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SEMI-DETAILED SOIL SURVEY REPORT
OF
KRETAM AREA, SABAH

BY

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1. INTRODUCTION

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1. Profile Description and Analysis Results

Pocket

1. Soil Map
2. Terrain Map
3. Soil Suitability Map

1. INTRODUCTION

This semidetail soil survey was carried out in compliance with the agreement made between Permodalan Plantations Sendirian Berhad and Perbadanan Khidmat Pertanian FELDA. Under the terms of agreement the scope of the contract work shall be as follows :-

- a) To carry out a semidetail soil survey of the area as indicated on the map which occupy 20,000 acres,
- b) To provide a semidetail soil map,
- c) To provide a soil suitability map basing on the soils and terrain classification,
- d) To collect soil samples of the different soils mapped and arrange for analysis to be carried out by the first party.

- e) To provide a soils report.

Soil survey in Sabah began in the early 1950s by the staff of the Department of Agriculture Sabah where certain selected areas were surveyed to assess the areas for the cultivation of rice. The soils were classified as soil series according to parent materials and stages of weathering. In the late 1950s a broad reconnaissance soil survey was carried out which continued until the early 1970s under various aids. The soils were mapped as association where two or more soil family formed a mapping unit. As access was the main limiting factor, the survey was mainly based on the geology and topographic features and only

short traverses were made along main roads and timber tracks.

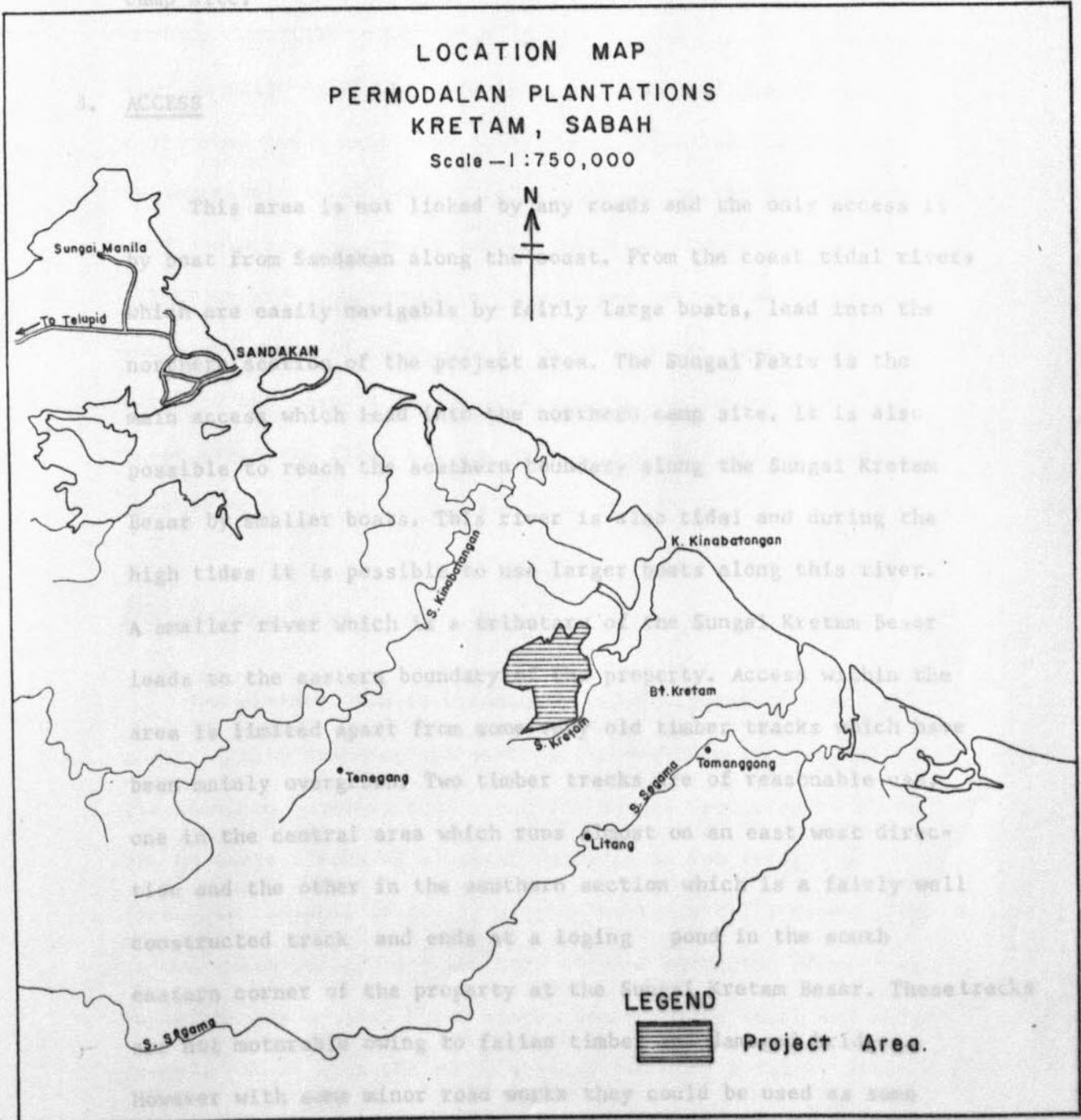
The present soil map of Sabah only gives a very broad indication of the various soils mapped and has to be used with caution when more detail planning is necessary for agricultural development. This semidetail survey carried out in Kretam has indicated the possibility of mapping the soils into individual soil units according to their suitability class. This is a first attempt at mapping the soils at series level although it is not possible to locate the soil boundaries with reasonable accuracy as it was necessary to infer the boundaries between the traverses.

2. LOCATION

The area surveyed occupy part of the Kretam Forest Reserve. Part of the north and eastern boundary is bounded by the Nipah swamp, while the Sungai Kretam Besar forms the southern boundary. The western boundary is not well defined although on the map it appears that the Kretam Forest Reserve boundary falls within the surveyed area. The nearest village which is Lintang is 9 to 10 miles south of the area, while Sandakan is about 35 miles North West. Neither of these two towns are linked by road to the project area. At present the only means of transport to the project area is by boat from Sandakan. A fast speed boat takes about 2½ - 3 hours to reach the main camp site which is located on the northern area.

However during rough weather it is not possible to travel by speed boats. The larger boats take about 7 to 8 hours to reach the camp site.

Figure 1



However with some minor road work they could be used as some of the main roading system.

However during rough weather it is not possible to travel by speed boats. The larger boats take about 7 to 8 hours to reach the camp site.

3. ACCESS

This area is not linked by any roads and the only access is by boat from Sandakan along the coast. From the coast tidal rivers which are easily navigable by fairly large boats, lead into the northern section of the project area. The Sungai Pakis is the main access which lead into the northern camp site. It is also possible to reach the southern boundary along the Sungai Kretam Besar by smaller boats. This river is also tidal and during the high tides it is possible to use larger boats along this river. A smaller river which is a tributary of the Sungai Kretam Besar leads to the eastern boundary of the property. Access within the area is limited apart from some very old timber tracks which have been mainly overgrown. Two timber tracks are of reasonable use, one in the central area which runs almost on an east west direction and the other in the southern section which is a fairly well constructed track and ends at a logging pond in the south eastern corner of the property at the Sungai Kretam Besar. These tracks are not motorable owing to fallen timber and damaged bridges. However with some minor road works they could be used as some of the main roading system.

4. GEOLOGY

The geology of this area is very mixed with mainly sedimentary formation which range in age from Escene to the Pliocene. They comprise mainly of sandstone, mudstone and shales with occasional tuffs overlying this. These sedimentary rocks occur on moderately to slightly steep slopes and on the gently sloping land subrecent and recent terrace alluvium occur. The recent alluviums are along the major rivers and valleys while the subrecent terraces occur on the larger plains. Part of the northern and eastern boundary is occupied by marine alluvium. These areas are tidal and are very saline with mainly Nipah vegetation.

