

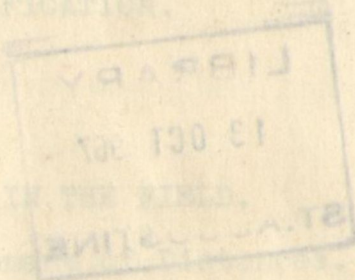
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AN EXPERIMENTAL SAMPLE
LAND UTILIZATION SURVEY

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SUPERVISOR'S NOTE

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 surveying in the field, calculation of the areas of the two strata and the two sampling fractions, 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.

AN EXPERIMENTAL SAMPLE LAND UTILIZATION SURVEY

INTRODUCTION

There is an imperative need in most Colonies to increase agricultural production in order to safeguard the food supplies of an ever increasing population and to raise the standard of living of the people by the export of cash crops.

An indispensable preliminary to all investigational, extension and advisory work aiming at increased agricultural production in a territory is a survey of the existing land utilization. When data of the land utilization of a particular area are available then one has a basis on which to work in calculating such important factors as the general level of prospective food supply for the area and hence its estimated human carrying capacity, or the acreage of cash crops in the area, or the potentialities for future development in the area. Without the data from a land utilization survey calculations of the three items mentioned above are at best only a rough approximation and not satisfactory for general application.

The type of land utilization survey undertaken in the area will depend to a large extent on whether the area is in a highly developed stage or not, on the size of the area to be surveyed, on its topographical features, on the natural vegetation and agricultural crops of the area, on the use which is to be made of the information collected, and perhaps most important of all, upon the resources at the disposal of the organiser of the survey.

The technique of sampling has universal application and when applied to a land utilization survey does not restrict the type of survey to any particular set of circumstances or conditions, e.g. an area having all types of topography and bearing all kinds of vegetation can be sampled. The advantages of a sample survey over a total survey of a given area are that:

(a) the sample survey takes less time; (b) the number of staff required is less, closer supervision can be achieved and the estimates obtained should therefore be more accurate; (c) costs are much less; (d) it should be possible to obtain more detailed information; (e) owing to the reduced volume of material that has to be handled the quality of abstraction and analysis should be higher. Mahalanobis (1952) directed a National Sample Survey in India on a sound statistical basis and found a discrepancy of some 20 to 25 per cent. between the actual quantity of grain consumed and the supply as estimated from the agricultural statistics. All the advantages to be gained in carrying out a sample survey are lost if the samples chosen are not representative of the whole aggregate, i.e., the errors introduced by the sampling process (the random sampling errors) are so large that they invalidate the results for the purposes for which they are required.

The main objects in carrying out this survey were to evolve the best sampling methods and surveying techniques to employ in an area such as the Northern Plain of Trinidad. The question of providing information of practical value on the utilization of the land in this area was considered incidental to the main objects. No similar survey had been carried out in Trinidad previously and little work has been done in this line elsewhere.

Five postgraduate students worked together on the survey and provided an excellent example of team-work. It was considered that as much planning as possible was desirable in the office before commencing the field work, and the five members of the team met regularly in the planning stages of the survey to discuss the design and working details under the chairmanship of Dr. A.L. Jolly.

It was decided that each member of the survey team should act as the supervisor of the other four members of the

team for certain operations to be carried out both in the office and in the field. This procedure, it was thought, would give experience to the students who might be employed in this type of work in the future and supervising staff elsewhere. The supervisor had to work out the details of the operation assigned to him and then issue instructions either verbally or written so that, had the other four members of the team been poorly educated assistants, they would have understood these instructions thoroughly. By carrying out this procedure it was thought that the organisation of the survey would simulate that normally required in most Colonial territories where five enumerators of the educational standard of the members of the survey team would be very unlikely to be available. In undeveloped territories more demands are made upon enumerators than in developed territories due to the inability of the local population to complete questionnaires and so it is essential that instructions given to enumerators are fully understood.

The members of the survey team provided their own transport as each member was a part-owner of a car. The number of cars required each day and the distance to be travelled whilst surveying in the field were closely studied by each supervisor to ensure that the most economical use was being made of the facilities available.

The main handicap of this survey was the very limited time available for field work. The only time available for surveying the sampling units in the field was during the three weeks of the Christmas Vacation, 1954, not a period of the year to be relied upon for dry weather. Consequently the scope of the survey was restricted in the choice of the frame, the sampling method, the sampling fraction, the nature of the information to be collected and in the methods of surveying.

I. THE FRAME

CHOICE OF TYPE OF FRAME

As the members of the survey team had only a vague knowledge of the agriculture of Trinidad, it was decided to choose a suitable frame firstly, and later when the area had been examined to decide upon the nature of the information to be collected. Owing to the limited time available for work on the survey it was considered desirable to choose a frame, the preparation of which would not entail a great amount of work and also not make great demands on the funds available for the survey. Furthermore as contacting persons is always a lengthy process and as it was thought that the members of the survey team and the local farmers would mutually find difficulty in understanding each other's accents, it was decided to choose a frame entailing the minimum amount of contact with the local population.

It was suggested that the frame might take the form of a list of farms or fields but the construction of a frame on this basis would be too lengthy a business in the time available. The definition of a farm would present difficulties as shifting cultivation is not uncommon in Trinidad and also the farm may be fragmented or sub-let. A list of farmers as a frame was ruled out as it was thought that there would be difficulty in drawing up a correct list (no such list existing) as well as difficulty in contacting the farmers. The use of a list of villages as a frame was considered but villages in Trinidad are not distinctly demarcated as in many undeveloped countries and it was thought that the difficulty in deciding to which village various individuals owe allegiance would be very great. As there are no tribal systems in existence in Trinidad the use of tribes as the basis of a frame was ruled out, but in many

territories there would seem to be many advantages in basing the frame on a list of tribes. The last census of population in Trinidad was suggested as the basis of a frame, but as this census was carried out in 1946 the data would now (1954) be inaccurate being out of date, and it was also thought that a great amount of office work would be involved. The suggestion was therefore discarded.

The suggestion that the frame should take the form of a map of the area chosen appeared to be the best suggestion put forward for use in this particular survey. It was decided to use maps for the frame of scale no larger than 1:50,000 (being the scale of the Government Map of Trinidad and Tobago, 1926) even if larger scale maps were available in order to simulate conditions occurring in many overseas territories. In the survey of a large area the expense entailed in using large scale sheets (if available) could be very great and should be borne in mind.

CHOICE OF AREA FOR THE SURVEY

The Trinidad and Tobago Government map used of scale 1:50,000 was surveyed in the field in 1920-25 and it was found necessary to bring sheets B and D up to date by surveying and mapping in the Churchill-Roosevelt Highway and the Princess Margaret Highway (formerly the Southern Trunk Road) before the area of the frame could be defined. Hannagan and the writer surveyed the Princess Margaret Highway by first of all fixing its northern end by taking bearings with a prismatic compass and pacing the distances from the San Juan River and the entrance to the I.C.T.A. New Farm. They then proceeded southwards along the Highway measuring distances by the car's mileometer and taking bearings whenever the road deviated from the previous bearing. All bearings were converted from magnetic to true bearings by subtracting 9° from the reading in the field. The

Churchill-Roosevelt Highway was surveyed in a similar manner by the other three members of the survey team, and both roads were then drawn in on sheets B and D of the Trinidad and Tobago Government map.

It was decided not to cover mountainous areas in the survey as the importance of these areas is not as great as the lowland areas in Trinidad's agricultural economy. Also it was thought that in the limited time available only a very small area of mountainous country could be satisfactorily covered compared with a greater area of lowland, owing to poor communications and difficult terrain in the mountains. It was therefore decided to exclude the Northern Range and the major part of the Central Range. It was considered that the flat, highly productive area lying between the Northern and Central Ranges should comprise the major part of the area to be surveyed both from the point of view of importance and considering time taken in travelling to and from College. The lowland area between the Churchill-Roosevelt Highway and the Northern Range was excluded owing to the large amount of urban settlement on it which would have made surveying there extremely arduous. The Caroni Swamp was excluded from the area chosen for the survey because of its doubtful agricultural value and its present inaccessibility for surveying purposes.

The main considerations in fixing both the eastern and southern boundaries were: (a) the area of the survey had not to be so large that it would be difficult to take an adequate sampling fraction in the time available, and (b) the time spent in travelling to and from College to possible sampling units had not to be very great. It was also considered advisable to exclude the Arena Forest Reserve and the Tumpuna Forest Reserve by choosing the eastern boundary to the west side of these reserves.

It was suggested that the area for the survey

might be bounded by chosen parallels of latitude and chosen meridians of longitude shown on the map. However it was thought that it would be extremely difficult to identify these boundaries and furthermore be rather difficult to exclude certain features such as the Caroni Swamp and the urban area to the north of the Churchill-Roosevelt Highway without excluding a large area of land which it was considered desirable to include in the survey. It was generally agreed that the best boundaries for the survey area should be features easily recognisable both on the map and on the ground, e.g., first, second (and perhaps third) class roads, government railways and large rivers.

The area finally chosen for the survey was one of approximately 112,646 acres being bounded by: the Churchill-Roosevelt Highway on the north; the Princess Margaret Highway down to the Madame Espagnole River, the River itself to the coast, and then the coast-line down to Couva on the west; the main road through Couva, Gran Couva, Flanagin Town, Mamoral and the second and third class roads to Mundo Nuevo on the south; and finally to the east the main road from Mundo Nuevo through Talparo, San Raphael and north towards Arima until this road joined the Churchill-Roosevelt Highway (Appendix 8).

The main soil type of the south-eastern half is a hydromorphic parched clay.

The original vegetation of the area consisted of mainly marsh forest in the region of the Caroni Swamp of today and extending southwards down the coast in a broad strip; deciduous seasonal forest down the middle of the area, and finally semi-evergreen merging into evergreen seasonal forest towards the eastern boundary.

