
<th>G.</th>
<th>NA.</th>
<th>U.</th>
<th>Total (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>11.3</td>
<td>1.9</td>
<td>1.1</td>
<td>4.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.8</td>
<td>-</td>
<td>2.2</td>
<td>0.6</td>
<td>9.5</td>
<td>33.5</td>
</tr>
<tr>
<td>2</td>
<td>7.2</td>
<td>12.0</td>
<td>3.1</td>
<td>1.1</td>
<td>4.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>3</td>
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<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>0.6</td>
<td>-</td>
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<td>0.1</td>
<td>1.6</td>
<td>33.5</td>
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<td>0.3</td>
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<td>1.3</td>
<td>-</td>
<td>-</td>
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<td>0.7</td>
<td>-</td>
<td>11.8</td>
<td>1.1</td>
<td>12.4</td>
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<tr>
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<td>-</td>
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**Total (acres)**: 63.0, 83.0, 10.0, 16.0, 34.0, 1.5, 3.7, 43.0, 0.8, 129.5, 42.5, 42.0, 7.0, 60.0, 536.0
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APPENDIX G

Examples of the calculation of sampling error and total estimated area for each land utilization division.

Where :

- $f$ = sampling fraction.
- $g$ = raising factor.
- $i$ (suffix) = denotes values belonging to a particular stratum $i$.
- $n$ = number of units in the sample.
- $S$ = summation over the units of the sample.
- $Si$ = summation within stratum $i$.
- $V$ = variance.
- $y$ = quantitative variate under investigation.
- $Y$ = estimated total of $y$ for the population.

$$Si^2 = \frac{Sy^2}{ni-1}$$

$$V(Si(y)) = Si^2 x ni (1 - fi)$$

$$V(Yi) = V(Si(y)) x g^2$$

1. Bad farmers sugar cane (SB)

<table>
<thead>
<tr>
<th>Stratum</th>
<th>ni</th>
<th>ni-1</th>
<th>$Sy^2$</th>
<th>$Si^2$</th>
<th>$V(Si(y))$</th>
<th>$V(Yi)$</th>
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<tr>
<td>A. Cane - arable</td>
<td>96</td>
<td>95</td>
<td>131.13</td>
<td>2.01</td>
<td>179.87</td>
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<td>B. Bush - plantation</td>
<td>64</td>
<td>63</td>
<td>2420.37</td>
<td>38.42</td>
<td>1859.91</td>
<td>31320.88</td>
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</table>

$V(Y)=70491.17$

Sampling Error $= \sqrt{70491.17} = 265.46$

Total area of SB in stratum $A$ x $g$ for stratum $A = 546.01$ acres

$\text{Total Estimated area of SB in area surveyed} = 113.63$ acres

Sampling Error as percentage of Total Estimated area $= 25.8\%$
2. Citrus (C)

<table>
<thead>
<tr>
<th>Stratum</th>
<th>n1</th>
<th>n1-1</th>
<th>S^2</th>
<th>S^2</th>
<th>V(Si(y))</th>
<th>V(Y)</th>
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<tbody>
<tr>
<td>A. Cane - arable</td>
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<td>95</td>
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<td>B. Bush - plantation</td>
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<td>63</td>
<td>1337.57</td>
<td>21.23</td>
<td>1027.74</td>
<td>17307.14</td>
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</table>

\[
\text{Sampling Error} = \sqrt{124297.54} = \pm 352.53
\]

Total area of C in stratum A x g for stratum A = 842.80 acres

Total Estimated area of C in area surveyed = 1140.05 acres

Sampling Error as percentage of Total Estimated area = 30.2%

3. Short term food crops (F)

<table>
<thead>
<tr>
<th>Stratum</th>
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<th>n1-1</th>
<th>S^2</th>
<th>S^2</th>
<th>V(Si(y))</th>
<th>V(Y)</th>
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<tbody>
<tr>
<td>A. Cane - arable</td>
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<td>63</td>
<td>6694.88</td>
<td>106.27</td>
<td>5144.53</td>
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\[
\text{Sampling Error} = \sqrt{158739.70} = \pm 398.38
\]

Total area of F in stratum A x g for stratum A = 1296.88 acres

Total Estimated area of F in area surveyed = 2309.12 acres

Sampling Error as percentage of Total Estimated area = 17.0%
APPENDIX H.

It is hoped that the accompanying photographs may enliven this thesis and illustrate some aspects of the land utilization divisions chosen.

1.
Low Bush (LS) in foreground, High Bush (HS) behind, sample unit 76.

2.
Estate Cane (SE) and typical grass track (G), sample unit 56.

3.
Un-pitched road (RA), grass verges (G) and bad farmers' cane (SC), sample unit 76.

4.
Bad farmers' cane (SB), abundant weeds, less than 50% cane.
5. CAFAKO RIVER (L) WITH GRASS TRACE (O) AND ESTATE CAME (S) IN BACKGROUND. SAMPLE UNIT 56.


7. CONT. RAILWAY LINE (NA), LOW BUSH (L), AND COCONUT PALMS ON AN ABANDONED ESTATE.

8. TYPICAL SWAMP AREA (W).