A SOIL AND AGRICULTURAL SURVEY
OF PART OF THE SAN FRANCISCO
LAND SETTLEMENT, AND A DISCUSSION
OF LAND SETTLEMENT SCHEMES IN
TRINIDAD.

by

A. F. Heberden, B.Sc. Agric. (Natal).

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INTRODUCTION

An appraisal in 1944 of Trinidad's land resources based on an unpublished provisional soil map and other data (A proposed land Allocation Policy for Trinidad, 1944) concluded that only $37\%$ of the island's total area was really suitable for agriculture. Of the land suitable for agriculture a large proportion is devoted to the production of the important export crops such as sugar and cocoa. At the same time it was estimated that $14\%$ of the area that was being cultivated was definitely unsuitable for permanent agricultural use. Thus it appears that only a relatively small area of land is fitted for the production of food crops.

With the ever increasing population in Trinidad it is essential, therefore, that the best use of the available agricultural areas should be made. Suitable farming systems and practices, especially for small-scale farming, together with greater intensification of the present production of food crops in suitable agricultural areas should be encouraged. At the same time, attention should be paid to the possibilities of extending agricultural production to areas at present considered unsuitable for agriculture. A large area on the steep hill sides of the Northern Range is considered unsuitable for cropping due to serious danger of soil erosion and flooding. A permanent high water table at the mouths of certain of Trinidad's rivers gives rise to fairly large areas of swamp land. Furthermore, there are extensive areas of unproductive and semi-derelict land in central Trinidad which is mainly due to poor soil fertility.

Government has been investigating the possibility of draining and reclaiming the Nariva Swamp which would appear to be a very costly procedure to open up new land for food crop production. The author, however, feels that more emphasis should be placed, in the initial investigations at any rate, on the possibility of reclaiming land in the Northern Range and also the extensive areas of unproductive land in Central Trinidad. Soil conservation measures as practised in St. Vincent, for example, have shown that it is possible to make good use of the similar steep slopes. However, investigations under local conditions should first be carried out. Dr. Greene in his visit to Trinidad in 1956 posed the question whether it would not be more economical in the long run to invest capital in building up the soil fertility of the extensive areas in Central Trinidad rather than the Swamp Drainage Projects being considered by Government.

This project is a continuation of work started in 1956 (See Supervisor's note) by Orr (1957), Clark (1957) and others. The aims of this project were:

1. To provide standards for the recognition of the different soil series to be found in San Francisco Land Settlement.
2. To map the topography and soil boundaries in the above area.
3. To determine and map the present land use of the above area.
4. To study Land Settlement Schemes in Trinidad with special reference to the San Francisco settlement.

It is hoped that when the complete land settlement is surveyed, the work may be of some use to those directing, and farming, the settlement. The project has provided the author with valuable experience of small scale settlement schemes.
A. CLIMATE: Rainfall in Trinidad varies considerably and in general decreases from East to West. Clark (1957) studied the records of four stations in the Southern part of the Caroni plain and obtained figures which were closely representative of the San Francisco Land Settlement area. Over a 25 year period, the mean annual precipitation of 68 inches showed a marked seasonal pattern, with a mean monthly precipitation of 2.6 inches from January to May, and 7.8 inches from June to December.

B. VEGETATION: The vegetation of Central Trinidad has been fully described by Beard (1946). The whole area was covered by Evergreen Seasonal Forest before Trinidad was colonised. Small patches of Semi-evergreen Seasonal Forest have been found on the drier hilltops of the Central Range but the area covered by this survey has a very mixed vegetation and is entirely secondary.

C. GEOLOGY: The rocks of Central Trinidad are entirely sedimentary with representatives from the whole sequence between Holocene and Lower Cretaceous. In the area under investigation the strata dip to the North-West forming successfully older formations as one travels south-east towards the Central Range. According to Suter (1954) and information obtained from the Dominion Oil Company by Orr (1957), the area under investigation is located over the geological "Talparo formation" which is marked as 95% Talparo Clay.

D. TOPOGRAPHY: The area under investigation is a dissected peneplain formed in the Pleistocene Age. This peneplain slopes to the north-west. The dissected peneplains rise to 50-200 feet giving rise to steep slopes, narrow ridges and a very sharp undulating topography. The Couva river is the main drainage basin in the area surveyed, with one or two subsidiary valleys supplementing it.

3. METHOD OF SURVEY

A. LOCATION OF SAN FRANCISCO LAND SETTLEMENT

The area surveyed by the author and his co-worker, I. Eleje, was the western block of the above settlement near Freeport. The exact location and boundaries can be obtained from Clark's map 3 (Clark, 1957). The area surveyed was approximately 40 - 45 acres.

For the purpose of the survey a tracing of a 1:2500 map of the settlement was obtained from the Agricultural assistant, Caroni County. Copies of this map were used in the initial survey work because of their ease in carrying and plotting in the field.
Later, an enlarged version of the map drawn to scale (1:1250) was used to do the final plotting and mapping of all survey work and maps 1 and 2 (see appendix) are produced from it.

B. TRAVERSES:

After a general reconnaissance of the area it was decided to use the Southern boundary of the settlement as the base line for the survey work. This was a straight line measuring 19 Gunther's Chains (418 yards) long. From this cleared base line 5 traverses were to be cut at right angles to the base line at 88 yards intervals and a sixth traverse 66 yards from the fifth traverse. It was impossible to supervise the actual outlassing of the traverses through the bush and, due to a misunderstanding on the part of the labourers, about the base pegs, traverse four was mistakenly cut 6 chains (132 yards) from traverse three instead of 4 chains (88 yards). As a result only five traverses were cut through the bush. Again, due to the lack of close supervision, it was found that some of the traverses were not cut at right angles to the base line as can be seen in map I.