The Northern Plain of Trinidad is today important as a sugar cane growing area, estate sugar cane predominating and extending down to the sea on the west coast where the

II. THE AREA INVOLVED

The area chosen for the survey includes the major portion of the Northern Plain of Trinidad, of elevation between 0 and 100 feet above sea level. Higher ground occurs towards the south and east of the area especially in the Montserrat district, with dissected peneplains and low hills in the La Gloria and Saca Manteca districts. The highest point in the area is 582 feet above sea level near Pepper Village, Montserrat (see the Trinidad and Tobago Government map).

The rainfall of the coastal strip is around 40 inches per annum and in this region there is an intense dry season, usually of 4 to 6 months duration. Further inland at I.C.T.A. the rainfall of an average year is 65 inches per annum. The central and greater part of the area chosen occurs in a rainfall belt of around 60 inches per annum where there is a marked dry season of 2 to 3 dry months. The part of the area lying to the east of an imaginary line running north and south approximately 10 miles from the western coastline of Trinidad has a rainfall of 70 inches per annum and a weak dry season usually of 1 month's duration.

The main soil type of approximately the north-western half of the area is a hydromorphic low humic gley soil whereas the main soil type of the south-eastern half is a hydromorphic perched gley.

The original vegetation of the area consisted of mainly marsh forest in the region of the Caroni Swamp of today and extending southwards down the coast in a broad strip; deciduous seasonal forest down the middle of the area, and finally semi-evergreen merging into evergreen seasonal forest towards the eastern boundary.

The Northern Plain of Trinidad is today important as a sugar cane growing area, estate sugar cane predominating and extending down to the sea on the west coast where the

swamp land has been artificially drained. To the south in the Montserrat district there appears to be little sugar cane and many cocoa estates are to be found. On the eastern side of the Northern Plain in the undulating Las Lomas and La Gloria districts bush with sporadic peasant agriculture appears to predominate.

The area chosen for the survey was well supplied with roads except for the southern and eastern parts of it at the time of the survey. However, very few of these roads allowed rapid travel of vehicles along them owing to their bad surfaces. A Government railway traversed the area connecting Flanagin Town, Caparo, Todd's Road, Longdenville, Jerningham Junction and Caroni with both Port of Spain to the north and Couva and San Fernando to the south (Appendix 8). Numerous sugar estate railway systems were also to be found in the area.

(see Section VI on Surveying in the Field).

Just as in the case of demarcating the frame, it was considered that rectangular areas marked on the map, e.g. grid squares, would be unsuitable as sampling units owing to the difficulty of identifying these exactly on the ground. Similarly, in using a point sampling method, i.e., choosing a given number of points at random within the area of the frame and identifying these with areas on the ground, there would be great difficulty in finding the points sufficiently accurately enough and reasonably quickly enough on the ground in the first place. It was suggested that with paid enumerators the points identified on the ground may be found nearer to points of communication than they actually are, thus allowing bias to enter in.

The most satisfactory form of sampling units for use in this case appeared to be units of area which could be defined by features which were shown on the map and features

III. THE SAMPLING UNITS

CHOICE OF SAMPLING METHOD

Once the survey area had been fixed it was necessary to decide what form the sampling units should take.

As the map being used was out of date it was thought that the line method of sampling might be suitable. This method involves following a compass bearing across the frame and noting the use of the land along the line traversed, measuring distances as you proceed. A certain number of lines on various compass bearings would be chosen at random to constitute an adequate number of sampling units to produce a satisfactory sampling fraction. This method of sampling was not adopted as it was thought that there would be great difficulty in following a bearing through, for example, fields of sugar cane or through high bush (see Section VI on Surveying in the Field).

Just as in the case of demarcating the frame, it was considered that rectangular areas marked on the map, e.g. grid squares, would be unsuitable as sampling units owing to the difficulty of identifying these exactly on the ground. Similarly, in using a point sampling method, i.e., choosing a given number of points at random within the area of the frame and identifying these with areas on the ground, there would be great difficulty in finding the points sufficiently accurately enough and reasonably quickly enough on the ground in the first place. It was suggested that with paid enumerators the points identified on the ground may be found nearer to points of communication than they actually are, thus ^{introducing} allowing bias to enter in.

The most satisfactory form of sampling units for use in this case appeared to be units of area which could be defined by features which were shown on the map and features

which were also readily identifiable on the ground, such as main roads and railways. It was not thought necessary to have the sampling units of the same size and indeed this would have been extremely difficult with the type of boundaries chosen. It was thought, however, that the frame should be divided into as many sampling units as possible provided they were of size not less than $\frac{1}{2}$ square mile. It was desirable to have as many sampling units as possible in order to minimize the random sampling error. The minimum size of $\frac{1}{2}$ square mile was fixed as: (a) it would have been difficult due to lack of features on the map to make the area much smaller, and (b) the work involved in demarcating sampling units of less than $\frac{1}{2}$ square mile on the map and identifying them in the field would have been excessive, (c) a greater number of smaller units would have been required in order to constitute an adequate sampling fraction and this would have meant more time spent in travelling to and from these units.

THE DIVISION OF THE FRAME INTO SAMPLING UNITS

For this procedure Mitchell acted as supervisor of the other four members of the team and gave each, including himself, a tracing of a region of approximately one-fifth of the area of the frame, the five regions being allocated to the five members of drawing lots.

The instructions given by the supervisor to the team were as follows:

"(1) The object is to divide each region into as many sampling units as possible providing that the units are not smaller than $\frac{1}{2}$ square mile.

(2) In order to determine whether an area is $\frac{1}{2}$ square mile grids drawn on tracing paper are provided. $\frac{1}{2}$ square mile is equivalent to $\frac{7}{9}$ square inch on the map and should fill seven of the small squares on the grid.

(3) Features on the map to be used for the boundaries of

sampling units should be those that could easily be found in the field. Railways, first and second class roads are suitable. Third class roads and bridle paths are less reliable but could be used if the map showed that they had houses along them or that they led between two definite places. Sugar cane traces should not be used as they might have changed since 1920-25 when the map was made. Sugar cane railways should only be used near factories as elsewhere they are not permanent.

The Caroni River should always be used as a boundary because if it is in the middle of a sampling unit one might then have to swim it. Other rivers on the map should only be used to divide up excessively large sampling units and in this case only perennial rivers should be used. The drawback of using rivers is that they may have changed their course and also they are difficult to follow in the field.

(4) Any doubtful boundaries should be marked as a dotted line and these could later be investigated in the field."

The supervisor integrated the five regions when complete and obtained a tracing showing the whole of the frame divided up into sampling units. Many boundaries, however, were shown to be doubtful ones requiring investigation in the field and some new boundaries were also required to be found in order to try and cut down the excessive size of some of the sampling units.

Humphrys acted as supervisor for the investigation of (a) doubtful and (b) new boundaries (where required) of the sampling units. For this operation the supervisor divided the frame up into three regions. Hannagan and the writer were given a tracing of one region, Castle and Mitchell were given a tracing of region number 2, and the supervisor had a tracing of region number 3. The members of the team were instructed to investigate dotted lines on their tracings

noting in a field notebook whether or not these lines would make suitable boundaries for sampling units. Instructions were also given to ascertain in some instances if an excessively large sampling unit could be divided up into smaller sampling units (of not less than $\frac{1}{2}$ square mile) by features plainly visible on the ground but not shown on the map being used. New boundaries so found were required to be surveyed by prismatic compass and pacing (or a car's mileometer) and drawn in on the tracing provided. Later during the actual survey of some of the large bush units the writer came to the conclusion that these large units could have been profitably split up into smaller units had more time been spent at this stage in investigating new boundaries in the field. The supervisor also instructed members of the team to roughly note in field notebooks the type of agriculture, bush and other forms of land use of the areas they passed through.

The frame was divided into 110 sampling units, the units being numbered 1 to 110. The largest unit was number 78, being 6,400 acres in size; the smallest units were of the minimum size of $\frac{1}{2}$ square mile (320 acres), there being six of these.

STRATIFICATION

Whilst investigating doubtful and new boundaries of the sampling units it was noticed that the units tended to fall broadly into two main types on the basis of topography and agriculture. Those to the north and the west of the area tended to be situated on flat topography, the agriculture being mainly sugar cane and other arable crops. Sampling units to the south and east appeared to be situated on hilly or undulating land, the vegetation being mainly forest and plantation crops. Furthermore, the latter type appeared to be larger on the whole than the former type. It was therefore decided to stratify the sampling units into two

strata: (a) the cane and arable stratum, and (b) the bush and plantation stratum. (Henceforth in this thesis sampling units from the former stratum will be referred to as "arable units", and those from the latter stratum as "bush units".) The line of demarcation between the two strata was fixed as shown on the map (Appendix 8).

Yates (1953 (a)) describes the two purposes of stratifying sampling units as: (1) to increase the accuracy of overall population estimates and (2) to ensure that subdivisions of the population which are themselves of interest are adequately represented. The former of these purposes is achieved by the reduction of sampling error between units in a stratum, as there should be less variation between units within a stratum than between units within a whole population. It appeared from the preliminary inspection of various sampling units during the checking of boundaries that the cane and arable units were more uniform in composition than the larger bush units, but this was later found not to be so.

SAMPLING FRACTION

The size of the sample taken was restricted since the only time available for surveying in the field was the Christmas Vacation, 1954. Owing to the time taken in travelling to and from sampling units there was insufficient time available in the afternoons of term-time to visit units and survey them. As members of the team had little idea how long it would take to survey a sampling unit in the field, a pilot survey of a sampling unit was suggested. It was thought however that time was not available to do a pilot survey of a sampling unit and as there appeared to be large differences in composition between some units, the pilot survey would only give an estimate of time taken to survey a unit of a particular composition. It was considered that 10 sampling units could be surveyed in the first instance in the Christmas

Vacation, i.e., 1/11 of the total of 110 units, and that an additional 5 units could be taken if time allowed. By taking 10 sampling units it meant that each member of the team could supervise the surveying of 2 units.