5. PHYSIOGRAPHY

The project area is bounded by swamp vegetation along the north eastern boundary and part of the northern section. Although the southern boundary runs along the Sungai Kretam Besar there are no large tracks of alluvial deposits or low lying land. Basically the area is gently sloping with low hills especially in the north western and southern section where the slopes can be on the steep side. These slopes are normally short and range from 12° to 18° . In the north western boundary a fairly steep sided ridge runs on a north-south direction and occupy a small area.

5.1. Also in the southern section there are a few steep-sided hills with very sharp gully. Rock exposures are common along these valleys and on the slopes.

In the northern and central areas large tracks of low terraces are present some of which have high water table most part of the year. The low terraces are subjected to flood conditions during very wet months as a number of small streams drain these low lying areas. One fairly large stream which drains into the north eastern section has been observed to have tidal effect. Most of these streams are very slow sluggish flowing owing to the accumulation of fallen timber and other woody material within them. A number of small man-made ponds are also present which have been caused by the construction of timber tracks. The natural flow of the streams have been disturbed and resulted in permanent

5.2. waterlogged conditions in the lowlying areas. This is well marked in these man-made lakes where there is an ecological change in the vegetation. The remnants of the large timber trees are still present while swamp vegetation is taking over in these permanently waterlogged areas. With improved drainage these areas can be converted to agricultural land.

A terrain map indicating the different slope class has been produced basing from the field observations along the traverses. The system adopted is similar to that used in West Malaysia. In the project area this has been divided into four physiographic groups.

5.1. Nearly Level To Lowlying 0° to 2°.

These areas occupy about 33% of the total area surveyed. They occur mainly in the northern and eastern section fringing the swamp boundaries. Smaller pockets occur along the valleys and as narrow strips along the smaller streams. The greater portion of these areas are subjected to flooding during the very wet months and a small percentage is waterlogged most part of the year. With good drainage the water table can be reduced and maintained at a low level for the cultivation of crops. In the north eastern section a small area is subjected to tidal influence. This could be checked

5.4. with a tidal gate at the boundary where the stream flows into the area.

5.2. Very Gently Sloping Land 2° to 6°.

This terrain class occupy about 28% and is distributed throughout the project area and fringes mainly along the

6. CLIMATE level to lowlying areas. They include small rounded hills and terraces reaching about the 50 foot contour. Some of these areas may be subjected to flooding during the wet months. However drainage is rapid and permanent waterlogged conditions are not present.

5.3. Moderately Sloping Land 6° to 12°.

These areas occupy about 27% of the total acreage and have a relative relief of about 100 to 150 feet above sea level. They occur mainly on the western boundary where the topography tends to emerge into the steeper hills. Slopes are generally very gentle, but along the narrow valleys short and steep slopes can be encountered which are more than 12°. These areas are only localised and occupy only small pockets.

5.4. Moderately Steep Land 12° +

This terrain class occupy 12% within the surveyed area. They occur as small hills and long narrow ridges. Although the slopes are very variable most of these areas have slopes less then 20° and are dissected by steep valleys often with rock exposures.

6. CLIMATE

The climate of Sabah is controlled by the northeast and southeast trade winds. It is a monsoonal climate with a seasonal reversal of dominant winds and it is these winds with their associated air masses which determine the seasons. Between October and February the north east trade winds are dominant while between May to August the weather is controlled by the

MEAN MONTHLY AND ANNUAL RAINFALL AND STANDARD DEVIATION

NUMBER OF RAIN DAYS IN DAYS PER MONTH

Station	Total Year Of Record	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Des	Annual
Sandakan	70	18.4	10.3	7.9	4.7	5.9	7.5	7.2	8.7	9.7	10.5	14.5	18.5	123.1
	SD	10.1	7.2	6.0	3.1	5.3	3.0	3.0	3.8	4.3	3.4	5.4	7.0	22.3
Lamag	34	13.6	7.7	7.8	4.7	8.0	8.7	7.7	9.6	10.4	9.1	9.4	13.1	110.2
	SD	7.5	4.4	5.2	3.1	3.8	3.6	3.8	5.3	6.1	4.6	3.8	7.7	26.4
Kretam	18	18.1	9.4	7.0	6.1	9.4	8.6	7.8	7.3	8.6	10.2	10.9	14.8	118.0
	SD	14.0	6.8	5.0	3.6	2.7	3.5	2.2	3.1	2.3	3.2	4.9	6.6	23.6
Tomangsong	8	18.7	12.1	7.6	4.6	8.8	8.2	7.1	7.1	9.4	11.4	10.8	15.9	125.5
	SD	10.5	9.1	6.4	3.1	3.2	2.4	2.8	3.2	2.2	3.6	6.3	8.0	25.7

NUMBER OF RAIN DAYS IN DAYS PER MONTH

Station	Total Year Of Record	Jan.	Feb.	March	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Sandakan	12	22	17	14	10	14	16	14	16	16	18	20	23	200
Lamag	13	15	12	7	7	14	13	11	15	10	14	15	16	150
Tomanggong	9	20	16	14	10	18	19	14	17	18	20	21	21	209
Litang	15	17	14	11	10	15	12	13	11	14	17	14	15	163

FREQUENCY OF YEARS WITH DRY MONTHS

Station	Total Year Of Record	Years With 1 or More Dry Months	
		Total	Proportion
Sandakan	70	36	51
Lamag	41	21	51
Litang	18	4	22
Kretam	18	6	33
Tomanggong	9	2	22

Figure 2

north west trade winds. These winds bring considerable cloudiness and often wide spread rain especially during the months of November to January.

The project area being on the east coast the north east monsoon results in a rainy season between October and March with a distinct rainfall maximum in December and January. This rainy season is not one of steady rain but rather the alternation of spells of heavy and prolonged rain, moderate and interrupted rain and sunny periods. The severity of the rain can be felt during the month of January where most of the days have rain and is a prelude to severe flooding. The rainy season is usually followed by a dry period in March and April, however these months are not completely dry and have rain up to about 4 to 5 inches per month. It has been recorded that in some years there has been dry months where the rainfall was less than 2.4 inches. The month of April is the driest month along the east coast and the occurrence of this tend to take place once in 2 to 3 years.

7. METHOD OF SURVEY

The soil survey was carried out on a semi-detailed basis on a scale of 1:25,000. The base map used was on a scale of 1:50,000 which was enlarged to provide a larger scale map for field mapping. A traverse or rentis network plan was then drawn up (See Fig. 2). The rentis lines were cut at predetermined

Figure 2

bearings and were clinched such that they cut different landforms,

soil associations and lithological types. This was based on

the structure of the landform geological

information, and it was planned to cut in a east-west direction

would cut through the different soil types and different land-

forms. Since dense jungle cover both primary and secondary

provided difficulty with access and logistics, observations were

made entirely on foot along rentis lines. The area was divided

into 2 portions to facilitate ease working. For the northern half

a base line from the main camping site was cut and from the base

line east-west lines were cut at 60 chain interval for the

southern half it was necessary to move camp to the central region

of the area. Here again a base line was cut to reach the southern

tip and from this line east-west lines were cut at 60 chain interval

Examination of the soils along the traverses were carried

out at 10 chain intervals using a jerrycan auger to a depth of

one meter. Slopes were also recorded along the traverses and

swamp boundaries were also possible to indicate on this scale of

mapping were also noted. Soil pits were dug on the different soil

types and sampled for laboratory analysis.

