Report No.139/1

Report on a Semi-Detailed Soil Survey

of the

BLOCK C AND THE ADJACENT MIXED ZONE LAND LAMBIR - SUBIS AREA

4th. Division

by

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HUNTING TECHNICAL SERVICES

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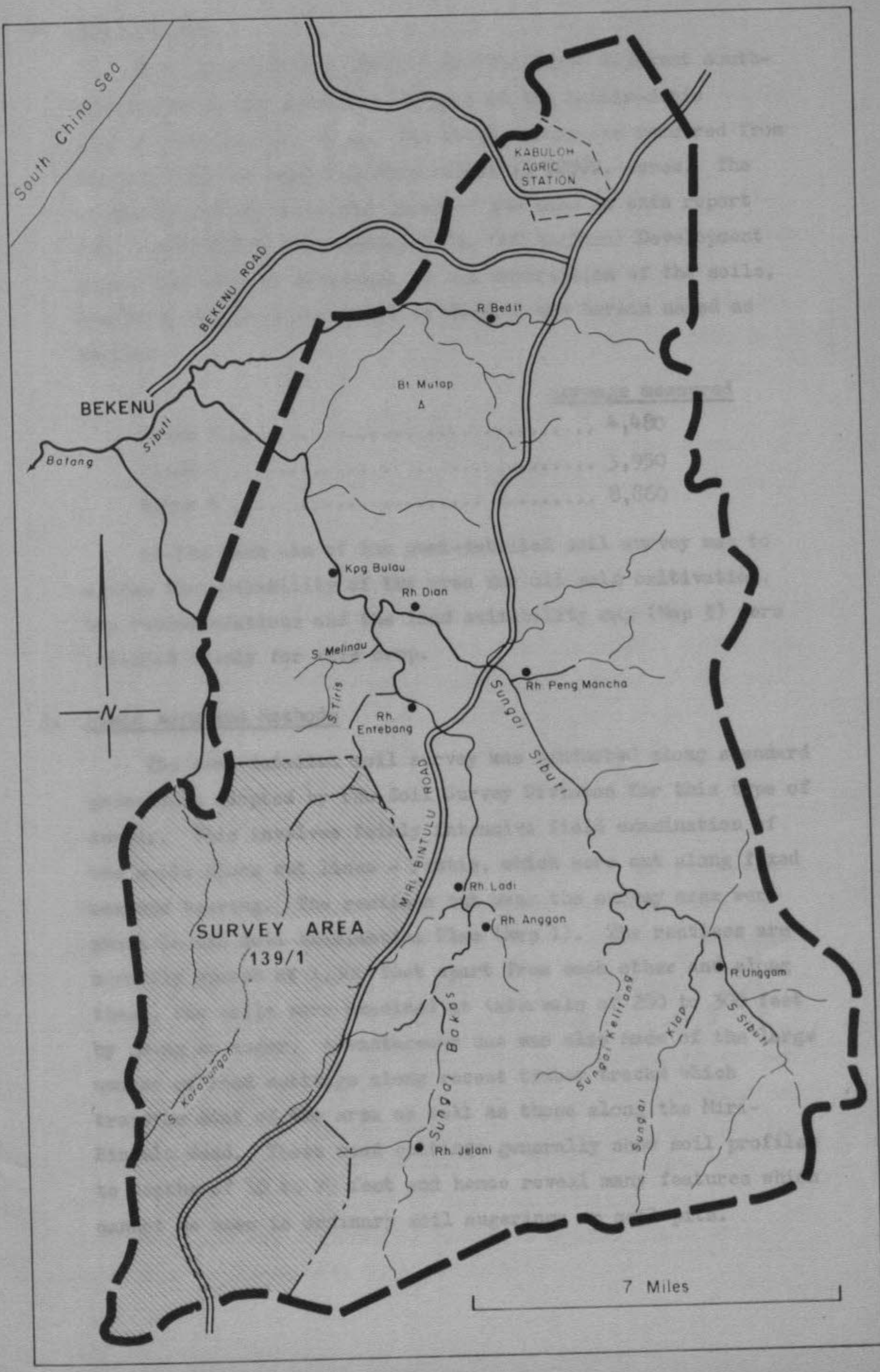

Report on a Semi-detailed Soil Survey of

Block C and the Adjacent Area.

1. Introduction

This report covers Block C and the three adjacent southern blocks of the southwestern part of the Lambir-Subis Regional Development Area. The total acreage as measured from the soil map accompanying this report is 22360. acres. The boundaries of those blocks shown on the maps in this report were derived from the average 1:50, 000 Regional Development plan. For ease of reference in the description of the soils, the three blocks sited south of Block C are herein named as follow:

	acreage measured
Block F..................................	4,480
Block G	3,950
Block H	8,860

As the main aim of the semi-detailed soil survey was to assess the suitability of the area for oil palm cultivation, the recommendations and the land suitability map (Map 3) were intended mainly for this crop.