In order to cover more sampling units, second stage sampling was suggested, i.e. surveying only a certain fraction of the first stage sampling units. However, it was considered that demarcation of second stage sampling units would be difficult in the field and was found to be impossible from the map. It was however realized that when the whole of the first stage sampling units had been surveyed some form of sub-division of the units would be necessary in order to reduce the sampling error. As sub-division in the field did not prove feasible it was decided that a random sub-division method would be employed in the office (Appendix 1).

Of the 10 sampling units taken, it was decided that 6 units should be taken from the cane and arable stratum and 4 units from the bush and plantation stratum. Similarly, of the additional 5 units, it was decided that 3 units should be taken from the cane and arable stratum and 2 units from the bush and plantation stratum, if necessary. The reasons why more arable sampling units were taken than bush sampling units were:

(a) because the cane and arable stratum was considered the more productive area and therefore of greater importance in the agricultural economy of Trinidad;

(b) because there were 92 sampling units in the cane and arable stratum and 18 units in the bush and plantation stratum, and it was considered that at least 4 units should be taken to constitute a satisfactory sample, and a higher sampling fraction, from the latter stratum due to the large size of the units and the expected greater

variation within units. Therefore out of the total sample of 10 units, if the arable units had to exceed the bush units in number, at least 6 arable units had to be taken.

The units to be surveyed were chosen at random using tables of random numbers. The cane and arable stratum (A stratum) was filled first and then the bush and plantation stratum (B stratum) filled in both the 10 and the 5 lots of sampling units. Two units were allocated to each member of the team out of the first 10 sampling units employing the random numbers again.

The numbers of the 10 units chosen are tabulated below and the position of the sampling units in the two strata can be ascertained from the map (Appendix 3).

A Stratum		B Stratum	
Sampling Unit	Supervisor	Sampling Unit	Supervisor
56	Hannagan	39	Mitchell
71	Humphrys	11	Castle
49	Hannagan	76	Devonald
4	Castle	110	Humphrys
52	Devonald		
13	Mitchell		

The additional 5 sampling units were not allocated to any supervisors, this was to be carried out only if time allowed the survey of them; these units were not surveyed. The numbers of the additional 5 units chosen were:

A Stratum	B Stratum
Sampling Unit	Sampling Unit
42	65
99	107
41	

The writer was given the task of calculating the sampling fractions, based on area, for each of the two strata. The areas occupied by the two strata were first ascertained by making a copy of the frame from the Trinidad and Tobago map (to a scale of 1:50,000) on to a sheet of squared paper, 2' 6" by 2' 0", and counting the 1 inch and 1/10 inch squares. At this scale a 1 inch square represented 398.4 acres and a 1/10 inch square (i.e. 1/100 square inch) represented 3.984 acres. The areas of the sampling units were obtained from the respective supervisors. The calculation by the supervisors of the areas of their respective sampling units was not a laborious process from the enlarged maps of the units (see Section V on Mapping), but accurate calculation of these areas was not carried out until the units had been surveyed in the field and their boundaries fixed. The additional 5 sampling units were not included in these calculations.

The following sampling fractions were obtained:

$$\frac{\text{Total area sampled in A stratum}}{\text{Total area of A stratum}} = \frac{5501 \text{ acres}}{81186 \text{ acres}} = \frac{1}{14.757}$$

$$\frac{\text{Total area sampled in B stratum}}{\text{Total area of B stratum}} = \frac{7665 \text{ acres}}{31459 \text{ acres}} = \frac{1}{4.104}$$

- SC. Good Farmers' cane.
- SB. Bad Farmers' cane. (less than 50% cane; rest - bush).
- R. Rice (stools showing rice has been planted this year).
- F. Short term food crops (tannia, cassava, sweet potato, pigeon peas, tomato, plantain, etc.).
- UN. Coconuts (in stands of 1/2 acre or more).
- G. Orchard crops (Cashew nuts, tonka beans, pineapple, etc. in stands of 1/2 acre or more).
- C. Citrus (in stands of 1/2 acre or more).
- CC. Cocoa, bananas and coffee (separate or mixed, cutlassed and generally looked after).
- F. Pure stands of timber trees.

IV. THE CLASSIFICATION

Consideration was given to the idea of collecting information on various subjects such as housing, soils, drainage and erosion, in addition to the main information required on land utilization of the area chosen. However, it was thought that there would be no time to deal with any of these subjects if the land utilization survey was to be done thoroughly in the time available.

Hannagan was given the task of defining the divisions of land use which were to be enumerated in the field, after each division had been discussed by the five members of the survey team. He issued the following notes to the other four members in which the divisions chosen were defined:

"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. Sugar cane - Estate cane.

SG. Good Farmers' cane.

SB. Bad Farmers' cane. (less than 50% cane; rest - bush).

R. Rice (stools showing rice has been planted this year).

F. Short term food crops (tannia, cassava, sweet potato, pigeon peas, tomato, plantain, etc.).

CN. Coconuts (in stands of $\frac{1}{2}$ acre or more).

O. Orchard crops (Cashew nuts, tonka beans, pineapple, etc. in stands of $\frac{1}{4}$ acre or more).

C. Citrus (in stands of $\frac{1}{2}$ acre or more).

CO. Cocoa, bananas and coffee (separate or mixed, cutlashed and generally looked after).

T. Pure stands of timber trees.

Uncultivated Land (Land not satisfying any of the requirements of Cultivated Land).

- HB. High bush (majority of vegetation above 6' in height, including bamboo and old 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, ~~marshes~~^{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, gardens of less than $\frac{1}{4}$ acre per house) with a density of at least 2 houses per 100 yds., and 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 $1/10$ 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."

A statement by Hunt (1952 (a)) sums up the approach of the team in choosing the divisions of land use: "The guiding principle in choosing local definitions should be that they fit the practice even at the cost of less 'tidy' statistics for publication than might be desired." Thus, "Co" marked on the enlarged maps (Appendices 6 and 7) indicates cocoa, bananas or coffee, or a mixture of any of these three. It should be noted that "further detailed remarks and observations" as suggested in paragraphs 4, 6 and 10 of "Notes for Enumerators" were not made after the first day's surveying in the field as the procedure was found to take up too much time. Crops such as bananas growing under coconuts, or food crops growing between rows of farmers' cane were ignored in this survey as it was considered that their relative importance in the question of land utilization was not great enough to warrant their enumeration. If at some time statistics on banana cultivation in a given area were required, then it was considered that a separate survey for the crop would be a worth-while undertaking.

It was realized that in defining the divisions of land use, the divisions alone would not be suitable for use by untrained staff and that visual aids such as photographs and drawings would prove useful. It was considered that a period of training in the field prior to surveying proper was desirable for enumerators of a moderate standard of education. In this period of training the enumerators would familiarize themselves with applying the list of definitions in the field to areas specifically chosen by the supervisor for the characteristic problems they pose. Problems such as when to class cocoa as abandoned or not, how to judge whether the majority of bush is over 6 feet or under 6 feet in height, and when to class farmers' cane as "good" or "bad", were found to trouble the survey team on occasions and could be presented to enumerators during training. Difficulty was encountered in distinguishing between estate cane and farmers' cane on occasions, but this problem was usually solved by asking responsible people in the district.

The only definition found to be unsatisfactory in the field was the "G. Grazing (main stand of grass)" definition. Large areas of lalang grass were encountered in some areas, e.g. Unit 52, which were not grazed, the grass being very coarse and waist high. The enumerators decided to class this type of vegetation as "low bush". A better definition of "G. Grazing" would have been "main stand of grass with evidence of grazing".

With regard to paragraph 7 of "Notes for Enumerators" it was later decided that all measurements should be recorded in yards, i.e., paces (see Section VI on Surveying in the Field).

V. MAPPING

It was necessary to make map enlargements of the sampling units for use in the field as at this time these were demarcated on the Trinidad and Tobago map of scale 1:50,000, a scale much too small to allow the accurate mapping of land use.

Castle was given the task of deciding to what scale the sampling units should be enlarged. The availability of sheets of squared paper measuring 2' 6" by 2' 0" influenced his decision. He considered that the largest sampling unit to be surveyed should fit on to one of these sheets. He therefore chose the scale of enlargement as 1 inch to 220 yards, each 1 inch square on the squared paper thus representing 10 acres and each small square (of side 1/10 inch) representing 1/10 acre. This scale is commonly used in compiling soil maps and so any connection between the soil of an area and the utilization of land on the area could easily be determined.

The method of enlargement of a sampling unit was as follows:

(a) the parallels of latitude and meridians of longitude cutting the sampling unit on the Trinidad and Tobago map were drawn onto the sheet of squared paper to the enlarged scale;

(b) the boundary of the sampling unit was then drawn in to the enlarged scale by taking numerous points along the middle of the boundary of the sampling unit on the Trinidad and Tobago map and plotting these points on the squared paper, fixing their position from the grid lines by taking right angle offsets to the enlarged scale;

(c) features shown on the Trinidad and Tobago map within the sampling unit which were considered to be

fairly permanent and be existing today such as roads, Government railways and large rivers were drawn in to the enlarged outline on the squared paper.

From this preliminary inspection of the field the members of the survey team came to various decisions regarding methods of surveying in the field that should be adopted.

MEASUREMENT OF DISTANCES

It was decided that all distances in the field should be measured by pacing. Owing to the size of some of the sampling units (the largest being 3,151 acres) measuring distances by chain would have entailed a great amount of extra work and time (which was not available) and it was thought that pacing was sufficiently accurate enough when compiling maps of scale 1 inch to 250 yards. Also the writer found it extremely difficult to use a chain to measure distances along a boundary of low bush with high grass in a trial he conducted.