The length of the traverses varied from 22 Gunther's chains (484 yards) for traverse three to 8½ chains (176 yards) for traverse five. Distances from one chain apart, to three or four chains apart, depending on the conditions found along the traverse.

C. METHOD OF SOIL SAMPLING IN THE FIELD:

All samples taken along traverses were taken in the following manner. A small hole 15 - 18 inches deep and 12 inches square was dug with a spade. One side of the hole was chipped away by means of a trowel to expose a miniature profile. On examination this profile was divided into horizons. Brief notes were made in the field of the colour, texture and structure of each horizon, and also evidence of earthworm activity, depth of humus penetration, presence of concretions and internal drainage status. Notes on the vegetation and crops being grown in the vicinity were also taken. A sample of each horizon was then taken and brought back to the laboratory. A one inch screw auger was used to sample to 45 inches, samples brought up being grouped into horizons and their colour and texture noted. Later it was decided to make more detailed notes on the colour, texture and structure of each horizon in the Laboratory in order to speed up the field work.

D. SOIL PROFILE PITS:

Profile pits were dug to a depth of six feet in areas which were representative of a particular type of soil. These were sampled in the usual way by taking samples at each horizon down the profile. A detailed description of the complete profile was taken in the field. Samples were brought back to the laboratory for further study.
E. LABORATORY EXAMINATIONS:

All samples taken in the field were brought back to the laboratory where the samples for each small pit were laid out in their respective horizons in split bamboos for reference purposes. The bamboos were all treated against the beetle borer (a Dinoderus Specie). The large number of soil samples collected were studied closely. The pH values of the various horizons were also determined and the soils grouped and identified by means of Chenery's (1952) descriptions of the soils of Central Trinidad, and the work of Orr (1957), Clark (1957) and others.

Samples from the soil profile pits were put in standardised soil profile boxes. The colour descriptions of the soil profiles were based on the Munsell Soil Colour Charts (1954). Texture was determined by means of finger tests compared with standard samples which had been analysed. The terms used for structure are those of the U.S.D.A. Soil Survey Manual (1951).

F. VEGETATION SURVEY:

The units of vegetation used were based partly on those used in routine surveying in S.W. Nigeria (Vine, 1954). Notes of the vegetation and crops were made while taking soil samples along each traverse. These were supplemented by observations and a general reconnaissance over the area, boundaries being roughly paced where necessary. The vegetation and land use map was then drawn (See map 2.).

G. TOPOGRAPHICAL SURVEY:

This was done by the aneroid barometer method employed in Nigeria (Vine, 1954). Owing to the irregular spacing of the traverses, due to the error explained above, it was impossible to use them for obtaining a grid for drawing in contour lines. Thus seven traverses at 66 yard intervals were used. Readings were taken at 50 yard intervals (determined by pacing) with the aid of a compass to follow the traverse through the bush. As no bench mark was available these were referred to one of the contours in Clark's (1957) map 4, whose position could be fixed reasonably accurately from the features on the map. With the aid of these fixed points, aerial photographs and a knowledge of the drainage areas, form lines were inserted with reasonable accuracy.

RESULTS OF SURVEY

A. THE SOILS.

Map 1 shows the distribution of the soil series found in the area. There are seven soils found, namely: Couva, Freeport, Ecclesville, Moruga, Talparo series, "Sandy" Ecclesville subseries, and Valley Sands and Muds.

A. COUVA SERIES:

This soil series was found on the terraces adjoining the Couva River. Generally
there was a narrow lower terrace above which was a much broader terrace. The topsoil consists of a layer of dark brown silt to silty loam of varying depths up to 20 inches. Below this yellowish brown to brown silty loam occurs. The structure of the soil is most highly developed in the top few inches of the profile which tends to become structureless below 20 inches.

With a few exceptions, where bananas are grown, the whole of this soil series is planted to cocoa. Most of the cocoa has been planted in the last few years and some of the settlers intend to plant more. The cocoa appears to be doing very well which indicates a fairly good soil nutrient status, probably due to the recent alluvium brought down from the Central Range. This soil is the best in the area for tree crops because of its light loamy texture to great depth which enables the roots of the tree crops to penetrate the soil very easily in search of nutrients and moisture. This is borne out by the fact that there is no root mat in the top few inches of the profile which is common in soils of less permeability and heavier texture.

Profile description (Pit C24 C - Couva 24 - No. of holding.)