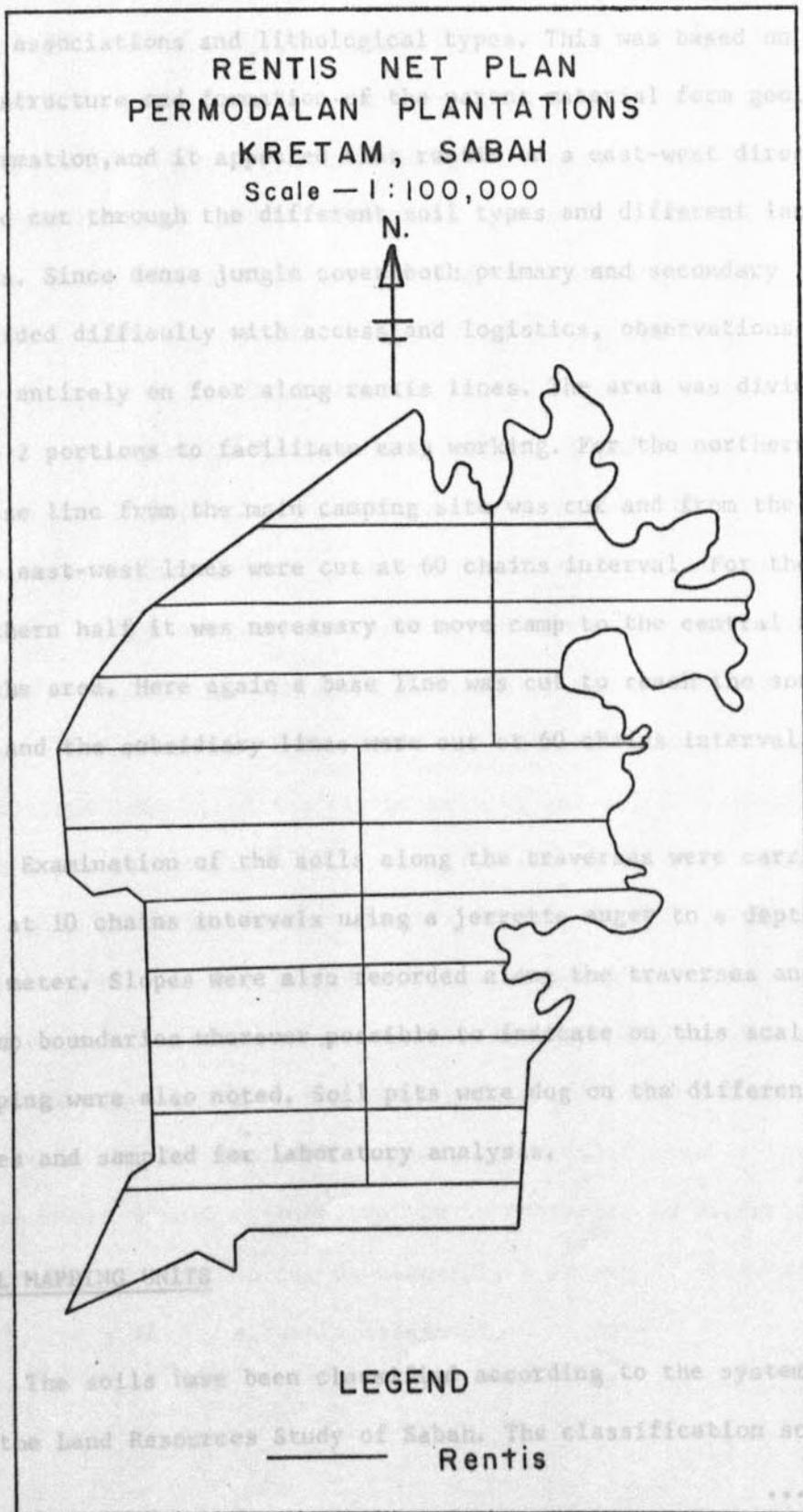
6. SOIL MAPPING RESULTS

The soils have been classified according to the system used

in the Land Resources Study of Sabah. The classification scheme

LEGEND

— Rentis



bearings and were clined such that they cut different landforms, soil associations and lithological types. This was based on the structure and formation of the parent material from geological information, and it appeared that rentis on a east-west direction would cut through the different soil types and different landforms. Since dense jungle cover both primary and secondary provided difficulty with access and logistics, observations were made entirely on foot along rentis lines. The area was divided into 2 portions to facilitate easy working. For the northern half a base line from the main camping site was cut and from the base line east-west lines were cut at 60 chains interval. For the southern half it was necessary to move camp to the central region of the area. Here again a base line was cut to reach the southern tip and the subsidiary lines were cut at 60 chains interval.

emphasized that at this scale of mapping and the complex nature of the area

Examination of the soils along the traverses were carried out at 10 chains intervals using a jerrette auger to a depth of one meter. Slopes were also recorded along the traverses and swamp boundaries wherever possible to indicate on this scale of mapping were also noted. Soil pits were dug on the different soil types and sampled for laboratory analysis.

At this stage where a soil suitability map is necessary to determine the

8. SOIL MAPPING UNITS area for development, a survey of this nature will give a fairly accurate assessment.

The soils have been classified according to the system used in the Land Resources Study of Sabah. The classification scheme

is similar to the FAO system and although this system has not been fully tested out, an interim key to soil units has been issued (FAO 1970) in which diagnostic horizons are identified and the soil units are classified by the presence or absence of these horizons within a depth of 120 cm from the surface. These units are subdivided according to combinations of these horizons with other prominent specified soil properties, for example base saturation, colour and the presence of concretions. The criteria used to further subdivide the associations is on the physical properties such as drainage, colour, texture, structure, effective soil depth to parent material and stoniness.

8.1. Chemical properties are also considered where acid sulphate or saline conditions are present. Although an attempt is made in this survey to map out the soils as individual soil units, it must be emphasised that at this scale of mapping and the complex nature of the parent materials makes it difficult to further subdivide the soils at series level. Within a mapping unit it is possible to have more than two series as the soil boundaries have to be inferred between traverse lines. This is unavoidable when the traverse lines are more than half a mile apart and the survey has to be carried out under dense jungle conditions. At this stage where a soil suitability map is necessary to determine the potential of the area for development, a survey of this nature will give a fairly accurate assessment.

The top soil which is about 5 to 8 cm thick is a dark brown very fine sandy clay loam, very friable with moderate to strong, medium crumb. Below this is a narrow E horizon which extends to a depth of about 15 to 20 cm. The textures are fine sandy clay to silty clay, friable to slightly firm,

The soils have been classified into four soil associations which has been further subdivided into 8 soil mapping units. Although the mapping units have not been named but these can be related to the soils classified by the Land Resource Study of Sabah.

The following is a general description of the soils mapped within the projected area. Some of the minor soil units which were encountered on the field but not indicated on this scale of mapping is also described.

8.1.

Rumidi Association

This has not been mapped out as it is only limited. This soil occur as cappings on the rounded hill Series 1 - This series has been classified as a Chromic Luvisol under the FAO classification and is derived from tuffaceous rocks interbedded with mudstones. They occur on very low hills with gentle slopes and the relative height is less than 100 feet above sea level. The soils are deep with a A, E and Bt horizons underlain by a C horizon which is more than one meter deep from the surface. It is well to moderately well drained.

The top soil which is about 6 to 8 cm thick is a dark brown very fine sandy clay loam, very friable with moderate to strong, medium crumbs. Below this is a narrow E horizon which extends to a depth of about 15 to 20 cm. The textures are fine sandy clay to silty clay, friable to slightly firm,

with strong coarse subangular blocky structure. The colour is strong brown to reddish yellow with a distinct pinkish tint and often difficult to match with the colour chart. The Bt horizon extends to about 90 to 100 cm below which is the C horizon. The Bt horizon is a silty clay, firm to slightly firm with strong coarse subangular blocky structure. Clay skins are continuous along pad faces and occasional fine distinct mottles are present. This horizon has a distinct pinkish red colour which becomes darker with depth.