The use of recording wheels and also range-finders for measuring distance was considered. The former is only useful for measuring long distances, i.e. of several miles and it was considered that it would be a hindrance in measuring up small patches of land and in the difficult terrain likely to be encountered in some sampling units. Range-finders are usually not very accurate in measuring distances of less than 250 yards and under wet tropical conditions readings over 800 yards may be difficult; they were therefore not used in this survey.

The pacing of the five enumerators were checked over different types of terrain before field work was commenced. This was carried out by measuring 100 paces of the enumerator with a chain. On fairly firm level ground the results showed that 100 paces covered 100 yards

VI. SURVEYING IN THE FIELD

Each supervisor carried out a reconnaissance of his two sampling units in the field before surveying proper commenced. From this preliminary inspection of units in the field the members of the survey team came to various decisions regarding methods of surveying in the field that should be adopted.

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The pacing of the five enumerators were checked over different types of terrain before field work was commenced. This was carried out by measuring 100 paces of the enumerator with a chain. On fairly firm level ground the results showed that 100 paces covered 100 yards

approximately, the largest deviation being 4 yards in the first trial. When trials of pacing were made on sloping ground it was found that enumerators tended to take a pace of over 1 yard when descending a slope, and under 1 yard when ascending a slope; with practice, however, each enumerator was able to control his variation in pacing considerably and therefore reduce errors of measurement. It was decided that each enumerator should aim at taking a pace of 1 yard in all conditions; this was found to be very difficult in some instances at first, e.g., in swampy conditions, but with practice before commencing the survey proper the enumerators became very proficient at pacing accurately. Although pacing appeared to be the best method of measuring distance in this survey it was realized that in certain areas, e.g., of uneven terrain or swampy condition, that the pacing errors would be one of the greatest sources of error in the survey.

SURVEYING TECHNIQUE

The possibility of employing the line method for surveying the sample units was considered. However after the writer had reported to the team upon his failure to follow a bearing through a growing crop of sugar cane and also through an area of high bush in a trial attempt, it was realized that unless the vegetation was cut down to facilitate sighting the method would be useless. The labour cost of cutting and the compensation that would have to be paid to owners who suffered from having their crops cut prematurely would be high in the case of this survey as most of the sampling units appeared from inspection to contain a high proportion of sugar cane and/or high bush. Also the hilly topography in the south and east of the frame would add further difficulties to following a bearing across a sampling unit. Thus the taking of lines through

the sampling units was not adopted although in areas where there are large acreages of crops growing which would not interfere with sighting, e.g., rice and ground provisions, this technique would probably be very useful.

The writer found that the only suitable method of surveying the sampling units in the field appeared to be by measuring up the different divisions of land use by pacing and taking necessary angles by prismatic compass. Bearings taken were converted to true by deduction of 9° (the Westerly Magnetic Variation in Trinidad). Each enumerator was supplied with a clip board (14 inches x 9 inches) upon which were listed the land use divisions and their respective abbreviations and also rectangles drawn to show what $1/10$, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 10 acres looked like when drawn to the scale being used. Upon these boards the enumerators clipped their enlarged map outlines. Enumerators were also supplied with a prismatic compass, a field notebook, 2 sharp pencils and an india-rubber. They were also given a letter to carry on their persons describing who they were and what they were doing in case a landowner, who had not been contacted previously, suspected an unfortunate enumerator of pursuing unlawful business on his property. Most of the large estates concerned were approached before surveying commenced for permission to carry out the surveying on their land. It was found in many areas that enumerators in measuring up various crops tended to arouse the suspicion of the farmer and the local populace. The writer always endeavoured to explain to the farmer concerned what he was doing and allay the farmer's suspicions, but it showed that tact was necessary and in territories where political feeling runs high, great care should be taken in choosing enumerators. No cases of obstruction by peasant farmers to the work of the enumerators were encountered on this survey; on the contrary, when told

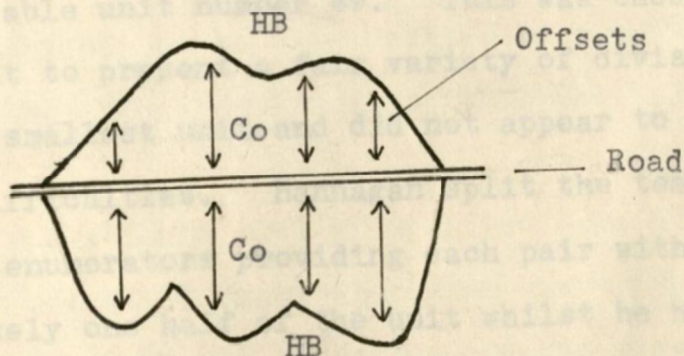
what was taking place most of the peasant farmers showed great interest and many found the proceedings humorous. In some areas, where a newspaper or newsheet gets fairly good circulation, it may be advisable to give the people warnings by placing a notice in these publications stating that a land utilization survey is to be carried out in a certain area on a given date. In the area surveyed this was not thought to be necessary.

The question of whether it was advisable to employ different methods of surveying in the arable sampling units to those in the bush sampling units had to be considered owing to the differences in topography and vegetation between the two strata. It was suggested that use might be made of any large scale maps that sugar estates possessed of their land and so eliminate the necessity of surveying these areas on the ground. This was not compatible with the earlier decision of not employing maps of scale greater than 1:50,000, but it was thought that the time saved and further experience gained in using these maps justified their use. It was thought, however, that these estate maps should not be used without the areas being looked at on the ground as:

- (a) the estate maps are possibly not up to date and therefore inaccurate;
- (b) the area of land occupied by traces is not marked on sugar estate maps;
- (c) the sampling unit boundaries may not coincide with the field boundaries therefore making accurate measurement of areas difficult.

In the case of the bush units it was found in the preliminary reconnaissance that patches of cultivated land occurred frequently in the midst of large areas of high bush, but always had footpaths or traces leading to them. It was decided that the measuring up of exact acreages

of high bush would be difficult and was unnecessary in the bush units. It was considered accurate enough if all paths and traces were followed up to enumerate cultivated areas, and by subtracting all cultivated land plus uncultivated land except "high bush" from the total area of the unit (ascertained from the map) the actual acreage of high bush in the unit could be found. The majority of paths and traces through high bush were not marked in on the maps being used and therefore had to be surveyed and drawn in upon the map before the correct position of the cultivated areas along them could be mapped. This took up a great amount of time but, in the absence of a more detailed map, it did not seem worthwhile to map in paths and traces before mapping in the remainder of the unit as was suggested at one stage. The use of horses for transport purposes in the large bush units was considered, but owing to the need to pace distances and to walk through crops such as cocoa, where horses could not go, the idea was abandoned. In measuring an area of a crop such as cocoa or bananas bordering on high bush it was considered sufficient to pace offsets on a definite bearing at certain intervals, e.g., 100 yards, along a road, trace or footpath going through the crops, then with the measurements obtained, a sketch map such as that below could be drawn and the area of the crop ascertained approximately.



An aerial survey of the sampling units chosen would not have been satisfactory without ground coverage also, if the divisions of land use decided upon had been employed. Aerial photographs of scale 1 in 11,000 for some of the arable units and 1 in 45,000 for the remainder of the arable units and the bush units were obtained, and it was found very difficult to identify the different divisions of land use on them. It was impossible to distinguish cocoa being grown under shade trees from high bush on these aerial photographs. They did come in useful, however, for the making of rough maps by the supervisors of sections of their sampling units for the guidance of enumerators in the field. It was also found that many inaccuracies in the Trinidad and Tobago map used for the frame could be corrected in the enlarged maps used in the field by employing these aerial photographs which were taken in 1950 (the smaller scale) and 1952 (the larger scale) and therefore much more up to date than the Trinidad and Tobago map.

PROBLEMS ENCOUNTERED IN THE FIELD

It was considered desirable that the whole 10 sampling units should be surveyed in succession by the members of the survey team in one period of intensive effort in order that the survey could be said to refer to the utilization of the land at one specific time i.e. December, 1954.

The first unit to be chosen for survey was Hannagan's arable unit number 49. This was chosen because it was thought to present a fair variety of divisions of land use, was the smallest unit and did not appear to present any formidable difficulties. Hannagan split the team up into two pairs of enumerators providing each pair with a map outline of approximately one half of the unit whilst he himself was to supervise and be on hand to answer any questions from the enumerators, and to make decisions in cases of doubt. Only

one of each pair did the mapping, his partner pacing the distances and measuring angles and shouting them to the mapper. In addition to accurately plotting the different divisions of land use, the mapper entered up measurements in his field notebook referring to areas on the map by the use of a symbol and subscript, e.g., $SG_2 = 50 \text{ yds. } 0^\circ \times 30 \text{ yds. } 90^\circ$, so that necessary adjustments to the map drawn in the field could be made at leisure in the office.

After the first day of working in the field on unit number 49 it was evident that the surveying would have to be speeded up if all 10 units were to be surveyed in the limited time available. It was therefore decided to employ all 5 members of the team in surveying and mapping. The supervisor provided map outlines of approximately one-fifth the area of his unit to each enumerator and himself. The boundaries of these sections had to be clearly identifiable by enumerators in the field in order to obviate the danger of over-lapping in surveying. The supervisor was therefore not on hand to give decisions, but as all the 5 members met for lunch and tea, this afforded ample opportunity to discuss difficulties. The keeping of field notebooks was also discontinued as a compulsory measure. It was found that except for certain complicated regions it was quite easy to draw areas of land use accurately on the squared paper without the need for writing down the distances paced along each boundary of such an area, thus saving a great amount of time. Also it was decided not to note details of crops as it was thought that the time spent in doing this was unjustified in this survey.

It was found that after a few days in the field that the best method of proceeding when surveying and mapping a section was first of all to survey and map areas adjacent to roads, traces and footpaths, and subsequently to survey and map the remainder of the section. By carrying out this

procedure the difficulty of fitting together accurately on the map areas measured on the ground, experienced in the first day or two, was very much reduced.