<table>
<thead>
<tr>
<th>Topography:</th>
<th>Level terrace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation:</td>
<td>Cocoa, with banana and Immortelle shade.</td>
</tr>
<tr>
<td>Drainage:</td>
<td>Free</td>
</tr>
<tr>
<td></td>
<td>0 - 2&quot; pH 6.1 (MT.674)</td>
</tr>
<tr>
<td></td>
<td>Dark brown (7.5 YR 3/2) silt to silty loam.</td>
</tr>
<tr>
<td></td>
<td>Fine crumb structure under leaf litter. No root mat. Firm and friable.</td>
</tr>
<tr>
<td></td>
<td>Worm action.</td>
</tr>
<tr>
<td>2 - 9&quot;</td>
<td>pH 6.5 (675)</td>
</tr>
<tr>
<td></td>
<td>Greyish brown (10 YR 5/2) silt to silty loam.</td>
</tr>
<tr>
<td></td>
<td>Granular structure. Soft and friable.</td>
</tr>
<tr>
<td>9 - 19&quot;</td>
<td>pH 6.4 (676)</td>
</tr>
<tr>
<td>19 - 33&quot;</td>
<td>pH 6.2 (677)</td>
</tr>
<tr>
<td>33 - 42&quot;</td>
<td>pH 5.9 (678)</td>
</tr>
<tr>
<td>42 - 49&quot;</td>
<td>pH 5.9 (680)</td>
</tr>
<tr>
<td>49 - 58&quot;</td>
<td>pH 6.2 (681)</td>
</tr>
<tr>
<td></td>
<td>Yellowish brown (10 YR 5/4) silty loam. Structureless. Very soft. Fine, small roots observed. Also small holes which could possibly be worm holes or old root channels left from previous vegetation.</td>
</tr>
<tr>
<td>58 - 63&quot;</td>
<td>pH 6.2 (682)</td>
</tr>
<tr>
<td>63 - 72&quot;</td>
<td>pH 6.0 (683)</td>
</tr>
</tbody>
</table>
2. **FRESPORT SERIES:**

This series occupies an extensive area on a broad intermediate terrace on both sides of the river Couva. The topsoil is a dark grey brown to yellowish brown loam overlying mottled material in the region of 8 - 10 inches. The profile pit was dug to 90 inches and it shows a definite parent material of shale in the lower profile. Carbonate tests were negative but cold hydrogen peroxide tests showed that there was an even distribution of manganese dioxide down the profile with greater concentrations from midway down to the bottom. The pit, which was dug in the dry season, was widely cracked to a depth of about 47 inches where the parent material begins to appear. During the wet season, however, the clays tend to pack together and in some places it was noticed that a certain amount of free water was held.

**Profile description:**

<table>
<thead>
<tr>
<th>Topography</th>
<th>Drainage</th>
<th>Vegetation</th>
<th>pH</th>
<th>Color Code</th>
<th>Structure</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad upper terrace</td>
<td>Imperfect</td>
<td>Orange, Cashew trees, bamboo grass.</td>
<td>5.4</td>
<td>2.5Y 4/2</td>
<td>Granular</td>
<td>Friable.</td>
</tr>
<tr>
<td>0 - 2&quot;</td>
<td>4.9</td>
<td>Dark grey brown (2.5Y 4/2) loam. Small root channels. Granular structure. Friable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(NT.652)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - 7&quot;</td>
<td>4.9</td>
<td>Grey brown (10 YR 5/2) fine sandy loam. Small root channels present. Granular structure. Friable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(653)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - 12&quot;</td>
<td>4.9</td>
<td>Light yellowish brown (10 YR 6/4) clay loam with very slight yellowish brown mottling (10 YR 5/6). Sub-angular blocky structure. Hard but friable. Roots and root channels still present.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(654)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(655)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 - 24&quot;</td>
<td>4.8</td>
<td>Light grey (2.5Y 7/2) with strong brown (7.5YR 5/6) mottling. Clay loam. Sub-angular blocky structure. Hard and dense. Small roots present.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(656)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 - 30&quot;</td>
<td>4.8</td>
<td>Light grey (2.5Y 7/0) with strong brown (7.5YR 5/8) mottling. Silty clay. Practically Structureless. Fairly hard and dense. Roots and what appeared to be soft bodied insects living in old root channels.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(657)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 - 38&quot;</td>
<td>4.7</td>
<td>Grey (10 YR 6/1) with yellow brown (10 YR 5/6) mottling. Silty clay. Practically structureless. Fairly soft and dense with small roots.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Profile description

Topography: Middle of a fairly steep slope
Vegetation: Three-year-old cocoa with banana, cassava and Immortelle shade.
Drainage: Impeded.

0 - 2" pH 6.6 (MT.638) Very dark brown (10 YR 2/2) silt loam. Granular structure. Friable. Roots and worm holes present.
6 - 12" 5.2 Dark yellowish brown (10 YR 4/4) silt loam. Sub-angular block structure. Brittle and soft. Roots and worm holes present.

12 - 18" 5.2 Yellowish brown (10YR 6/6) with white (10 YR 8/1) mottling. Silty clay loam. Sub-angular blocky structure. Brittle and soft.

18 - 22" 5.3 Brownish yellow (10 YR 6/6) with white (10 YR 8/1) mottling. Silty clay loam. Sub-angular blocky structure. Brittle and soft.

22 - 26" 5.1 Reddish yellow (7.5 YR 6/6) with white (10 YR 8/1) mottling. Silty clay loam. Sub-angular blocky structure. Brittle and soft.

26 - 31" 5.2 Light grey (5Y 7/1) with reddish yellow (7.5 YR 7/8) mottling. Silty clay. Practically structureless. Brittle and soft. Roots and worm holes still present.

31 - 40" 5.3 Light grey (5Y 7/1) with brownish yellow (10 YR 6/6) mottling. Silty clay. Structureless. Dense and cloddy. Fine roots present.

40 - 47" 5.2 Light grey (2.5Y 7/0) with strong brown (7.5YR 5/6) mottling. Clay. Structureless. Dense and cloddy. Fine roots present.