A slightly shallow phase of this series has been recorded in small pockets. This has not been mapped out as it is only limited. This soil occur as cappings on the rounded hill where the parent material appear at depths of 70 to 90 cm. However the rocks are well weathered and will not hinder rooting as observed in a pit dug to more than 130 cm. Some coarse roots were present below the weathered rocks in this profile. The Bt horizon is well developed in this series and has strong coarse subangular blocky structure.

8.2. Series 2 - Rumidi Association

This series is derived from mudstone and occur on low hills with gentle slopes between 6° to 12° . They have a A, Bt and C horizon with the E horizon being very narrow and sometimes absent. The majority of the profiles are moderately deep with the C horizons having highly weathered mudstones. They

are well to moderately well drained although there are some occasional mottles present in the lower horizons which indicates a slightly poor drainage in some profiles.

owing to the sandy textures. The profile has a A, E, Bt

The A horizon which is about 6 cm thick is a fine sandy clay loam, dark brown with medium and fine crumb structure. Below this is a narrow E horizon which extends to about 12 to 14 cm, brownish yellow to yellowish brown fine sandy clay, with strong medium and coarse subangular blocky structure. It is well drained with some patchy clay skins along pores and structure faces. This extends to a moderately deep Bt horizon which is usually about 60 to 90 cm. The texture changes to a clay loam with occasional fine sand present within the clay matrix. The colours are yellowish brown to strong brown, with strongly developed coarse subangular blocky structure. Clay skins are well developed with some faint mottles appearing just above the C horizon. This horizon overlies a highly weathered C horizon composed mainly of mudstones. The depth of this horizon varies from 60 to 90 cm and on the very gentle slopes the C horizon is well below 120 cm while on the rounded hills it may be shallow.

8.3. Series 3 - Rimidi Association

This series is similar to Series 2 except for the sandy textures. They occur on similar topography with slopes

topographic location they occur. These two series/19

..../20

ranging from 6° to 12° and well drained. Colours range from yellowish brown to strong brown and may change to red in the subsoil on the more rounded hills. They are well drained owing to the sandy textures. The profile has a A, E, Bt sequences where the E is well pronounced.

ridge tops and are of limited occurrence within the project

The top a A horizon is a shallow fine sandy loam with weak medium crumbs. The colours are dark brown to brown, very friable. Where erosion has taken place this horizon is absent owing to the easily erodable nature of these soils. The E horizon extends to about 50 cm in most cases although it may appear shallower in places. The textures are sandy clay loam, brownish yellow, with moderate coarse subangular blocky structure. Few patchy clayskins are present along channels. Rooting is well distributed with many coarse and medium roots. The Bt horizon is a sandy clay, yellowish brown to strong brown, strongly developed coarse subangular blocky structure and well drained. This horizon extends to about 60 to 90 cm and below this is the well weathered parent material mainly composed of sandstone and shale. The depth of the weathered rock varies according to the topography.

more below the surface before reaching the weathered rocks.

8.4. Series 4 - Kretam Association above the parent material.

Although the profiles are shallow, rooting was noted to be present below the Bt horizon as this is not a compacted layer and mapped basing on the depth of the profile and the nature of the weathered rocks being soft. topographic location they occur. These two series are

3.3. developed on similar parent material, mainly sandstone interbedded with mudstones.

This series has been separated from Series 4 owing to the higher percentage of clay content. The profiles of Series 4 occur mainly on moderately sloping land with slopes greater than 12° . They occupy the high hills and ridge tops and are of limited occurrence within the project area. The most striking difference in this series is the presence of sandstone rocks exposed on the surface along the ridges and along erosion scars. Also along the dissected valleys, rocks are a common feature. Although the rocks are exposed on the surface, the soils are fairly deep and extend to more than 50 cm below the surface.

The surface horizon is a sandy clay loam, very friable with weak fine crumbs. Below this the E horizon which extends to about 10 to 12 cm with a sandy loam texture, yellowish brown colours, friable and slightly excessively drained. Structures are weak coarse subangular blocky. The Bt horizon is a sandy clay loam strong brown and sometimes redder with moderate yellowish brown subangular blocky structure. Faint fine mottles are common at depth. This horizon may extend to 50 cm or more below the surface before reaching the weathered rocks. A B C horizon is present just above the parent material. Although the profiles are shallow, rooting was noted to be present below the BC horizon as this is not a compacted layer and the nature of the weathered rocks being soft.

8.5. Series 5 - Kretam Association

are not severe although surface wash may take place when cleared or the natural vegetation owing to the friable nature of the top soil. With good covers this could be avoided and conserve the organic top soil.

This series has been separated from Series 4 owing to the higher percentage of clay content in the argillic B and having deeper profiles. They are derived from similar parent material, sandstone being dominant with interbedded mudstones.

8.6. Series 6 - Lungmanis Association
gentle slopes between 6° to 12°.

This soil association occupy the recent and subrecent

The surface horizon which is not more than 6 to 8 cm thick is very friable, loose and is easily erodable being a fine sandy loam. Below this is a fairly thick E horizon extending to about 25 to 30 cm below the surface. The colours range from yellow to brownish yellow, fine sandy loam with weak coarse subangular blocky structure. It has a very friable consistency and very well drained. Below this is a very well developed Bt horizon which extends to more than 120 cm. This is a fine sandy clay with moderate to strong subangular blocky structure, friable to slightly firm and having yellowish brown to strong brownish colours. Faint mottles are common at about 60 cm and below. However drainage is well and rooting is not restricted to more than 90 cm. The BC horizon which appears at 120 cm and below has highly weathered mudstones and fine sandstones interbedded.

terrace level and the drainage pattern.

As this soil occur on very gentle slopes erosion problems are not severe although surface wash may take place when cleared of the natural vegetation owing to the friable nature of the top soil. With good covers this could be avoided and conserve the organic top soil.

8.6. Series 6 - Lungmanis Association textures of silty clay

to clay, moderate to strong coarse angular blocky structure

This soil association occupy the recent and subrecent terrace soils and occur on nearly level to very gently sloping land. They are the result of recent accumulation of soil wash from the surrounding hills and form fairly wide tracks of alluvial plain which are subjected to flooding during very wet months. Some of these areas are on slightly higher terraces and as a result the soil formation and horizonation of the profiles differ according to the terrace level and the height of watertable.

of surface water to more than 3 feet above the surface during

Two different soils have been identified within this association but these two soils have not been separated in the mapping unit as the occurrence appear in small pockets with one major soil unit dominating. The traverse information

is not sufficient to draw a well defined boundary between

8.7. Series 7 - Lungmanis Association

these two soils. The differences are mainly between the terrace level and the drainage pattern.

major drainage system and are mapped as alluvial soils

The higher terrace soil has a deep to fairly deep profile where the gleyed horizon does not appear within 80 cm, while the lower terrace soil has a gleyed horizon at less than 80 cm and the permanent watertable fluctuates at this depth.

Both these profiles have similar textures of silty clay to clay, moderate to strong coarse angular blocky structure and is poorly to very poorly drained. The lower terrace soils have profused mottling at 30 cm which increases with depth. The gleyed layer appears at 50 cm and below. The permanent watertable is at 80 cm. The higher terrace soils are better drained with deeper profiles and the watertable is below 80 cm. These areas are subjected to flooding during the wet months. The lower terraces may be subjected to prolonged periods of surface water to more than 3 feet above the surface during the wet months. With proper drainage this limitation can be corrected as most of this area have good outlet to discharge the excess water.

8.7.