The surveying of rivers, which had to be carried out frequently due to their courses having changed since the Trinidad and Tobago map was surveyed, was found to be very difficult on occasions owing to dense vegetation and swampy conditions frequently existing along the banks. A canoe might have been very useful in surveying, for example, the stretches of the Caroni River. Another problem was that the boundaries of map outlines provided by supervisors to enumerators were sometimes found to be inaccurate due to inaccuracies in the Trinidad and Tobago map. The enumerator had therefore to spend valuable time in the field correcting their section boundaries on occasions; this was thought to be inevitable when working from an out-of-date map.

PERFORMANCE OF ENUMERATORS

It was obvious from the experience of the survey team in the field that either highly intelligent or highly trained enumerators are required to carry out efficiently a survey such as this one.

It was noticeable that with practice in enumeration members of the survey team become more efficient in that they covered greater areas in a day as the survey progressed, e.g., $1\frac{1}{2}$ days were spent by the 5 members of the team, i.e. 55 man-hours, in surveying 536.0 acres of unit number 49 at the commencement of the survey, whereas unit number 71 of 718.9 acres was completed in the equivalent of 1 day by the whole team, i.e. 40 man-hours, later in the survey. Both these units had large amounts of small areas of food crops to be measured up in them, but the prevalence of large areas of sugar cane in unit number 71 may account for the greater ease of surveying and therefore quicker progress. It was

expected that the surveying of the bush units would take a considerable amount of time considering their large size and difficult terrain. However, the surveying of unit number 76 of 1575.0 acres took only 52 man-hours and it was found that with high bush occurring in large blocks over most of these units, large areas of land could be covered in a surprisingly short time.

The accuracy in recording of the enumerators appeared to be high in this survey although no form of checking on accuracy was carried out. The team showed great interest in the aims of the survey and it is unlikely that recording errors would be anything like as great as those to be expected from poorly educated enumerators who may treat their recording as "just another job to be finished off as quickly as possible". Hunt (1952 (b)) outlines a device of using interpenetrating samples in order to check on possible recording errors of enumerators. "The total number of sample units to be taken in each district is distributed at random between two or more enumerators. Thus District 1 might be enumerated by A and B, District 2 by B and C, District 3 by C and A. Thus the work of each enumerator can be compared with that of two others working in similar conditions. If one proves to be unreliable, an estimate for the district is available from the other, though naturally based on half the intended number of records. A second advantage is the ease with which the scope of a study can be cut. If there are local difficulties then one of the enumerators can be withdrawn, the reliability of the remaining one being tested by comparison in his other district. At worst the scope of the whole project can be halved at the sacrifice of the check on enumerator's individual reliability". Had we been employing paid enumerators we should very likely

have adopted the above device to check on their recording accuracy.

Probably the greatest errors of the enumerators occurred in the pacing of distances over varying types of terrain, but a more efficient method of measuring distances in the circumstances was not found.

THE SURVEYING OF SAMPLING UNITS 52 AND 76

Sampling unit 52 (an arable unit) and bush unit 76 were the units allocated to the writer for supervision.

UNIT 52. This roughly rectangular sampling unit of 1320.2 acres lying to the north-east of Longdenville was in the cane and arable stratum. From the writer's reconnaissance of the unit it was found that the area was mainly flat, the south east portion of about 400 acres was found to consist entirely of high bush except for a few low bush clearings on the western boundary of this section. Whilst walking along the traces to the south and the east of this solid section of high bush the writer measured the trace lengths and widths and took bearings of them thus obviating the necessity of covering the ground again in the actual survey. The remainder of the unit appeared to consist predominantly of peasant and estate crops in the western half, and predominantly low and high bush with small amounts of peasant agriculture in the north-eastern portion of the unit.

It was found that the roads represented by a continuous line on the map (Appendix 4) were pitched and accessible to the cars at our disposal. The roads represented by a dotted line on the map (Appendix 4) were found to be of dirt or grass surface and not negotiable by the cars.

The usefulness of pitched roads to demarcate a section to be covered by an enumerator and also their usefulness in providing accessibility to each section influenced the

supervisor in delineating the section to be given to each enumerator. The unit was therefore split up into 5 sections as shown on the map (Appendix 4) and a map outline of his section was given to each enumerator. The enumerators were also given rough maps compiled from aerial photographs of their respective sections to serve as a guide to enumeration in the field.

The surveying of unit 52 was commenced at 1.00 p.m. on the 14th December with 4 enumerators and 2 cars available. The enumerators commenced the surveying of their sections at the points indicated by E₁, E₂, E₃ and E₄ on the map (Appendix 4), the cars being parked at C₁ and C₂. The enumerators were instructed to meet at T (Appendix 4) between 4.30 and 5.00 p.m., E₄ being responsible for collecting car C₂ and E₂ being responsible for collecting car C₁ on the way to the rendezvous. The meeting showed that sections 2, 3 and 4 had been completed in the afternoon, leaving section 5 to be surveyed and section 1 to be completed on the morrow.

In the evening the supervisor split Section 5 into approximately 2 equal sub-sections and drew map outlines and rough maps of these two areas so that E₅ and himself could work on this Section and finish off the unit by lunch-time next day. Only one car was needed the following morning to transport the 2 enumerators (i.e. including E₁ who would be completing Section 1) and supervisor to the unit. The supervisor also gave himself the task of surveying the low bush clearings on the east side of Section 5 as well as surveying half of this Section. After commencing surveying at 9.00 a.m. all Sections were completed by 12.30 p.m. Thus 26½ man-hours were spent in surveying 1320.2 acres of the sampling unit, but it must be noted that nearly one-third of the area of this arable unit consisted of a solid block of high bush which had previously been surveyed on the reconnaissance - taking up only 2 man-hours. Thus, the

total time spent in surveying this unit was 28½ man-hours.

This sampling unit lent itself very readily to being split up into sections for enumeration, there being little fear of the enumerators not recognising the boundaries of their sections in the field as in many cases these were straight, pitched roads and the sections roughly rectangular in shape. The rough maps compiled from aerial photographs were found to be extremely useful in indicating to the enumerators the type of land use to expect. The approximate boundaries of the high bush were found to have changed little in the 4 years since the aerial photographs used were taken.

This unit was surveyed after a large amount of rain had fallen in the preceding days and flooding made the survey of the rice valleys in Sections 3 and 4 difficult. The enumerators of these Sections were compelled to wade waist deep in water to get to rice bunds in order to pace out the acreage of rice in many instances in these areas. Flooding had been reported from many areas of the Northern Plain of Trinidad at this time and it was considered that to abandon Sections 3 and 4 until a later date in favour of commencing another unit might have been "jumping out of the frying-pan into the fire".

UNIT 76. This irregularly shaped sampling unit of 1575.0 acres lying to the west of the Government Railway between Todd's Road Station and Caparo Station was in the bush and plantation stratum. It was found to consist of a strip of flat country between the railway and the Longdenville - Flanagin Town main road and extending a little distance to the west of the road growing mainly sugar cane, and an area of undulating country rising to 250 feet in places and supporting peasant food crops, farmers' cane and appreciable amounts of low and high bush.

In the reconnaissance of the unit the roads

around the perimeter were found to be mainly pitched and all negotiable by car. The writer verified that the trace marked on the Trinidad and Tobago map and roughly cutting the unit north and south into halves existed, but he found no other traces which would serve for splitting up the unit easily into 5 sections for enumeration. He decided to delineate the sections as shown on the map (Appendix 5) and gave map outlines to the enumerators of their respective sections. As the aerial photographs of this unit did not show land use divisions at all clearly, rough maps were not compiled from them for issue to enumerators. Many of the boundaries of sections were decided upon by the writer observing in the reconnaissance impenetrable high bush in the region of the boundaries. Instructions were given to enumerators that when such high bush was encountered in the region of their section boundary (position being known approximately by the distance paced) that they should map in the fringe of this high bush and take it as the boundary of their section. They were instructed that they should on no account attempt to penetrate such high bush even by means of paths if their pacing and compass bearings showed that they had crossed the section boundary arbitrarily placed on their map outlines by the supervisor.

The survey in the field was commenced at 9.00 a.m. on the 21st December with 5 enumerators and 2 cars available. The enumerators commenced the survey of their sections at the points shown on the map (Appendix 5) and were instructed to rendezvous at point L at 12.30 p.m., enumerator E₂ being responsible for collecting car C₂ and picking up E₁ on his way, enumerator E₅ was responsible for bringing car C₁ to the rendezvous point. It was found that only E₃ had completed his section in the morning and so he was instructed to survey part of E₄'s section in the afternoon, a map outline being

VII. COMPILATION OF MAP DATA

drawn for him in the field by the supervisor. At the next rendezvous at 5.00 p.m. at T (Appendix 5) it was found that Sections 1 and 4 were still incomplete. These sections were subsequently completed in a spare afternoon later by 4 enumerators, each being provided with a map outline of half of one of the Sections; 2 cars were used.

The time taken in surveying this bush unit was 52 man-hours, a creditable performance on the part of the enumerators considering the difficult terrain and lack of communications within the unit. Much time was found to be taken up in walking along paths through high bush in order to ascertain if any cultivated land lay along them or at the end of them. This could not be avoided using the method of surveying we adopted but up to date large scale aerial photographs if available would have been very useful for spotting clearings of cultivated land in the bush units and for indicating when there was no need to follow up a path through high bush.

	Sampling Unit 52 (Arabic Unit)	Sampling Unit 76 (Push Unit)
	acres	acres
SE	18.2	77.8
SO	30.7	119.2
SE	3.8	21.6
R	70.5	19.8
F	21.1	76.5
CR	-	-
O	6.9	0.5
C	12.0	-
Co	19.4	51.9
T	-	-
EB	808.6	1014.0
LB	214.3	115.2
W	17.6	6.3
G	40.0	42.5
NA	9.8	12.4
V	27.5	17.3
Total	1520.2	1695.0

VII. COMPILATION OF MAP DATA

The maps of the different sections of sampling units completed by enumerators in the field were used by the supervisors to produce composite maps of each sampling unit on sheets of squared paper, 2 ft. 6 ins. by 2 ft. in size. Tracings of the composite maps produced by the writer of his 2 units are given in Appendices 6 and 7. It was found that it was advisable to fit together the field maps as soon as possible after they had been drawn in the field, and if discrepancies occurred to tackle the enumerators concerned before their memory of the section had become hazy, otherwise a return visit to the unit might be necessary, taking up valuable time and increasing costs.