54 - 61" 4.8 Grey (5Y 6/1) with red (10 YR 5/3) mottling. Fine sandy clay. Structureless. Dense and soft.


71 - 76" 5.1 Grey fine sandy clay (5Y 6/1) with strong brown (7.5 YR 5/8) mottling. Structureless. Very soft.

Pine sandy clay parent material was first observed at 54 inches in the profile.

4. 'SANDY' ECCLESVILLE SUB-SERIES:

This sub-series, like the normal series, is found along slopes and ridges, but it is a more sandy topsoil than the Ecclesville series described by Chenery (1952). It appears to have lost most of its humic topsoil, probably because of erosion in the past. From 16 inches downwards there was heavy clay cracking into massive clods on drying. Free sand was found in the profile from 20 inches to 43 inches. Manganese dioxide was found throughout the profile. Worm holes and worm casts were found to a depth of 50 inches. Profile characteristics below the top sandy layer were very similar to Ecclesville series.

Profile description: (Pit D 35)

Topography: Middle of gentle slope.

Vegetation: Orange grove.

Drainage: Imperfect.
5. MORUGA SERIES:

This series is derived from very variable fine sand-silt-clay shales of Pliocene Age. The soils are generally found on slopes and ridges. The topsoil is yellowish brown fine sandy loam becoming a light brownish grey with strong brown mottling lower down the profile. Thus Moruga series differs from the "Sandy" Ecclesville sub-series in the colour of the topsoil but not in texture. Carbonate tests were found to be negative but manganese dioxide was evenly distributed over the profile. The profile pit was heavily cracked from about 30" downwards. Roots were observed to a depth of 72" and worm casts, holes and insect activity to about 35".

Profile description (Pit A33).

Topography: Flat top of a fairly steep hillock.
Vegetation: Secondary bush with Black Sage (Cordia Cylindrostachya) dominant.
Drainage: Imperfect.

0 - 1" pH 5.7
(NT. 628)

1 - 4" 5.6
(629)

4 - 10" 4.9
(630)


0 - 1" pH 5.6
(NT. 618)

1 - 4" 5.9
(619)

4 - 12" 5.5
(620)

12 - 16" 5.3
(621)

16 - 20" 5.4
(622)

20 - 32" 5.5
(623)

32 - 48" 5.1
(624)

48 - 60" 4.9
(625)

60 - 72" 5.4
(626)

72 + 6.0
(627)


Grey (7.5 YR 5/0) with reddish yellow (7.5YR 6/6) mottling. Clay. Structureless. Very hard and laminated.


Light grey (10 YR 7/1), with yellowish brown (10 YR 5/4) mottling. Silty clay. Structure less developed. Very hard.


6. FREIGHT - ECOLESVILLE TRANSITION SOIL:

This profile pit was sited at the lower part of a fairly steep slope - the upper part being Ecoesville and the lower part of the slope being Freeport series. The profile illustrates how similar the two soil series are. The topsoil consists of a poorly drained transported silty clay to loam. The profile pit shows wide cracking from 24 inches downwards but little evidence of surface cracking. Carbonate tests were negative. White crusts of salt were observed on the surface of the lower profile. These crusts appear to have been deposited after seepage water had evaporated from the surface of the profile.

Profile description: (Pit F/E 25)

Topography: Lower part of a steep slope.
Vegetation: Orange grove with pigeon peas and bamboo grass (Fasciculatum).
Drainage: Imperfect.

<table>
<thead>
<tr>
<th>Depth</th>
<th>pH</th>
<th>Color Description</th>
<th>Texture</th>
<th>Structure</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2&quot;</td>
<td>6.1</td>
<td>Dark greyish brown (10 YR 4/2) loam. Granular structure. Friable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - 5&quot;</td>
<td>5.8</td>
<td>Dark greyish brown (10 YR 4/2) loam. Sub-angular blocky structure Friable.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 16&quot;</td>
<td>5.0</td>
<td>Brown (10 YR 5/3) with a faint trace of orange mottling. Silty loam. Angular blocky structure. Friable but hard.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 - 20&quot;</td>
<td>5.1</td>
<td>Light brownish grey (2.5Y 6/2) with strong brown mottling (7.5YR 5/6) Silty loam. Angular blocky structure. Friable but hard.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 24&quot;</td>
<td>5.1</td>
<td>Light brownish grey (2.5Y 6/2) with a more predominant strong brown mottling (7.5YR 5/6) Silty loam. Prismatic structure. Hard and dense.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
24 - 31" pH 5.0 Strong brown (7.5 YR 5/6) with light grey mottling (2.5Y 7/0) Silty clay. Practically structureless. Hard and dense.
31 - 44" Light grey (2.5 Y 7/0) with brown mottling (7.5YR 5/4) Clay Structureless. Hard and dense.
44 - 52" Grey (2.5Y 6/0) with brown patches (7.5Y 5/4). Clay. Structureless Soft and dense.
59 - 65 Grey (2.5Y 5/0) with an equal amount of yellowish brown (10 YR 5/4). Zones of shale parent material can be distinguished within the clay. Structureless. Soft and dense.
65 - 72" Grey (2.5Y 5/0) with an equal amount of yellowish brown (10YR 5/4). Laminated clay shale. Soft and dense.