Series 7 - Lungmanis Association

These soils occur along the narrow valleys and along the major drainage system and are mapped as alluvial soils

which are waterlogged most part of the year. They are mainly silty clays to clays and are gleyed throughout the profile owing to the high watertable. The structures are massive and sticky and have very poor profile development.

3) Drainage

These areas can be utilised for cultivation provided good drainage facilities can be provided. As these areas are along the major drainage system drainage can be effectively carried out.

The table below shows the crop-suitability class. This has to be referred with the soil map.

8.8. Series 8 - Weston Association

	Crops	Acres
<p>These soils occupy only a small percentage of the surveyed area and occur along the northern and a small portion on the eastern boundary. They are highly saline soils and have tidal influence. These soils are not considered suitable for agriculture and should be left as forest reserves.</p>	<p>Suitable for most crops.</p>	<p>4,668</p>
<p><u>SOIL SUITABILITY CLASS</u></p> <p>Basing on the survey information a crop suitability map for the project area is enclosed. The criteria used in assessing the suitability class is similar to that adopted in West Malaysia which are as follows :-</p>	<p>Marginal for oil palm and coconut, suitable for cocoa.</p>	<p>1,953</p>

Some areas of series 2 and 3 within the Kuzidi Association have been included with series 4 owing to slightly steep slopes and moderately deep soils as the suitability class is also based on the terrain map. These areas are only border lines where the terrain class falls just outside the limit of more than 12° with short slopes. However most of series 2 and 3 are within the 12° slope range and minor conservation measures may be required in certain areas.

- 1) Effective soil depth
- 2) Soil texture
- 3) Structure
- 4) Terrain
- 5) Drainage
- 6) Salinity and potential acid sulphate soils
- 7) Erodability

Within the Luvuvu Association the soils on the upper terraces will require minor drainage as these areas are subjected to flooding during very wet months. Although the flood water will not remain for long periods these areas are not suitable for most crops severe flooding during rainy seasons. On the lower terraces where the permanent water table is at 2 feet and below, drainage is essential before the area can be utilised for cultivation. In the Krel Association the soils are considered suitable for cocoa and other crops. In the Krel Association the soils are considered suitable for cocoa and other crops. In the Krel Association the soils are considered suitable for cocoa and other crops.

Series	Limitation	Crops	Acre
1 & 5	No limitation	Suitable for most crops.	4,668
6 & 7	Drainage is essential. High watertable and floodable areas.	Suitable for oil palm, coconut and cocoa.	6,225
2 & 3	Minor conservation measures required owing to shallow soils.	Suitable for most crops.	7,013
4	Shallow soils on moderately steep slopes. Requires terracing and conservation measures.	Marginal for oil palm and coconut, suitable for cocoa.	1,953
8	Saline and acid sulphate conditions.	Unsuitable for cultivation.	236

Some areas of series 2 and 3 within the Rumidi Association have been included with series 4 owing to slightly steep slopes and moderately deep soils as the suitability class is also based on the terrain map. These areas are only border lines where the terrain class falls just outside the limit of more than 12° with short slopes. However most of series 2 and 3 are within the 12° slope range and minor conservation measures may be required in certain areas.

Within the Lungmanis Association the soils on the upper terraces will require minor drainage as these areas are subjected to flooding during very wet months. Although the flood water will not remain for long periods on these areas damage to crops can be severe during very bad rainy seasons. On the lower terraces where the permanent water table is at 2 feet and below, drainage is essential before the area can be utilised for cultivation. These lower terraces are subjected to very severe flooding and the flood water may remain above the surface for long periods. With a good drainage system these areas can be drained and can be converted to very productive land as the soils are considered suitable for cocoa and coconut.

In the Kretam Association, series 4 needs soil conservation measures to prevent severe erosion when cleared of the natural vegetation. These areas are on moderately steep slopes and have shallow soils. There are small pockets of areas having soils with rocks on the surface which is the result of gradual soil wash, exposing the parent material. With good terracing and cover crops this could be corrected. However as these

areas will have highly leached and depleted soils, fertilizer rates should be higher for better production.

1. The Soils of Sabah, Land Resource Study.

10. CONCLUSION of Overseas Development, England.

This semidetailed survey has revealed that the 20,000 acre block in Kretam has 8 major soil types with some pockets of minor soil series or phases of a series which is not possible to indicate on the map at this scale of mapping. With a more details survey these areas can be mapped out at series and phase level. This has to be carried out at a latter stage when the area is coming into production. One important way to achive a high level of production efficiency in a plantation is to provide the crop with sound nutrition and management practice so as to attain the most profitable use of fertilizer applied. This depends largely on the nature of the soil in which the crop is planted, presunning other factors are not limiting. This means that in a commercial plantation, it is desirable to know the soil conditions. These soil conditions refer to the physical characteristics and the general nutrient status of the soil. To obtain this information it is necessary to conduct a detailed soil survey of the plantation and prepare a soil map depicting the nature and distribution of the soils. With the soil map a manager is in a position to really know his soils and fields intimately so that he can apply the best technique to upgrade their production.

11. REFERENCES

1. The Soils of Sabah. Land Resource Study. Ministry of Overseas Development. England.

2. Leamy M.L. and Panton W.P. 1966. Soil Survey Manual For Malay Conditions.

3. Wong I.F.T. 1966. Soil Suitability Classification For Dryland Crops in Malaya.

Horizon	Depth (inches)	Description
A	0 - 1	Very dark grayish-brown 10 YR 3/3 fine sandy to silty clay loam, very friable, moderate, medium and fine crumb structure, many medium and fine roots, distinct boundary.
B 1	1 - 13	Strong brown 7.5 YR 5/6 silty clay loam, moderate coarse subangular blocky structure, friable, many medium and coarse roots, well drained, boundary diffused.
B 2.1	13 - 24	Yellowish red 5 YR 5/6 silty clay loam moderate to strong coarse subangular blocky structure, slightly firm, many continuous clay skins along ped faces, many coarse roots, boundary diffused.

Profile 1

Depth (inches)	Description
Soil Association Rumidi (Series 1)	
Location	Line 2 Bearing 270° Post 12
Slope	4°
Elevation	150 feet ±
Drainage	Moderately well
Parent Material	Tuff with mudstone
Vegetation	Dipterocarp forest
Classification	Orthic Luvisol

Horizon	Depth (inches)	Description
A	0 - 1	Very dark grayish brown 10 YR 3/2 fine sandy to silty clay loam, very friable, moderate, medium and fine crumb structure, many medium and fine roots, distinct boundary.
B 1	1 - 13	Strong brown 7.5 YR 5/6 silty clay loam, moderate coarse subangular blocky structure, friable, many medium and coarse roots, will drained, boundary diffused.
B 2.1	13 - 24	Yellowish red 5 YR 5/6 silty clay loam moderate to strong coarse subangular blocky structure, slightly firm, many continuous clay skins along ped faces, many coarse roots, boundary diffused.

Horizon	Depth (inches)	Description
B 2.2.	24 - 36	Yellowish red 5 YR 6/6 silty clay strong coarse subangular blocky structure, firm, many clay skins along structure faces, few fine faint mottles, some soft weathered rocks.
B c	36 - 51	Yellowish red 5 YR 6/8 silty clay, weak coarse blocky structure firm, many weathered rocks, few fine roots tends to get very firm with depth.
A	0 - 2	Dark brown 10 YR 4/4 fine sandy loam, very friable, medium and fine subangular blocky structure, and coarse roots, many fine roots, distinct boundary.
B 1	2 - 14	Strong brown 7.5 YR 5/6 sandy to fine sandy clay loam, medium and coarse subangular blocky structure, friable, many medium and coarse roots many pores, diffused boundary.
B 2.1	14 - 22	Yellowish red 5 YR 4/8 fine sandy clay, strong coarse subangular blocky structure, many continuous cutans along pedis and channels, many pores, many coarse roots, friable, diffused boundary.
B 2.2	22 - 34	Yellowish red 5 YR 4/8 sandy clay to clay, strong coarse blocky structure, common cutans along channels, common roots, friable, diffused boundary.
B C	34 - 42	As above. Weathered parent material common, very loosely packed, few to common roots.