2. Field Work and Methods

The semi-detailed soil survey was conducted along standard procedures adopted by the Soil Survey Division for this type of survey. This involves fairly intensive field examination of the soils along cut lines - rentis, which were cut along fixed compass bearing. The rentises cut over the survey area were shown in the Soil Examination Plan (Map 1). The rentises are normally spaced at 1,300 feet apart from each other and along these, the soils were examined at intervals of 200 to 300 feet by using an auger. Advantageous use was also made of the large number of road cuttings along recent timber tracks which traverse most of the area as well as those along the Miri-Bintulu Road. These road cuttings generally show soil profiles to depths of 10 to 20 feet and hence reveal many features which cannot be seen in ordinary soil augerings or soil pits.

3. Maps

The 1:10,000 topographic maps with contour intervals of 25 feet were used as base maps throughout the field work and later in the compilation of the soil maps. As the compilation of the contour maps by the Land and Survey Department was based largely on tree-top elevations, these topo-base map must necessarily contain some degree of errors. This applies particularly to the survey area which, because of the small relief contrast and the primary vegetation cover, identification of small hills less than 50 feet elevation is difficult on vertical air photographs. To minimise the possible errors on the topographic maps, the field data collected in the soil investigation also included details on topographic changes, and for hilly terrain, the slope steepness and the approximate elevation above the local base level were also recorded. These data serve to check on the details on the contour maps as well as in the compilation of the soil map and the land suitability map.

Contours for a narrow strip of land south of Block G are not available. The Land and Survey Department is presently bridging this gap, but the completed map was not available at the time of writing. The soil boundaries and the boundaries of the land suitability classes in this area probably contain a greater margin of error compared with the rest of the area.

4. Geology

The whole of Lambir-Subis area is developed on the Sibuti Formation which consists of shale with marl and thin lenses of limestone and rare, impersistent beds of siltstone and sandstone.

In the survey area, calcareous shale and limestone lenses are common in Blocks F, G and the western part of Block H. Olive green calcareous shale outcrops striking northeast-southwest are common on soil surface or in streambeds and as large boulders on hill slopes, and the common occurrence of this rock type in this area is due probably to the proximity to the Subis Limestone further south. The remainder of the area comprises mainly of black shale and few remnants of sandstone capping shale which occur only in the eastern part of Block H.

5. Topography and Drainage

The topography of the area probably reflects the differential rates of erosion and weathering of the various lithologic units of the Sibuti Formation. In the southwestern parts of area - Blocks F, G and the western half of Block H - rapid chemical dissolution of the calcareous shale by organic acids has resulted in an overall lowering of the land surface and thus accounts for the almost flat, terrace-like and lower topography. Elsewhere, where shale is the dominant lothologic unit the topography consists typically of convex, rounded low hills.

In the eastern part of Block H, the higher hills formed from shale with remnants of sandstone on hill summits probably indicate that sandstone once formed a capping bed over the less resistant shale and the removal the sandstone bed by erosion in recent times has exposed the shale to renewed dissection and gullying by the headwaters of Sungai Tangap.

The main streams in the area are Sungai Karabangan, which forms the western boundary of Block H, Sungai Tangap, Sungai Pakut, Sungai Manatan and Sungai Separoh. All these streams are aleigned northeast-southwest, which seems to indicate the importance of structural control in their development. The main watersheds lie in Block G and in part of Block H. As these streams form the headwaters of the major streams draining the Lambir-Subis Area, they are of limited size and capacity, and are relatively dry for most part of the year. Probably the only streams which have a fairly constant flow and can be relied on for water supply are Sungai Karabangan, Sungai Tangap and Sungai Manatan. However, in times of heavy rainfall, these streams are rapidly swollen, thereby causing flash flooding to their immediate banks.

6. Vegetation

Primary forest covers most of the area but the forest along the Miri-Bintulu Road front south of mile 43 up to mile 46 has been cut down during the last two years by local people-mainly from Rumah Pakut, for shifting cultivation. Although such forest felling and occupation has been considered illegal, it was observed that the practice was still continued for the last padi season at the time of the field work in September, 1970.

Much of the timber in the forest in the area has already been extracted. However, the bulk of the forest occurring on calcareous shale parent rock is extremely poor, being mainly of small trees, with thick undergrowth of creepers and has therefore remained untouched in the timber extraction process.

7. SOILS

The soils are mapped at the family level, all as single soil units on the basis of the parent materials and the topographic units.

The hill soils occur in a relatively simple pattern, consisting of only two soil groups: the Red-yellow Podzolics derived from non-calcareous sedimentary parent materials and Brown Forest Soils derived form calcareous shale.