7. TALPARO SERIES:

There was only a very small strip of this Talparo series found at the southwestern corner of the Settlement (See Map 1.). A soil profile pit was not dug, but a number of auger samples were taken. To a depth of about 6" the samples were a yellowish brown silty clay. From 6 - 12" there was an orange mottling while deeper a stiff reddish-grey mottled clay was found. Internal drainage is impeded, and is negligible after the dry season cracks have been sealed up. Chenery (1952), however, says that during the time the cracks are open a great deal of water may find its way to the shaly clays via gypsum veins, old root traces and bedding planes. If the slope is very steep, the wet clay-dry clay shale contact will be lubricated to such an extent that the wet mass will slide over the dry clay, resulting in land slippage. This is what appears to have happened in this case, as land slippage has taken place from the higher slopes just outside the Settlement area. (See Map 1).

8. VALLEY SANDS AND MUDS:

These soils were only found in the low lying areas and valley bottoms and varied considerably. They tend to have more sand and clay in the upper part of the profile than the soils on the higher lying ground. Generally speaking they were found under rice cultivation and have a seasonal high water table. They are generally waterlogged and structureless during the wet season but dry out considerably in the dry season, the water table dropping 2 - 3 feet.

B. PRESENT LAND USE AND VEGETATION:

The present land use and vegetation are shown on Map 2. From this map, it can be seen that cocoa, citrus and to some extent bananas are the main tree crops being grown. Some holdings are attempting to grow food crops such as rice, cassava, okra, and pigeon peas, and some maize and tomato were grown with reasonable success on holding 34. On the whole, however, it does not appear as if the settlement is being cropped to any great extent. Most holdings contain a small area of vegetable and other
provision crops while some of the more progressive have small citrus orchards and cocoa. Some of the holdings have extensive areas of thicket consisting mainly of Black Sage (Cordia cylindrostachya) and Bamboo grass (Paspalum fasciculatum).

In general one cannot distinguish any close correlation between cropping and soils found on the settlement. Most holdings only cover two or three soil types. However, the general impression obtained is that cocoa is being planted mainly on the low lying and sheltered Couva series, found along the banks of the river Couva. Bananas are often interplanted for shade purposes. From the excellent growth and progress shown by the cocoa planted in holding 24, for example, this soil is well suited to the production of cocoa. Cocoa is not so well suited to the other soils on which it is grown (eg. on Freeport series on holding 26, where the growth is not nearly so luxuriant).

Citrus has been planted mainly on the higher ground and is found on several soil types. It is difficult to assess the suitability of these different soils to the growth of citrus as the various peasant holders do not appear to be using any similar cultural treatment. Citrus, however, responds readily to fertilizers and consequently it can be profitable grown on less fertile land than is needed for Cocoa.

Rice has been planted only in the low lying swampy areas during the wet season. The standard of rice cultivation did not appear to be very high. The author was unable to obtain reliable information of the yields obtained but the rice on holding 35 was only fair due to weed growth.

The various provision crops are not grown to any great extent and are grown, with varying success, on a number of different soil types. Much of the success, or otherwise of these crops, depends on the diligence of the settler. It appears, however, that this settlement is a "part-time" settlement (see later) and the settlers seek outside employment on the neighbouring sugar estates.

Very little livestock was seen on the settlement. There were two or three head of cattle on holding 29 last year but these have since been sold. A donkey is kept in a small pen on holding 30. Apart from a few goats and fowls around the homestead, no other livestock was seen. There is very little scope for grazing of livestock on the settlement - apart from some patches of grassy thicket.

The author is of the opinion that this settlement is more of a housing settlement rather than a land settlement. Very few of the settlers obtain much if any, in the way of income from their holdings.
V. DISCUSSION OF LAND SETTLEMENT SCHEMES IN TRINIDAD WITH PARTICULAR REFERENCE TO THE SAN FRANCISCO LAND SETTLEMENT.

In the British West Indies there are large problems of settling unemployed, or under-employed, persons on the land in order that they may provide their own food supplies. With the ever increasing population more and more food is required. This has resulted in a major problem, in fact, a paramount necessity, of widening the range of agriculture in the West Indies, particularly in the direction of growing more foodstuffs. Most of the trouble of the West Indies have resulted from excessive specialisation on a single crop - sugar. In the case of Trinidad, sugar, with other major export crops such as cocoa and citrus, run on an estate basis mainly, do not, without income from oil, produce a sufficient income to enable importation of foodstuffs for the already heavily populated island.

The history of land settlement in the West Indies is a long and complicated one, and it goes back to the last century. The author had difficulty in obtaining information about the history of land settlements in Trinidad, but a considerable amount of information is filed in the Department of Agriculture, Trinidad and Tobago. However, to peruse these files would require considerable time and energy, beyond the scope of this project. A suggestion was made by a member of the Department that a survey of the history of land settlement schemes in Trinidad should be undertaken.

Engledow (1945) in his report on Agriculture in the West Indies stated that much attention should be given to the special requirements of land settlement. He stated that the special requirements would vary in details depending on the local conditions but that the following were some of the more important among them:

a) A most careful examination of the proposed site from every point of view is necessary to ensure both that the soil is suitable in texture and chemically, and that slopes likely to induce erosion are avoided.

b) Good access from a main road to the settlement, including some form of internal communication.

c) A good water supply should be ensured.

d) Proximity to schools, churches and other social amenities.

e) So far as is possible each holding should be compact.

f) Variations in the size of holdings will depend in part, on the nature and fertility of the land and also on the system of farming to be adopted.

g) Repayment of purchase money should not begin for some two to three years and should be spread over about 30 years. (Jolly (1956), however, states that purchase of land in instalments over 15-20 years has, as some governments have learnt to their cost, resulted in the ruin of the land. It would appear, therefore, that more stringent
regulations under leasehold tenure would be a better measure).

h. Credit facilities are widely demanded. However, the problem of repayment is a major one in underdeveloped areas or among peasant farmers. (In a large majority of cases the credit is not used for the purpose it was originally granted. An actual example of the difficulties, and perhaps dangers, of providing credit cheaply to small farmers is provided by St. Vincent (Jolly, 1956).).

i. Consideration should be given to selection of settlers suitable for land settlement. This human factor in considering land settlement is of vital importance to the success of such a scheme.