Profile 2

Soil Association Rumidi (Series 2)

Slope 8°
 Elevation 150 feet +
 Drainage Well drained
 Parent Material Sandakan and Mudstone
 Vegetation Dipterocarp forest
 Classification Orthic Acrisol

Horizon Depth (inches)

Description

Horizon	Depth (inches)	Description
A	0 - 2	Dark brown 10 YR 4/4 fine sandy loam, very friable, medium and fine subangular blocky structure, and coarse crumbs, many fine roots, distinct boundary.
A	0 - 4	Dark brown 10 YR 4/4 fine sandy loam, very friable, medium and fine subangular blocky structure, and coarse crumbs, many fine roots, distinct boundary.
B 1	2 - 14	Strong brown 7.5 YR 5/6 sandy to fine sandy clay loam, medium and coarse subangular blocky structure, friable, many medium and coarse roots many pores, diffused boundary.
B 1	4 - 18	Strong brown 7.5 YR 5/6 sandy to fine sandy clay loam, medium and coarse subangular blocky structure, friable, many medium and coarse roots many pores, diffused boundary.
B 2.1	14 - 22	Yellowish red 5 YR 4/8 fine sandy clay, strong coarse subangular blocky structure, many continuous cutans along peds and channels, many pores, many coarse roots, friable, diffused boundary.
B 2.2	18 - 26	Strong brown 7.5 YR 5/6 sandy clay loam, moderate to strong coarse subangular blocky structure, many continuous cutans along peds and channels, many pores, many coarse roots, friable, diffused boundary.
B 2.2	22 - 34	Yellowish red 5 YR 4/8 sandy clay to clay, strong coarse blocky structure, common cutans along channels, common roots, friable, diffused boundary.
B C	34 - 42	As above. Weathered parent material common, very loosely packed, few to common roots.

Profile 3 Depth (inches)

Description

Soil Association Kretam (Series 4)

Location Line 3 Bearing 270° Post 240
Slope 16° mid slope
Elevation 250 feet +
Drainage Well to moderately well
Parent Material Sandstone
Vegetation Dipterocarp forest
Classification Orthic Acrisol

Horizon Depth (inches)

Description

A	0 - 4	Dark brown 10 YR 4/4 sandy loam, weak fine subangular blocky structure, breaking to moderate medium crumbs, many fine roots, many pores, abrupt boundary.
B 1	4 - 18	Yellow 10 YR 7/6 fine sandy loam, moderate to weak medium subangular blocky structure, many pores patchy cutans along ped, very few fine faint light grey mottles, many coarse & medium roots, well drained, diffused boundary.
B 2.2	18 - 26	Strong brown 7.5 YR fine sandy clay loam, moderate to strong coarse subangular blocky structure, common continuous cutans along channels and peds, many roots, common fine red mottles, boundary diffused.



Horizon	Depth (inches)	Description
B 2.3	26 - 32	Reddish yellow 7.5 YR 5/8 fine sandy clay loam, moderate to strong coarse subangular blocky structure, many distinct yellow and grey mottles increasing with depth and tends to be variegated, few roots, very patchy cutans, common weathered sandstones and mudstones.
Location		
Slope		
Elevation		
Drainage		
Parent Material		
Vegetation		Dipterocarp forest
Classification		Orthic Acrisol

Horizon	Depth (inches)	Description
A	0 - 2	Dark brown 10 YR 4/4 fine sandy loam, weak fine and medium crumbs, very friable, many fine roots, distinct boundary.
B 1	2 - 14	Brownish yellow 10 YR 6/8 fine sandy to sandy clay loam, moderate to weak coarse subangular blocky structure, few patchy clay skins along peds, many medium and coarse roots, well drained, diffused boundary.
B 2.1	14 - 26	Yellowish brown 10 YR 5/6 sandy clay loam, friable, moderate coarse subangular blocky structure, common continuous clay skins along structure faces and channels, many coarse roots, diffused boundary.
B C	26 - 36	Yellowish brown 10 YR 5/6 sandy clay loam, moderate to weak coarse subangular blocky structure, very firm, many weathered rocks, few roots.

Profile 4

Soil Association Kretam (Series 4)

Location Line 4 Bearing 90° Post 20

Location Line 4 Bearing 270° Post 128

Slope 18° mid slope

Elevation 250 feet +

Drainage Well drained

Parent Material Sandstone

Vegetation Dipterocarp forest

Classification Orthic Acrisol

Horizon Depth (inches) Description

Horizon Depth (inches) Description

A 0 - 3 Dark brown 10 YR 4/3 fine sandy loam,

A 0 - 2 Dark brown 10 YR 4/4 fine sandy loam, weak fine and medium crumbs, very friable, many fine roots, distinct boundary.

B 1 2 - 14 Brownish yellow 10 YR 6/8 fine sandy to sandy clay loam, moderate to weak coarse subangular blocky structure, few patchy clay skins along peds, many medium and coarse roots, well drained, diffused boundary.

B 2.1 9 - 17 Yellowish brown 10 YR 6 sandy clay loam,

B 2.1 14 - 26 Yellowish brown 10 YR 5/6 sandy clay loam, friable, moderate coarse subangular blocky structure, common continuous clay skins along structure faces and channels, many coarse roots, diffused boundary.

B 2.2 17 - 28 Strong brown 7.5 YR 5/6 sandy clay loam,

B C 26 - 36 Yellowish brown 10 YR 5/6 sandy clay loam, moderate to weak coarse subangular blocky structure, very firm, many weathered rocks, few roots.

<u>Profile 5</u>	Depth (inches)	Description
Soil Association	Rumidi (Series 3)	brown 7.5 YR 5/6 sandy clay loam,
Location	Line 4 Bearing 90° Post 20	blocky structure,
Slope	10° on rounded hill	mottles, weathered
Elevation	200 feet ±	and mudstone common, few fine
Drainage	Well drained	
Parent Material	Sandstone and Mudstone	
Vegetation	Dipterocarp forest	
Classification	Orthic Acrisol	

Horizon	Depth (inches)	Description
A	0 - 3	Dark brown 10 YR 4/3 fine sandy loam, very friable, moderate medium and fine crumbs, many fine roots, clear smooth boundary.
B 1.2	3 - 9	Yellowish brown 10 YR 5/6 fine sandy clay loam, friable, moderate coarse subangular blocky structure, some patchy clay skins along channels and peds, many coarse roots diffused wavy boundary.
B 2.1	9 - 17	Yellowish brown 10 YR/6 sandy clay loam, friable moderate to strong coarse subangular blocky structure, clay skins along structure faces well developed, many coarse roots, diffused boundary.
B 2.2	17 - 28	Strong brown 7.5 YR 5/6 sandy clay loam, similar to above, some fine faint mottles common, diffused boundary.

Horizon	Depth (inches)	Description
Soil BC Associate	28 - 36	Strong brown 7.5 YR 5/6 sandy clay loam, weak coarse subangular blocky structure, many fine distinct mottles, weathered sandstone and mudstone common, few fine roots.
Location		
Slope		
Elevation		
Drainage		
Parent Material		Sandstone and mudstone
Vegetation		Dipterocarp Forest
Classification		Orthic Acrisol

Horizon	Depth (inches)	Description
A	0 - 3	Dark brown 10 YR 4/3 fine sandy clay loam, very friable medium fine crumb structure, many fine and medium roots, boundary abrupt.
B 1	3 - 12	10 YR 5/6 yellowish brown, fine sandy clay loam, friable moderate coarse subangular blocky structure, few patchy clay skins along ped, many coarse roots, boundary diffused.
B 2,1	12 - 22	Strong brown 7.5 YR 5/6 fine sandy clay, moderate to strong coarse subangular blocky structure, continuous clay skins along structure faces, many roots, boundary diffused.
B 2,3	22 - 34	As above with weak coarse blocky structure, weathered parent material common, few coarse roots, many distinct mottles, diffused boundary.
BC	34 - 48	variegated colour with red to dark red being dominant, weak massive structure, mainly weathered parent material.