From the composite maps the area of each of the land utilization divisions in the unit was ascertained by simply counting the 1/10 inch squares (representing 1/10 acre each) covered by each division on the maps. The acreages shown below were calculated by the writer in this manner:

	Sampling Unit 52 (Arable Unit)	Sampling Unit 76 (Bush Unit)
	acres	acres
SE	18.2	77.8
SG	50.7	119.2
SB	3.6	21.6
R	70.5	19.8
F	21.1	76.5
CN	-	-
O	6.9	0.5
C	12.0	-
Co	19.4	51.9
T	-	-
HB	808.6	1014.0
LB	214.3	115.2
W	17.6	6.3
G	40.0	42.5
NA	9.8	12.4
U	27.5	17.3
Total	1320.2	1575.0

Later when it had been decided to sub-divide each first stage sampling unit into 16 second stage sampling units (see the next Section), the acreages of each of the land utilization divisions in each second stage unit were ascertained as outlined above. The compilation of data for each second stage unit was a very laborious process, the writer taking approximately 16 hours to compile the data for the 32 second stage sampling units which constituted his two first stage sampling units. (Appendix 3).

of the strata totals the total acreage estimates for each land utilization division for the total area of the frame were obtained and are given below:

	Acreage
SE	38,560.9
SO	7,564.6
SB	1,113.6
R	3,762.5
Y	2,309.1
CS	22.0
O	241.8
C	1,140.0
Co	3,062.5
T	6.6
HB	36,965.8
LB	4,914.0
W	1,479.5
G	7,399.5
NA	972.0
B	3,168.0
Total	<u>112,642.4</u>

The above estimates take no account of the errors introduced by the sampling process, i.e. the random sampling

VIII. ANALYSIS OF RESULTS

The acreage of each land utilization division measured in the cane and arable stratum was multiplied by 14.757 (the reciprocal of the sampling fraction in this stratum) in order to obtain the total acreage estimate of the stratum for each division. Similarly, the acreage of each land utilization division measured in the bush and plantation stratum was multiplied by 4.104 (the reciprocal of the sampling fraction in this stratum). By addition of the strata totals the total acreage estimates for each land utilization division for the total area of the frame were obtained and are given below:

	Acres
SE	38,660.9
SG	7,384.6
SB	1,113.6
R	3,782.5
F	2,309.1
CN	22.0
O	241.8
C	1,140.0
Co	3,082.5
T	6.6
HB	36,965.8
LB	4,914.0
W	1,479.5
G	7,399.5
NA	972.0
U	3,168.0
Total	112,642.4

The above estimates take no account of the errors introduced by the sampling process, i.e. the random sampling

errors, and these have to be determined for each land utilization division before any reliance at all can be placed upon such estimates. Assuming bias to be absent, the value for the sampling error is a measure of the chance differences between units in the sample and the rest of the population. The random sampling errors of a survey vary with the size of the sample, the variability of the material, the sampling procedure and the way the results are calculated. The actual magnitude of the sampling error to be tolerated in a land utilization survey depends upon the use that is to be made of the results obtained but it is readily seen that the lower the sampling error is, the greater will be the accuracy of the estimate.

Humphrys, whose task it was to analyse the results of this survey, found by the ratio method (Yates. 1953 (b)) that the sampling error of estate sugar cane for the 6 arable units was 35.7%. An error of this size for the most important crop in the area demonstrated that total acreage estimates obtained from the survey as it stood would be unreliable. However, it had always been realized that a second stage sample scheme would be necessary in order to reduce the sampling error, and prior to surveying in the field it had been decided that a random method of sub-division of the first stage sampling units could be carried out later in the office. This sub-division was achieved simply by drawing lines chosen at random on the maps. Mitchell thought of a method of fixing the position of lines required to be drawn at random on the maps and this was adopted (see Appendix 1 for details of the method). It was decided by Humphrys that 16 second stage sampling units in each first stage sampling unit, and 100% sampling of these second stage units was required in order to reduce the sampling errors to reasonable proportions. Therefore 160 sub-units were

demarcated on the maps by sub-division in the office. With 160 sampling units, the sampling error of estate sugar cane using the ratio method was found by Humphrys to be reduced to 9.4%, this figure being of tolerable magnitude in using the results of the survey for many purposes.

Four members of the team each analysed the results of 3 divisions, and the writer 4 divisions out of 16 divisions of land utilization for which acreages were collected. Humphrys found that the ratio method of analysis was very laborious and advised the other 4 members of the team to use the simpler method of determining the variance of the sample total by adding the variances of the strata totals. These variances are obtained by multiplying the sum of squares by $n_1(1-f)$, where n_1 is the number of units in the stratum and f is the sampling fraction, and by multiplying this figure obtained by the square of the raising factor, g^2 (Yates. 1953 (c)).

The writer determined the sampling errors listed below:

SG = 63.6%	(See Appendix 2 for details of
HB = 12.0%	the calculations of these sampling
W = 20.9%	errors).
T = 218.0%	

The sampling errors for the remainder of the land utilization divisions were found to be:

SE = 9.4%	C = 30.9%
SB = 23.8%	Co = 17.8%
R = 21.8%	LB = 21.5%
F = 17.2%	G = 9.8%
CN = 97.6%	NA = 13.8%
O = 33.3%	U = 20.8%

Humphrys found the use of a clip-card system (Jolly. 1950) very valuable for the recording of survey data.

IX. CONCLUSIONS AND RECOMMENDATIONS

It is seen that even when using 160 second stage sampling units the sampling errors obtained were in many cases very high. This indicates that the apparent high degree of variation between and within first stage sampling units had not been allowed for in designing the survey, e.g. arable unit number 52 was found to contain 808.6 acres of high bush whereas arable unit number 56 was found to contain only 2.0 acres of high bush. The results of the survey indicated that contrary to the conjecture of the members of the team at the commencement of the survey the variation between bush units turned out to be less than the variation between arable units, and it is suggested that if a future survey is undertaken the sampling fraction of the arable stratum could be raised and the sampling fraction of the bush stratum could be lowered.

It is obvious that an increase in the number of sampling units chosen would minimize the sampling errors to some extent. However, the greatest improvements in the design of a future survey are likely to be in the method of sampling and the stratification employed. After gaining a more intimate knowledge of the area the writer came to the conclusion that multi-stage sampling, which previously was dismissed as impracticable, would be possible. Many arable units were easily divided into 5 sections by the supervisors for enumeration purposes, and by employing the method of subdivision used by the writer for his bush unit the demarcation of sub-units in the bush and plantation stratum could be achieved without great difficulty.

Humphrys noticed that the variation in estate sugar cane acreages between some arable units was very large and so he experimentally stratified the 6 arable units again into: (i) an "estate sugar cane" stratum and (ii) an "other

arable" stratum to see if he could reduce sampling errors. When he determined the sampling error of estate sugar cane employing this additional stratification he found that the error had been reduced to 5.54%. He also calculated the sampling error of rice employing the triple stratification of the frame and found it to be 18.2% compared with 21.8% determined on the basis of the two original strata. Further stratification for other land use divisions would probably pay dividends in the greater reliability of the estimates in a future survey.

The original idea of choosing a frame which would entail the minimum amount of contact with the local population was found to be a good one, as in brief contacts with peasant farmers the enumerators found great difficulty in understanding the farmers' speech and often found information volunteered to be unreliable. The frame chosen, based on a map, tends to disregard community structure (not however of great importance in this survey) and in the absence of an up-to-date map an appreciable amount of work has to be put in to make the available map accurate enough for use as a frame.

It appears that there was too much field work involved in this survey for the time available as if in the random selection of first stage sampling units a certain number of large units had unfortunately been chosen, such as bush unit number 78 of 6,400 acres and arable unit number 75 of 3,936 acres, in addition to bush unit number 39 of 3,151 acres, then there would not have been time available to complete the survey. In a future survey carried out in similar circumstances, i.e., as a student project, it may be advisable to cut down the size of the frame and if additional information to land use, e.g., soil erosion, was required to be collected at the same time then the frame would have to be reduced.

The method of demarcating first stage sampling units by features easily recognised both on the map and on the ground proved to be a very good method once the inaccuracies of the map had been corrected.

The classification decided upon proved to be workable in the field with the proviso that enumerators should either be trained staff or highly intelligent people to apply the definitions chosen.

The use of sheets of squared paper having 1 inch and 1/10 inch squares marked on them proved to be a great help in mapping. The scale chosen for the enlarged map outlines was very convenient as the knowledge that each 1/10 inch square on the map represented 22 yards x 22 yards on the ground greatly facilitated mapping by the enumerators. It was found that the enumerators in this survey were rarely in doubt over matters in the field and there were few occasions when they needed to obtain a decision from the supervisor. When using people of a lower educational standard as enumerators it would probably be necessary for the supervisor to be present in the field solely to direct operations and not to attempt any surveying and mapping himself.

Pacing in the field was found to be a quick method of measuring distance and from trials carried out the errors involved did not appear to be great in the majority of cases. However, uneven terrain eventually tells on even the fittest enumerator and he may unconsciously take a different length of pace at the beginning of a day to that at the end of a day in the field; this was not checked and a check could be made in a future survey.