Despite these recommendations, examples of the success or failure of other similar ventures and other accumulated knowledge there are still a number of problems of management of small farms in the West Indies. Economic surveys of peasant agriculture in the Caribbean, carried out by Jolly (1956), shows that small farmers usually have to be content with poor-quality land, usually land which no planter thought good enough to form into an estate. However, even when small farmers are settled on good land they usually degrade it because of their other handicaps. Under-employment and the seasonal nature of production generally pursued by farmers is still a major problem. This often necessitates wage earning away from the holding in the off season and possibly the employment of paid labour on the farm in busy seasons.

Land tenure is usually unsatisfactory, for various reasons, in the West Indies - whether it be on a share cropping, cash tenancy or freehold basis. Freehold tenure, for example, usually limits the amount of capital to work the holding, as so much is sunk in the land.

Fragmentation of small farms, which is still common in Trinidad, and marketing of the crops produced by small scale farmers are two further problems brought out in Jolly's survey. Where small farmers produce export products they benefit from the existing highly organised and efficient marketing systems for these products. There are, however, potentially a number of locally consumed products suitable to small farmers which are at present produced in small quantities because of the inefficient and quite often disorganised local marketing facilities.

A major handicap to small scale farmers is lack of capital. The problem is not always one of absolute lack of capital but the unwillingness of farmers to make
agricultural investments. There appears to be an inherent acceptance among peasant farmers the world over that under-capitalised small scale farming is a recognised system and surplus funds are usually invested in non-agricultural undertakings.

The form and extent of financial and other assistance to settlers during and after establishment have been the subject of much debate in the past. Formal instructions, occasional advice, money and services such as co-operative transport, usually are considered. Experience has taught the lesson, however, that settlers may be spoiled and robbed of independence by having too much done for them. In fact it should be brought home to the peasant cultivator that nowhere in the world has the small small holding succeeded, under land settlement schemes, or any other system, except through the hard work of the individual.

The Agricultural Policy Committee of Trinidad and Tobago (1943) suggested the establishment of two kinds of land settlement, namely a) part-time farming and b) full-time farming. They suggest that "part-time" settlements are likely to be most successful in Trinidad until there is adequate knowledge and experience of mixed farming, and that obviously these settlements should be adjacent to centres of employment and where assured markets are available for the perishable crops grown on the settlement. "Full-time" settlements are required for those who give of their best as independent farmers. The full-time farmer should aim at self-sufficiency.

San Francisco Land Settlement was one of many land settlements started as a result of the recommendations of the West India Royal Commission and the suggestions of the Agricultural Policy Committee of Trinidad and Tobago. It was started in 1943 and has a total acreage of 169 1/4 acres.

In June 1957 (Guyadeen, 1957) the acreage occupied by tenants was 137 1/2 acres in 51 allotments. There was one vacant allotment of 1 1/2 acres, and the total acreage under reserves, recreation grounds, etc., was 30 1/4 acres. The average size of the allotments is approximately 2 1/2 acres. There are 176 people settled in the area made up of 46 adult males, 42 adult females and 88 children. Five settlers have applied for and have been given a second allotment in the settlement. All the tenants have entered into annual agreements (monthly rental of 50 cents per acre) with the Government.

The main points about the agreement which each settler has to sign after his selection are:-

a) Each settler is required to build a house on the allotment within 12 months of taking it over.

b) The settler has to crop the land satisfactorily with food crops and ground provisions. No sugar cane is allowed to be grown on the settlement. This stipulation,
according to the Department of Agriculture, was laid down as they wished all settlers to have land on which to grow food crops. In the past settlers had planted their holdings to sugar and had not grown provision crops. It is the declared policy of the Government to diversify the agriculture of Trinidad.

c. In the event of a tenant failing to pay his rent or farming the holding satisfactorily, the Government were empowered to dismiss him. Generally he was allowed a three-year probation period after the first warning, during which period the peasant holder must farm his holding under the guidance of the Agricultural Department.

d. Each settler can obtain a twenty-five-year land settlement lease provided he applies in writing, his allotment is farmed well, and all rents have been paid up to date.

A census of the crops and stock on the settlement in 1957 showed that there were:

I. Approximately 25 acres of old seedling and clonal cocoa.

II. 5 acres of citrus in fairly good condition.

III. Approximately 8 acres of widely scattered bananas in good condition.

IV. Approximately 20 acres of ground provision in fair condition.

V. No vegetables grown except in small areas on one or two holdings.

VI. Not much rice cultivation.

VII. 18 head of cattle, 10 goats, 8 pigs and 252 poultry.

Thus, there were 58 acres under cultivation and approximately 27 acres available for pasture on the Settlement.

It is evident that the San Francisco Settlement did not receive the care and supervision required in the early years of its establishment. In most instances, rents are in arrears and, due to lack of fixed programmes of agricultural development, many allotments have not been developed along correct lines. In some instances no work has been done at all. However, there are certain settlers who have shown through hard work and some agricultural knowledge that it is possible to establish their allotments reasonably well (e.g. Holding 35).