Within the Red-yellow Podzolics, three families are mapped; these are the Merit Family derived from shale, the Bekenu Family derived from sandy shale or sandstone and shale admixture and Nyalau Family from sandstone.

The Brown Forest Soils are probably more extensively in this area than anywhere else in the whole Lambir-Subis Area. They occur on topography which ranges from rolling low hills associated with soils of the Red-yellow Podzolics to almost flat terrain associated with soils derived from recent alluvium and colluvium.

Soils derived from recent alluvial deposits are confined to river levees, interior valleys and lower parts of hill slopes. Two families, differentiated on the basis of the drainage conditions, are mapped; these are the Seduau Family which is deep and moderately well drained and the Bijat Family, which has a high water table for most part of the year.

7a. HILL SOILS

Great Soil Group: RED-YELLOW PODZOLICS

7a.1. SOILS OF THE MERIT FAMILY

Soils of the Merit Family constitute the most important family of the Red-Yellow Podzolics mapped in the area, both in terms of areal extent and their suitability for agriculture.

Topography

Merit Family soils are mapped on gentle, low to moderately steep hills. The slopes are convex commonly range from 50 to 100 feet and the slopes may be up to 25° in places. The height above the local base level are seldom more than 100 feet, and that around 50 feet being the most common.

Parent materials

Merit soils are derived from dark-grey carbonaceous shale. In ordinary soil augerings or even in soil pits up to six feet deep, unweathered shale parent material is seldom reached because of the thick weathering zone underlying the solum. However, in deep road cuttings along the Miri-Bintulu Road, thin lenses of semi-crystallized limestone, with thickness ranging from a fraction of an inch to two inches may be found along the shale cleavages. Tests on the weathering zone or the soil profile indicate no presence of lime, and it can be assumed that the common presence of limestone lenses in the parent material has negligible influence on the soil chemistry or soil morphology.

Vegetation

Merit soils generally support good forest stands, and form the bulk of the timber extracted.

General Soil Profile Description

2 - 0" : Fresh litter and semi-decomposed leaves and twigs.

0 - 2" : Brown to dark greyish-brown loam to clay loam, moist, crumbly, friable; well rooted.

5 - 12" : Yellowish-brown (10YR 5/6) clay loam; moist, firm; weakly developed medium blocky structure.

12 - 24" : Yellowish-brown (10YR 5/6) clay loam to clay; mottled faintly with pale yellow; moist, firm to very firm; weakly developed coarse blocky structure, containing very dark-brown moderately hard but crushable concretionery shale pieces which form a 2 to 3-inch sub-parallel horizon to the soil surface.

24 - 36" : Yellowish-brown (10YR 5/6-5/8) clay in a matrix with weathering shale mottled with common distinct pale yellow, reddish-yellow, red and light grey; moist, firm; moderately well rooted.

36"+ : Light grey and reddish-yellow weathering shale, firm to very firm in place.

Physical Characteristics of Merit Soils

1. Colours:

Merit soils are generally coloured yellowish-brown to reddish-yellow. Yellow-brown is the more dominant colour for soils occurring on higher hills, while the stronger colours, reddish-yellow or yellowish-red are more dominant for soils found on low hills ranging from 10 to 50 feet in amplitude. It is not certain whether the stronger colours reflect any difference in the original material or whether they result from weathering processes related to the more subdued topography. The level of mapping, however, does not permit easy delineation of Merit soils into series or phases on the basis of the colour differences, but it can be servedas a good criterion for more precise definition of Merit soils in this area in future detailed mapping.

2. Texture

The topsoil is usually loam to clay loam; this changes rapidly to a clay loam to clay or directly to dense clay in the subsoil.

3. Structure

The structure of Merit soils is generally weakly developed in the moist field conditions, being a weakly developed coarse blocky in the B horizon and weakly developed fine blocky in the A horizons. In the dry exposures, the structures are more prominantly developed.

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4. Consistency

The consistency of the topsoil is friable while the that of the subsoils is us ally firm to very firm.

5. Inclusions

Dark reddish-brown, crushable ferruginous nudules commonly occur as a thin layer of less than three inches at depth of 20 to 30 inches. These inclusions are more common in well drained soils occurring on short, strongly convex slopes. In places, a second but less concentrated concretionary horizon may be found about 10 inches from the surface. The genesis of these concretions is debatable, but in most of the Merit soils mapped, it is thought that the concretions are not present in sufficient concentration and thickness to affect rooting of crops such as oil palm and rubber.

6. Depth

The depth of Merit soils are moderately deep and that between 30 and 40 inches being the most common. Unlike Kabuloh soils, Merit soils are generally underlain by a thick weathering horizon consisting of clay and weathered shale matrix, and this may extend to depth of 10 to 15 feet from the soil surface.

7. Surface Litters.

In contrast with the Kabuloh soils developed on calcareous shale parent materials, Merit soils are commonly covered with forest litters which may be as much as two inches thick. The presence of forest litters indicates the stability of the surface soil and the absence of surface erosion under primary forest vegetation.