The technique used in this survey of measuring up the different divisions of land use by pacing and taking necessary angles with prismatic compass proved to be a very efficient method in the arable areas. The method proved to

be more difficult in the bush units as one could not walk along some boundaries very easily, eg., between high bush and low bush. In the opinion of the writer, however, the method employed is a less costly procedure than cutting line traverses through these bush areas. Up-to-date large scale aerial photographs would greatly facilitate the surveying on the ground of areas of cultivated land in the midst of high bush, but would be useless in differentiating between cocoa with shade trees and high bush.

One of the big lessons learnt from this survey was that a reconnaissance of the sampling unit and subsequent planning of the surveying of the unit in great detail by the supervisor pays great dividends when the enumerators are sent into the field. In cases where certain details had not been covered in planning, for one reason or another, it was found that progress in the field was slowed down considerably. ✓

The office work involved in ascertaining the acreages of each of the land utilization divisions in each of the second stage sampling units was very great. It was however facilitated again by the use of 1 inch and 1/10 inch squared paper. The use of clip-cards for recording the survey data greatly facilitated the calculating required to be carried out on the results.

It was found that the ratio method of calculating sampling errors of the estimates (Yates. 1953 (b)) was very laborious and a simpler method (Yates. 1953 (c)) was adopted. As the results obtained from the two methods were practically identical, it is recommended that the latter method of calculating the sampling errors of the estimates should be adopted in a future survey.

Although one of the objects of the survey, i.e. to evolve the best sampling methods for use in an area such as the Northern Plain of Trinidad, was only partially achieved,

many facts have been brought to light and suggestions made on this matter which, it is hoped, will be of assistance to future workers in this field.

A sample land utilization survey was carried out by a team of five postgraduate students with the twin objects in view of (a) evolving the best sampling methods and (b) investigating the best surveying techniques to employ in an area such as the Northern Plain of Trinidad.

The frame was based on the Trinidad and Tobago Government map of scale 1:50,000. Sampling was carried out at two stages. The first stage sampling units were units of area of minimum size $\frac{1}{4}$ square mile, defined by features which were shown on the map and were also readily identifiable on the ground. A random method of sub-division of each first stage sampling unit into 16 second stage sampling units was carried out in the office after the first stage units had been surveyed in the field. 100% sampling of second stage units was carried out.

The first stage sampling units were stratified into (a) a cane and arable stratum, and (b) a bush and plantation stratum, 92 first stage units comprising the former stratum and 16 first stage units the latter stratum. A sample of 6 first stage units was taken from (a) stratum and a sample of 4 first stage units from (b) stratum. The total acreage of the survey area was 113,646 acres and 13,157 acres of this constituted the total sample taken.

Sixteen land utilization definitions for use in the field were chosen and were applied without difficulty by the enumerators. The time available for survey in the field was limited to the three weeks of the Christmas Vacation and information additional to actual land use was not collected.

The same method of surveying in the field, i.e., the measuring up of the land utilization divisions by pacing

X. SUMMARY

A sample land utilization survey was carried out by a team of five postgraduate students with the twin objects in view of (a) evolving the best sampling methods and (b) investigating the best surveying techniques to employ in an area such as the Northern Plain of Trinidad.

The frame was based on the Trinidad and Tobago Government map of scale 1:50,000. Sampling was carried out at two stages. The first stage sampling units were units of area of minimum size $\frac{1}{2}$ square mile, defined by features which were shown on the map and were also readily identifiable on the ground. A random method of sub-division of each first stage sampling unit into 16 second stage sampling units was carried out in the office after the first stage units had been surveyed in the field. 100% sampling of second stage units was carried out.

The first stage sampling units were stratified into (a) a cane and arable stratum, and (b) a bush and plantation stratum, 92 first stage units comprising the former stratum and 18 first stage units the latter stratum. A sample of 6 first stage units was taken from (a) stratum and a sample of 4 first stage units from (b) stratum. The total acreage of the survey area was 112,646 acres and 13,167 acres of this constituted the total sample taken.

Sixteen land utilization definitions for use in the field were chosen and were applied without difficulty by the enumerators. The time available for survey in the field was limited to the three weeks of the Christmas Vacation and information additional to actual land use was not collected.

The same method of surveying in the field, i.e., the measuring up of the land utilization divisions by pacing

and taking necessary angles with prismatic compass, was employed in both strata, and was found to be satisfactory.

The results obtained from the survey showed that with the majority of land utilization divisions the random sampling errors were much too high for reliance to be placed on the acreage estimates for most purposes. It was thought that great improvements could be achieved in the method of sampling and the stratification employed in a future survey.

to proceed on their land.

ACKNOWLEDGEMENTS

The writer wishes to record his thanks for the assistance and advice given by his supervisor, Dr. A.L. Jolly, also for the assistance given by the other members of the survey team in carrying out this survey.

He is also indebted to owners and managers of estates and farmers who gave permission for surveying to proceed on their land.

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APPENDIX 1

METHOD OF DIVIDING A SAMPLE UNIT INTO THE REQUIRED
NUMBER OF SUB-UNITS

From tables of random numbers a set of compass bearings corresponding to the number of lines required was obtained. By placing a straight edge (a piece of black cotton stretched between two weights was found to be very convenient in the writer's case) across the map of the sampling unit at the first bearing, in relation to north on the map, and moving this straight edge at right angles to its length across the map, the area of the sampling unit could be divided into halves if the area on one side of the straight edge was made equal to the area on the other side. In order to facilitate the estimation of equal areas a grid was prepared by each supervisor to place beneath his map tracings. These grids of squared paper had the 1 inch squares inked in in one colour and the $\frac{1}{2}$ inch squares inked in in a different colour to facilitate counting, the $\frac{1}{10}$ inch squares were left untouched. When the first line had been drawn in, the second line was drawn in in a similar manner by manipulating the straight edge across one half of the sampling unit at the chosen bearing, thus dividing this half into two further areas equal to $\frac{1}{4}$ of the area of the sampling unit. Similarly, the other half was divided until the whole area was in quarters. These quarters can then be sub-divided in a similar manner ad infinitum until the desired number of sub-units has been obtained.

APPENDIX 2

THE ESTIMATION OF THE SAMPLING ERRORS OF THE ESTIMATES

SG.

Strata	n_i	n_i-1	Sy^2	S_i^2	$V\{S_i(y_i)\}$	$V(Y_i)$
A	96	95	107465.00	1131.21	6326.86	22,046,171.37
B	64	63	2549.59	40.47	122.44	32,999.88
						<u>22,079,171.25</u>

$$\begin{aligned} \text{Sampling error} &= \sqrt{22,079,171.25} \\ &= \pm 4698.8 \end{aligned}$$

n_i = the number of units in the stratum.

Sy^2 = the sum of the squares.

$S_i^2 = \frac{Sy^2}{n_i-1}$ i.e. the estimated within strata variances.

$V\{S_i(y_i)\} = S_i^2 \times n_i(1-f_i)$ i.e. the variance of the strata total.

$V(Y_i) = V\{S_i(y_i)\} \times g_i^2$ i.e. the variance of the strata total where g_i is the raising factor.

$$\begin{aligned} \left. \begin{array}{l} \text{Sampling error as a percentage of the} \\ \text{total estimate of SG. in the area surveyed} \end{array} \right\} &= \frac{4698.8}{7384.6} \times 100 \\ &= 63.6\% \end{aligned}$$

HB.

Strata	n_i	n_i-1	Sy^2	S_i^2	$V\{S_i(y_i)\}$	$V(Y_i)$
A	96	95	52779.87	555.58	49720.81	10,827,650.64
B	64	63	673468.43	10689.43	517469.38	8,716,771.71
						<u>19,544,422.35</u>

$$\begin{aligned} \text{Sampling error} &= \sqrt{19,544,422.35} \\ &= \pm 4421.0 \end{aligned}$$

$$\begin{aligned} \left. \begin{array}{l} \text{Sampling error as a percentage of the total} \\ \text{estimate of HB in the area surveyed} \end{array} \right\} &= \frac{4421.0}{36965.8} \times 100 \\ &= 12.0\% \end{aligned}$$

W.

Strata	n_i	n_i-1	S_y^2	S_i^2	$V\{S_i(y_i)\}$	$V(Y_i)$
A	96	95	515.68	5.43	485.77	105,786.30
B	64	63	8.27	1.29	62.45	1,051.89
						<u>106,838.19</u>

$$\begin{aligned} \text{Sampling error} &= \sqrt{106,838.19} \\ &= \pm 326.8 \end{aligned}$$

$$\begin{aligned} \left. \begin{array}{l} \text{Sampling error as a percentage of the} \\ \text{total estimate of W in the frame} \end{array} \right\} &= \frac{326.8}{1479.5} \times 100 \\ &= 20.9\% \end{aligned}$$

T.