In 1956, twelve land settlements in North Trinidad which were developed by the Land Settlement Division, were placed under the control of the District Services of the Department of Agriculture. This division became responsible for the general administration, maintenance and further development of these Settlements. A new policy is under consideration at the present time but as yet only one or two of the settlements, such as La Pastora and Maracas Valley land settlements, are reaping any benefits. No schemes or definite ideas as yet have been prepared for the San Francisco settlement. The author suggests that when further development of the
settlement is discussed it should be discussed in the light of the present project carried out by the Chemistry and Soil Science Department at I.C.T.A.

At some future date, when studies have been completed, it is most probable that a pilot scheme to test and demonstrate the findings will be required. The author suggests that the San Francisco Land Settlement should be run as part of the pilot project but under a different policy and form than at present. Engledow (1945) stated that both peasant agricultural and estate agriculture have a place in the agriculture of the West Indies. However, until the intricacies of small scale farming have been worked out in more detail, especially in marginal agricultural areas, it has been found in St. Vincent that the West Indian estate system is more efficient than any other and is thus desirable from every angle except the political one.

The author suggests that the present San Francisco Land Settlement should become part of a land settlement scheme run on similar lines to the Leeward Land Settlement schemes in St. Vincent. These are two old estates bought by the Land Settlement and Development Board who decided to operate, rehabilitate and develop these somewhat run-down properties as estates. The initial capital was raised by means of grants and a debenture. The estates are being run with paid peasant labour who also rent small gardens for the production of their own provision crops. When the estates have been paid for and re-established, consideration will be given to other forms of tenure or settlement which might be suitable. The labourers who have helped to develop the estates would have first priority when settlers are selected. Housing schemes are also run in conjunction with the estates, some house lots can be obtained on a freehold basis, others on leasehold.

It is certain that any scheme to increase the fertility of the soils in the marginal area for agriculture, under consideration at the present, will require a large amount of capital. This could only be done profitably on a large-scale or estate-farming basis with money put up or borrowed by Government. It would be impossible to expect ordinary peasant farmers working on a small scale to be able to undertake such a task. It is a revolutionary step and it still remains to be seen whether it would be a worthwhile project to undertake. However, it is evident that the present form and policy, or lack of policy, in the San Francisco Land Settlement is of no real benefit to agriculture in Trinidad. Apart from a small acreage of good cocoa and citrus there is very little use being made of the Land and thus the settlement is more or less a housing settlement. The author has submitted the above suggestion to change the form of the settlement but does not preclude the possibility of other forms of land settlement being tried.
SUMMARY.

A soil survey was carried out on part of the San Francisco Land Settlement near Freeport. This survey was part of a project to investigate the soils in areas described as being unsuitable for agriculture or as poor agricultural land, in the Land Allocation Policy Plan for Trinidad and Tobago, 1944.

There were seven soils found in the area surveyed, namely: Couva, Freeport, Ecclesville, Moruga and Talparo Series, Sandy Ecclesville sub-series and Valley sands. Each was studied and described in detail and a map of the soils, incorporating a topographical survey, was drawn.

A vegetation and land use survey was undertaken and a second map was drawn.

In a brief discussion on Land Settlements in Trinidad with particular reference to the San Francisco settlement, the author suggests that the present form of the settlement should be changed. The settlement should become part of a land settlement scheme run on similar lines to the Leeward Land Settlement schemes in St. Vincent. This could be the basis of a pilot scheme to test and demonstrate the findings of the present project being carried out by the Department of Chemistry and Soil Science.
1. Agricultural Policy Committee of Trinidad and Tobago 1943. Pts. 1 and 2.


10. A Proposed Land Allocation Policy for Trinidad, 1944. Trinidad and Tobago Council Pamphlet 56.


The author wishes to express his thanks to:

1. Dr. H.A. Vine of the Imperial College of Tropical Agriculture for his guidance and assistance.
2. I. Elaje, a fellow student, for his assistance in carrying out the field surveys.
3. Members of the Chemistry and Soil Science Department for analysis of soil samples.
4. Members of the Department of Agriculture, Trinidad and Tobago, for their co-operation and help in giving the author access to information on Land Settlements in Trinidad.

(a) The problem of land-use in Trinidad

The report by L. Elaje, A.T. Burtin, R. Rowing, and L.A. Phillips form further contributions to the investigation of the soils lying between Longwood and stock-land to the north (about 0.5 acres of land) were obtainable for agriculture and should be acquired by the Government for the purpose of intensive farm land. It is also noticed by the Government that the land is not used to the best advantage, land which was originally used to grow crops should now be used for growing crops, which are more profitable, and the land should be managed as a stock-farm land and the crops should be managed as a stock-farm.

(b) The fertility of the soil in the area

The land occupied by crops and other vegetation, especially by means of pot experiments; it was considered that results obtained with this newly-induced sandy loam could be more generally correlated with other work in the horticultural and tropical agriculture than could those obtained with the predominant soil clays and sandy soils of the area.

Several pot experiments were done by L.A. Elaje in 1957 and 1958, as well as a laboratory test which indicated that a sample of topsoil of the La Loma Series considerably increased both the rate of increase of organic matter in soil samples and the rate of fixation of the organic matter formed.