Profile 6

Soil Association Rumidi (Series 2)

Location Line 4 Bearing 270° Post 17
Slope 6°
Elevation 150 feet ±
Drainage Well drained
Parent Material Sandstone and mudstone
Vegetation Dipterocarp Forest
Classification Orthic Acrisol

Horizon	Depth (inches)	Description
A	0 - 3	Dark brown 10 YR 4/3 fine sandy clay loam, very friable medium fine crumbs structure, many fine and medium roots, boundary abrupt.
B 1	3 - 12	10 YR 5/6 yellowish brown, fine sandy clay loam, friable moderate coarse subangular blocky structure, few patchy clay skins along peds, many coarse roots, boundary diffused.
B 2.1	12 - 22	Strong brown 7.5 YR 5/6 fine sandy clay, moderate to strong coarse subangular blocky structure, continuous clay skins along structure faces, many roots, boundary diffused.
B 2.3	22 - 34	As above with weak coarse blocky structure, weathered parent material common, few coarse roots, many distinct mottles, diffused boundary.
BC	34 - 48	variegated colour with red to dark red being dominant, weak massive structure, mainly weathered parent material.

Profile 7

Soil Association Kretam (Series 5) 6 loams terrace)
 Location Line 3 Bearing 270° Post 50.00
 Slope 7°
 Elevation 150 feet ±
 Drainage Well drained
 Parent Material Mainly Sandakan with mudstone
 Vegetation Deterocarp forest
 Classification Orthic Acrisol

Horizon	Depth (inches)	Description
A	0 - 3	Dark brown 10 YR 4/4 fine sandy loam, very friable and loose, weak fine crumbs, many roots, distinct wavy boundary.
B 1	3 - 12	Brownish yellow 10 YR 6/6 sandy loam to sandy clay loam, weak to moderate coarse subangular blocky structure, many coarse roots, very few patchy clay skins, diffused boundary.
B 1.2	10 - 22	skins along structures, many coarse roots, few fine faint mottles,
B 1.2	12 - 24	Brownish yellow 10 YR 6/8 sandy clay loam, friable, moderate coarse subangular blocky structure, continuous clay skins along structure faces, many coarse and medium roots, diffused boundary.
B 2.1g	22 - 28	skins along peds, many fine & medium mottles strong
B 2.1	24 - 36	Yellowish brown 10 YR 5/8 sandy clay loam, medium to strong subangular blocky structure, continuous clay skins along peds, some medium roots.
BCg	28 - 36	10 YR 7/2 silty clay sticky and massive structure, gleyed horizon, few coarse red mottles, high watertable.

Profile 8

Soil Association Lungmanis (Series 6 loams terrace)

Location Line I Bearing 270^o Post 100
 Slope Level
 Elevation 100 feet
 Drainage Poorly drained
 Parent Material Alluvium
 Vegetation Low jungle
 Classification Clyic luvisol

Horizon	Depth (inches)	Description
A	0 - 3	Fine sandy loam, very dark brown 10 YR
A	0 - 10	Dark grayish brown 10 YR 2/2 very fine sandy loam friable with medium and fine crumbs, many fine roots, thick organic layer above A horizon distinct many boundary.
B 1	3 - 10	loam moderate coarse subangular blocky structure, many coarse roots, few
B 1.2	10 - 22	Yellow 10 YR 7/8 sandy clay to silty clay, weak coarse angular blocky structure, some clay skins along structures, many coarse roots, few fine faint mottles, diffused boundary.
B 2.1	10 - 22	structure, few fine
B 2.1g	22 - 28	Very pale brown 10 YR 7/4 silty clay loam, weak coarse angular blocky structure, slightly sticky, patchy clay skins along peds, many fine & medium mottles strong brown and yellowish red, watertable at 22 inches, diffused boundary.
B 2.2	22 - 32	structure, few fine
B 3.1	32 - 48	Similar to above, few weathered sandstone,
BCG	28 - 36	Light gray 10 YR 7/2 silty clay sticky and massive structure, glazed horizon, few coarse red mottles, high watertable.

Profile 9

Soil Association Kretam (Series 5)

Location Base line Bearing 180° P 30
 Slope 9°
 Elevation 150 feet ±
 Drainage Sandstone & mudstone
 Vegetation Dipterocarp forest
 Classification Orthic Acrisol

Classification Clayic Acrisol
 Horizon Depth (inches) Description

Horizon	Depth (inches)	Description
A	0 - 3	Fine sandy loam, very dark brown 10 YR 4/3, medium and fine crumbs, many fine and medium roots, distinct boundary.
B 1	3 - 10	Yellowish brown 10 YR 6/6 fine sandy to sandy clay loam moderate coarse subangular blocky structure, many coarse roots, few patchy clay skins, boundary diffused.
B 2.1	10 - 22	Yellowish brown 10 YR 6/8 fine sandy clay loam, moderate medium and coarse subangular blocky structure, few fine strong brown mottles, many coarse roots.
B 2.2	22 - 32	Strong brown 7.5 YR 6/6 fine sandy clay, moderate to strong coarse blocky structure, many coarse, medium mottles, clay skins along peds, boundary diffused.
B 3.1	32 - 48	Similar to above, few weathered sandstone, slightly firm.

Profile 10

Soil Association Lungmanis (Series 6)

Location Line 1 Bearing 270° Post 3
 Slope Nearly level.
 Elevation 100 feet -
 Drainage Moderately well
 Parent Material Terrace alluvium
 Vegetation Low jungle
 Classification Gleyic Acrisol

Horizon	Depth (inches)	Description
A	0 - 2	Very dark grayish brown 10 YR 4/2 loam, friable, medium and fine crumbs, a thick root not over this horizon, many fine roots distinct boundary.
A B	2 - 11	Brownish yellow 10 YR 6/6 silty clay loam, moderate coarse subangular blocky structure, few clay skins, organic staining along structure faces, many roots wavy boundary.
B 2.1	11 - 23	Brownish yellow 10 YR 6/6 silty clay loam, moderate to strong coarse subangular blocky structure, many faint strong brown and rusty mottle, clays skins along structure faces, diffused boundary.
B 2.2 g	23 - 34	Similar to above. Mottles increases with depth some gley spots common, diffused boundary.
B C	34 - 52	10 YR light grey silty clay loam. Sticky and massive structure. Dark red mottles common, watertable at 40 inches.