Strata	n_i	n_i-1	S_y^2	S_i^2	$V\{S_i(y_i)\}$	$V(Y_i)$
A						
B	64	63	16.0	0.254	12.29	207.11

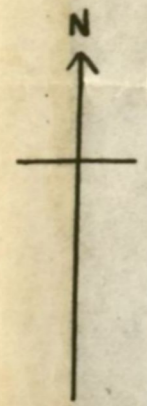
$$\begin{aligned} \text{Sampling error} &= \sqrt{207.11} \\ &= \pm 14.4 \end{aligned}$$

$$\begin{aligned} \left. \begin{array}{l} \text{Sampling error as a percentage of the total} \\ \text{estimate of T in the area surveyed} \end{array} \right\} &= \frac{14.4}{6.6} \times 100 \\ &= 218\% \end{aligned}$$

APPENDIX 3

DATA OF THE SECOND STAGE SAMPLING UNITS

SECOND STAGE SAMPLING UNITS		ACREAGES OF LAND UTILIZATION DIVISIONS														TOTAL (ACRES)
		SE	SG	SB	R	F	O	C	Co	HB	LB	W	G	NA	U	
52	1	-	12.5	3.6	0.3	3.5	-	8.0	18.7	11.1	17.1	0.3	4.4	4.2	0.9	84.6
	2	-	4.7	-	1.6	1.5	1.2	-	0.7	25.3	15.0	-	10.7	0.7	7.1	68.5
	3	-	-	-	-	-	-	-	-	47.4	24.5	0.8	3.6	0.4	2.9	79.6
	4	-	3.1	-	28.4	2.3	-	-	-	47.1	1.9	0.4	2.3	0.4	1.5	87.4
	5	-	-	-	23.9	-	-	-	-	45.4	5.4	7.2	1.1	0.6	0.6	84.2
	6	-	-	-	-	-	-	-	-	85.0	1.0	-	1.3	0.5	-	87.8
	7	-	-	-	-	-	-	-	-	78.8	-	-	1.0	-	-	79.8
	8	-	-	-	2.9	-	-	-	-	72.3	9.9	0.9	1.1	-	-	87.1
	9	2.7	5.5	-	8.7	-	-	-	-	39.2	10.4	3.7	2.1	0.5	7.0	79.8
	10	15.5	10.7	-	3.7	9.4	2.7	3.1	-	14.4	29.9	-	3.3	0.9	1.6	95.2
	11	-	14.2	-	0.6	4.4	2.2	0.9	-	20.5	31.2	0.6	0.8	0.9	5.7	82.0
	12	-	-	-	-	-	0.8	-	-	32.1	37.0	-	6.7	0.4	0.2	77.2
	13	-	-	-	0.4	-	-	-	-	54.5	19.2	3.4	0.1	-	-	77.6
	14	-	-	-	-	-	-	-	-	82.3	2.2	-	0.4	-	-	84.9
	15	-	-	-	-	-	-	-	-	73.1	0.3	0.3	0.5	-	-	74.2
	16	-	-	-	-	-	-	-	-	80.1	9.3	-	0.6	0.3	-	90.3
TOTAL (ACRES)		18.2	50.7	3.6	70.5	21.1	6.9	12.0	19.4	808.6	214.3	17.6	40.0	9.8	27.5	1320.2
76	1	-	18.7	0.7	-	5.3	-	-	-	54.5	18.6	-	1.3	1.6	-	100.7
	2	-	29.5	2.9	-	5.3	-	-	-	58.7	3.3	-	0.3	-	-	100.0
	3	-	12.5	0.3	-	9.0	-	-	-	51.7	25.0	-	0.9	0.6	-	100.0
	4	-	14.3	1.9	1.2	6.5	-	-	0.6	71.5	3.7	-	0.1	0.2	1.0	101.0
	5	7.4	3.7	1.0	1.2	2.4	-	-	2.8	78.3	0.2	0.5	3.5	0.4	0.1	101.5
	6	13.5	6.5	2.5	0.6	0.2	-	-	9.3	44.7	8.2	1.8	9.9	1.6	0.6	99.4
	7	40.7	0.5	-	1.0	-	-	-	0.1	29.5	10.1	1.4	10.9	2.0	3.2	99.4
	8	11.7	6.3	4.7	-	0.6	-	-	-	65.6	2.0	1.0	4.3	1.0	0.6	97.8
	9	4.5	17.0	5.4	8.6	6.1	-	-	-	31.6	1.3	1.6	5.4	1.7	7.3	90.5
	10	-	1.9	0.6	7.0	1.6	0.5	-	0.4	77.1	1.6	-	3.4	1.2	2.8	98.1
	11	-	-	-	0.2	2.4	-	-	26.2	66.0	1.9	-	0.7	0.1	-	97.5
	12	-	-	-	-	2.1	-	-	6.6	91.2	0.4	-	1.0	0.8	1.7	103.8
	13	-	-	-	-	16.0	-	-	0.8	53.8	18.4	-	0.5	1.2	-	90.7
	14	-	-	-	-	6.1	-	-	-	88.5	0.5	-	-	-	-	95.1
	15	-	-	-	-	3.7	-	-	5.1	83.8	6.8	-	0.1	-	-	99.5
	16	-	8.3	1.6	-	9.2	-	-	-	67.5	13.2	-	0.2	-	-	100.0
TOTAL (ACRES)		77.8	119.2	21.6	19.8	76.5	0.5	-	51.9	1014.0	115.2	6.3	42.5	12.4	17.3	1575.0



SECTION 1

SECTION 2

SECTION 3

SECTION 4

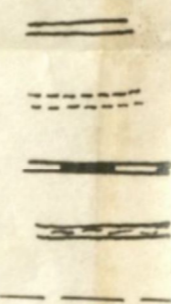
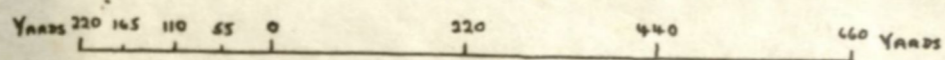
SECTION 5

DEPOT RIVER

LONGDENVILLE

Map to show the division of sampling unit 52 into sections for surveying in the field.

Scale 1 inch to 220 yards or 8 inches to 1 mile.



Reference

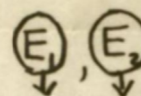
Pitched roads

Non-pitched roads and traces.

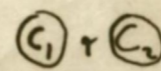
Government Railways

Depot lines.

A section boundary not recognizable on the ground.



Starting points of the enumerators

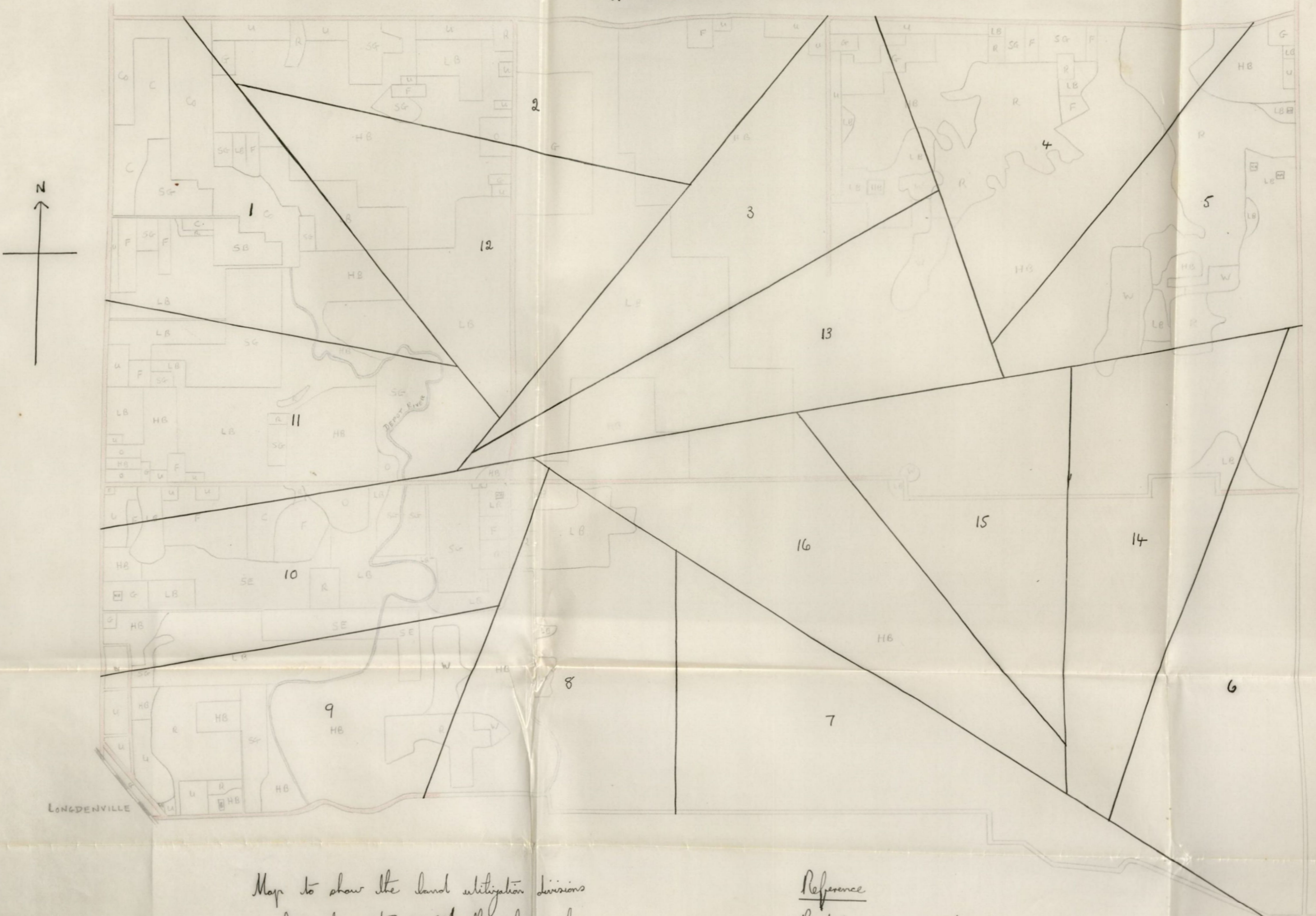


Places where 2 cars parked at the commencement of surveying.



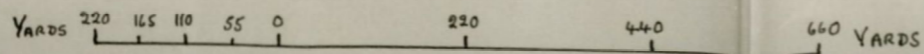
Rendezvous point.

APPENDIX 6



Map to show the land utilization divisions of sample unit 52 and the lines of demarcation of the 16 sub-units.

Scale 1 inch to 220 yards
or 8 inches to 1 mile.



Reference

- ==== Paved roads or gravel roads.
- ==== Traces.
- ==== Government Railway.
- ==== Rivers.
- ==== Boundaries of sub-units.

SE	Estate sugar cane.	Co	Cocoa, bananas & coffee (separate or mixed).
SG	Farmer's sugar cane (good).	HB	High bush.
SB	" " (bad).	LB	Low bush.
R	Rice.	W	Rivers and swamps.
F	Food crops.	G	Grazing
O	Orchard crops.	NA	Non agricultural use.
C	Citrus.	U	Urban areas.