The greatest nutrient effect, on soil used for crops, was that of phosphates, and the general indication was that production on this soil might well be transformed by means of containing phosphates and potassium fertilizers, as the Australian model.

E. Rowing and L.A. Elaje have therefore conducted pot experiments on samples of the La Loma Series, with particular interest in the growth and multiplication of a leguminous crop and the temperatures most suitable for application in further investigations.
The Reports by I. Eleje, A.F. Heberden, R. Hewson, and L.E. Palmer form further contributions to the investigation of the soils lying between Longdenville, Freeport, and Chickland, which was begun in 1956. These Reports should be considered in relation to the progress which has been made in three aspects of the investigation:

(a) The problems of land-use policy in Trinidad.

In a Land Allocation Policy put forward in 1942-44 it was suggested that 4500 acres of land in this section (with larger areas of similar land to the North East) were unsuitable for agriculture and should be acquired by the Crown; the remainder of the land is also noticeably of low productivity in present conditions. Clearly, according to precepts which are coming to be generally accepted, there is a need for planning of the use of this land, based on a proper recognition of the individual soils and their capabilities and semi-detailed mapping of their boundaries.

E.H. Chenery's soil map of Central Trinidad only shows boundaries in this part very approximately, but his report shows that the soils are diverse in physical properties and agricultural potentialities. One of the main purposes in the more detailed work has been to recognize the more promising soils, which are those on which trials of fertilizers, new crops etc., could most usefully be made in the first place. Further examination of the soils of the poorest physical qualities was also required, to aid in forming an opinion as to whether these should be relegated to forestry.

The characteristics of all the main soils and their mutual relationships and relationships to geology and relief were largely elucidated in detailed surveys of seven sample strips and a semi-detailed survey of a larger area (about 600 acres) near Longdenville, between 1956 and 1958, on which D.T.A. Reports have been written by E.K. Clark, G.M. Dickin, N. Orr, P.W. Schedler, T.J.W. Smethurst, P.R. Weare, R. Briggs, K.P. Isherwood, and A.M. MacDonald. E.C. Patterson, also, studied the physical properties of the very unproductive Long Stretch Series and obtained some interesting preliminary results; but his and other work indicated that this soil was much less extensive than shown on the published map.

(b) The fertility of strongly leached tropical soils.

The Las Lomas Series, an extensive soil in the area, was chosen for studies of fertility, especially by means of pot experiments; it was considered that results obtained with this freely-drained sandy loam could be more generally correlated with other work in the humid tropics than could those obtained with the predominant stiff clays and silty soils of the area.

Several pot experiments were done by C.H. Obihara in 1957 and 1958, as well as a laboratory test which indicated that liming a sample of topsoil of Las Lomas Series considerably increased both the rate of breakdown of organic matter to form ammonia and that of nitrification of the ammonia formed.

The greatest manural effect, on Eleusing and on Cowpeas, was that of phosphate, and the general indication was that production on this soil might well be transformed by means of combining phosphate and leguminous covers, on the Australian model.

R. Hewson and L.E. Palmer have therefore continued pot experiments on samples of the Las Lomas Series, with particular interest in the growth and nodulation of a leguminous crop and the techniques most suitable for application in further investigations here.
(c) The demonstration of soil survey methods.

It is the intention to continue work to demonstrate the procedure of combining detailed surveys of sample areas and the reconnaissance mapping of soil associations, taking the Caparo Drainage Basin as a natural region for study.

At this stage, however, the two students who undertook soil surveying in the field as their project - I. Eleje and A.F. Heberden - were asked to continue the work done by E.K. Clark and W. Orr on the San Francisco Settlement, a complete semi-detailed soil and agricultural survey of which should be useful to the Department of Agriculture, and also (like the semi-detailed survey near Longdenville, done by K.F. Isherwood and A.M. MacDonald) give an instructive demonstration of the mapping of a somewhat complicated medley of soils on a practical scale in Trinidad.

H. Vine
10th June, 1959
## APPENDIX

### 2) Chemical Analysis of Soil Profile Pits

#### PIT D-35: "Sandy" Eeglesville Sub-Series

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KEY TO VEGETATION MAP.

1. TREE DOMINATED VEGETATION:
   - BS2F - Black Sage Secondary Forest.
   - BSHTKY - Black Sage Thicket
   - BTHKT - Bamboo thicket.
   - BTHET - Bamboo and Balisier Thicket

2. GRASS DOMINATED VEGETATION:
   - G - Low Grass often grazed.
   - G1 - Tall grass dominant
   - G2BS - Tall grass with Black Sage
   - G1PP - Tall grass with Pigeon Peas
   - GBS - Low grass grazed with Black Sage.
   - G2 - Low grass with Black Sage or Urena Lobata. Grazed.

3. CULTIVATED CROPS:
   - Rfb.T - Rice followed by Tomatoes
   - MA - Mixed Arables
   - PP - Pigeon Peas
   - Ac - Arables mainly Corn.
   - CPP - Cassava mixed with Pigeon Peas.
   - CBpp - Cassava, Bananas and some Pigeon Peas.
   - MA/C - Mixed Arables and Cassava
   - SC - Sugar Cane
   - Ep - Egg Plant.

4. TREE CROPS:
   - B - Banana
   - Ca - Cacao
   - KT - Mixed Tree Crops
   - Ci - Citrus
   - CiB - Citrus and Bananas
   - BCipp - Banana, Citrus and Pigeon Peas.
   - Ck - Low grass with Cashew and Pineapples.