SOURCE OF SAMPLE : KRETAM

PROFILE NO: 1 SOIL ASSOCIATION : RUMIDI SERIES I

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 1	20	27	18	18	5.8	3.93	2.38	0.84	2.71	0.19	0.9	1.79	0.31
1 - 13	36	21	16	27	4.8	0.56	0.32	0.15	2.15	0.13	0.65	0.21	0.39
13 - 24	41	21	19	19	5.0	0.55	0.26	0.03	8.80	0.15	0.65	0.24	0.47
24 - 36	15	32	23	30	5.3	0.25	0.15	0.13	1.13	0.17	1.0	0.21	0.53
36 - 41	21	16	28	34	4.5	0.55	0.26	0.08	3.30	0.17	0.2	1.74	0.25

SOURCE OF SAMPLE : KRETAM

PROFILE NO: 3 ASSOCIATION : KRETAM SERIES 4

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 4	Samples		Missing		5.5	3.57	2.04	0.28	7.39	0.64	1.1	0.28	0.37
4 - 18	26	11	34	28	5.6	0.58	0.34	0.10	3.47	0.14	1.7	0.21	0.53
18 - 26	27	11	38	24	5.4	0.28	0.16	0.06	2.72	0.03	1.2	0.21	0.49
26 - 32	37	6	20	37	5.7	0.18	0.11	0.07	1.51	0.11	0.95	0.24	0.59
30 - 36	21	39	16	24	5.5	0.15	0.09	0.09	0.97	0.03	0.5	0.24	0.43

SOURCE OF SAMPLE : KRETAM

PROFILE NO: 5 ASSOCIATION : RUMIDI SERIES 3

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 3	32	39	17	13	5.5	3.52	2.04	0.28	7.39	0.14	1.1	0.28	0.37
3 - 9	25	10	25	40	4.7	1.06	0.61	0.15	4.11	0.14	0.65	0.21	0.35
9 - 17	20	26	24	36	5.2	0.96	0.56	0.11	5.07	0.12	0.65	0.24	0.29
17 - 28	38	38	5	20	5.4	0.25	0.15	0.11	1.38	0.19	0.65	1.74	0.35
28 - 36	21	39	16	24	5.5	0.15	0.09	0.09	0.97	0.03	0.5	0.24	0.43

SOURCE OF SAMPLE : KRETAMPROFILE NO: 6 ASSOCIATION : RUMIDI SERIES 2

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 3	14	26	28	32	5.4	1.54	0.99	0.35	2.56	0.09	0.8	0.28	0.47
3 - 12	25	21	26	27	4.7	0.19	0.32	0.22	1.56	0.09	0.56	1.74	0.33
12 - 22	31	27	13	29	5.2	0.35	0.21	0.11	1.97	0.05	0.8	0.21	0.43
34 - 48	41	36	18	6	5.7	0.25	0.15	0.10	1.46	0.04	0.8	0.24	0.59

SOURCE OF SAMPLE : KRETAM

PROFILE NO: 7 ASSOCIATION : KRETAM SERIES 5

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 10	32	43	7	18	3.6	6.31	3.66	0.55	6.65	0.14	0.8	1.74	0.23
10 - 22	35	15	23	27	4.9	0.66	0.38	0.09	4.24	0.05	0.4	1.74	0.27
22 - 28	21	16	28	35	4.65	1.77	1.03	0.12	8.57	0.03	0.4	0.21	0.31
28 - 36	26	21	25	29	5.15	0.56	0.32	0.09	3.59	0.05	0.4	1.74	0.39

SOURCE OF SAMPLE : KRETAM

PROFILE NO: 9 ASSOCIATION : KRETAM SERIES 5

Depth Inches	Mechanical Analysis %				PH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 3	14	26	28	32	5.4	1.54	0.99	0.35	2.56	0.09	0.8	0.28	0.47
3 - 12	25	21	26	27	4.7	0.19	0.32	0.22	1.56	0.09	0.65	1.74	0.33
12 - 22	31	27	13	29	5.2	0.35	0.21	0.11	1.97	0.05	0.8	0.21	0.43
34 - 48	41	36	18	6	5.7	0.25	0.10	0.10	1.46	0.04	0.8	0.24	0.59

SOURCE OF SAMPLE : KRETAMPROFILE NO: 10ASSOCIATION : LUNGMANIS SERIES 6

Depth Inches	Mechanical Analysis %				pH Fresh	Org. Matter %	C %	N %	C/N	Easily Soluble PPM		Ca %	Mg %
	Clay	Silt	Fine Sand	Coarse Sand						P	K		
0 - 2	36	16	22	26	5.1	4.18	2.43	0.56	4.33	0.11	1.2	0.13	0.23
2 - 11	21	18	20	31	4.4	3.22	1.97	0.20	9.33	0.21	0.8	0.21	0.33
11 - 23	20	37	29	15	4.85	0.35	0.21	0.24	0.86	0.21	0.3	0.24	0.35
23 - 34	36	10	23	31	4.55	0.15	0.19	0.06	1.46	0.17	0.4	0.13	0.35
34 - 52	20	21	24	36	5.4	0.05	0.03	0.04	0.72	0.17	0.4	1.74	0.29

**SOIL SUITABILITY MAP
PERMODALAN PLANTATIONS
KRETAM, SABAH**

Scale — 1:25,000

or 2 1/2 inch to one mile



LEGEND

SYMBOL	LIMITATION	CROP SUITABILITY	ACRES
	Major and minor drainage requirements.	Suitable for oil palm, coconut and cocoa with the required drainage facilities.	6,225
	No limitation	Suitable for most crops. Deep soils on very gentle slopes.	4,668
	Effective soil depth 2 1/2 to 3 feet. Erodeable soils.	Suitable for most crops with minor conservation measures. Moderately deep soils on rolling to gently sloping land.	7,013
	Shallow soils. Moderately steep slopes.	Marginal for oil palm and coconut. Suitable for cocoa and rubber. Requires good conservation measures and a high standard of maintenance.	1,953
	Saline soils leading to potential acid sulphate conditions.	Unsuitable for cultivation. High watertable and tidal influence.	236
TOTAL —			20,095

TERRAIN MAP
 PERMODALAN PLANTATIONS
 KRETAM, SABAH
 Scale - 1:25,000
 or 2 1/2 inch to one mile



LEGEND

SYMBOL	SLOPE	ACREAGE
	0 - 2°	6,698
	2 - 6°	5,594
	6 - 12°	5,407
	12° +	2,396
TOTAL		20,095

SEMI DETAIL SOILS MAP
 PERMODALAN PLANTATIONS
 KRETAM, SABAH

Scale - 1: 25,000

or 2 1/2 inch to one mile



LEGEND

ASSOCIATION	SERIES	TEXTURE	STRUCTURE	EFFECTIVE DEPTH	LAND FORM	DRAINAGE	REMARKS
Amidi	1	Silty clay to clay	Strong coarse subangular blocky to medium and coarse prisms.	3 feet +	Very gently undulating 0 to 6°	Well to moderately well drained	Suitable for cocoa, oil palm and rubber.
	2	Fine sandy clay to clay loam.	Moderate to strong coarse subangular blocky structure	Weighted parent rocks at 2 1/2 to 3 feet	Low hills with gentle slopes to nearly level land 6° to 12°	Well to moderately well drained	Suitable for cocoa, oil palm and rubber.
	3	Sandy clay loam to sandy clay	Moderate to weak coarse subangular blocky structure	2 1/2 to 3 feet	Low hills slope 6° to 12°	Well drained	Suitable for cocoa, oil palm and rubber.
Kretam	4	Sandy clay loam to sandy clay	Moderate to weak coarse subangular blocky structure	2 to 2 1/2 feet	Moderately sloping land 12° +	Well drained	Marginal for oil palm and coconut. Suitable for cocoa and rubber. Require conservation measures.
	5	Fine sandy clay loam to fine sandy clay	Moderate to strong coarse blocky structure	3 feet +	Low hills slope 6° to 12°	Well drained	Suitable for cocoa, oil palm and rubber.
Lugmanis	6	Silty clay to clay	Moderate to weak coarse blocky changing to massive to sticky below 2 1/2 feet	3 feet +	Nearly level land 0 to 2°	Moderate to poorly drained	Floodable areas. Suitable for coconut, cocoa and oil palm with drainage.
	7	Silty clay to clay	Massive and sticky	3 feet +	Lowlying land	Very poorly drained	High waterable most part of the year. Suitable for coconut and oil palm with drainage. Marginal for cocoa.
Wiston	8	Clay	Sticky	3 feet +	Mangrove swamps	High waterable	Unsuitable for cultivation.