8. Interal soil drainage

The internal drainage of Merit soils ranges from imperfectly drained to well drained. Because of the ralatively short slopes and the abrupt change from flat valley bottoms, drainage within Merit soils is not impeded to allow poorly drained soils to develop extensively. Towards the lower parts of somes foothills, faint grey mottles may be found, but such soils are not of importance. The grey colours observed in the weathering zones underlying the solum is almost certainly derived from the weathering shale.

Chemical Characteristics

Several profiles of Merit soils were sampled and are being analysed, but the results were not available at the time of writing. It can be assumed, however, that Merit soils have average fertility and contain no detrimental chemical properties to crops.

7a.2. SOILS OF BEKENU FAMILY

Soils of the Bekenu Family only occurs in small extent and thus do not deserve to be treated in similar details as Merit soils.

Bekenu soils are derived from fine sandstones of an admixture of sandstone and shale. The soils are mapped on the upper parts of dip slopes form on remnants of sandy shale which caps the less resistant shale.

Bekenu soils resemble Merit soils in all aspect except for the sandy texture of the topsoil, which is sandy loam to sandy clay loam. These soils are coloured yellowish-brown to yellow, moderately deep to deep. Bekenu soils are suitable for most crops, and their suitability for oil palm in the area is mainly limited by the steepness on the slopes where they occur.

7a.3. SOILS OF NYALAU FAMILY

Nyalau soils are developed on sandstone and like soils of Bekenu Family, these soils occur only in very limited extent. For this reason, only a brief mention is made on their main characteristics.

Nyalau soils have sandy loam to sandy clay loam topsoil, sandy clay loam to sandy clay in the subsoil, overlying weathering sandstone mixed with sandy clay. The soil is moderately deep, commonly more than 30 inches, moderately well drained to imperfectly drained. The main limitation for crops in this area is the steep slope on which those soils occur, and because they occupy the upper parts of dip slopes or cuestas formed by capping sandstone, these soils are generally unsuitable for oil palm cultivation.

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7b. Great Soil Group: BROWN FOREST SOIL

SOILS OF KABULOH FAMILY

Kabuloh soils are developed from calareous shale or marl which occurs extensively in the southwestern part of the Lambir-Subis area because of the dominance of the calcareous member in the Sibuti Shale Formation, and the proximity of this area to the Subis limestone. The distribution pattern of Kobuloh Soils, as can be seen in the Soil map, is largely dictated by the alignment of the parent rock which strikes consistently northeast - southwest.

Topography:

Kabuloh soils occur on almost flat to rolling terrain and on low hills which are generally less than 50 feet above the local base level and with slopes less than 20 degrees.

Vegetation:

The vegetation over the Kabuloh soils contrasts distinctly with that which occurs on other soil types mapped in the area. The forest consists of very small and stunted trees, with thick undergrowth and abundant creepers and thus bears a strong resemblance to that of the poorly drained swamp forest. Because of the poor quality of the timber, the forest has remained almost untouched in the current timber extraction.

Soils:

A common profile description of Kabuloh soils is as follows:

Location:	at tape 34 of Rentis C6.
Topography:	on gentle slope of low hill, about 30 feet above local base level.
Vegetation:	Primary forest, consisting of small trees and thick creeper undergrowth.
Parent material:	olive grey shale.

Profile Description

A1	0 - 1"	greyish-brown (10YR 5/2) loam, containing few faint pale yellow mottles; moist, friable; crumb structure; many fine and medium roots; smooth change to

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A2	1 - 12"	Light olive-brown (2.5Y 5/4) clay loam to clay with few faint fine pale yellow mottles; moist, firm to very firm; weakly developed angular structure; few fine roots; few fine, very soft black ferromanganese concretions; merging to,
B2	12 - 18"	light olive-brown (2.5Y 5/4) clay, mottled few fine faint pale yellow; moist, very firm; weakly developed angular blocky structure; common fine very dark brown to black ferro-manganese concretions; few fine and medium roots; almost indistinct boundary to,
B3	13 - 30"	light olive-brown (2.5Y 5/6) clay with few fine greyish-brown and pale yellow mottles; moist, very firm; abundant fine black ferro-manganese concretions and grading to very soft, moist to wet plastic clay lying on,
C	30"+	weakly weathered grey shale.

<u>Physical characteristics</u>

1. <u>Colours</u>:

Kabuloh soils can be recognised in the field in the moist conditions by the more subdued colours which are normally light olive-brown (2.5Y 5/4-5/6) in contrast to the stronger colours of the Red-Yellow Podzolics soils such as the Merit.

2. <u>Texture</u>:

Kabuloh soils are heavy textured, being clay loam in the topsoil and clay in the subsoil.

3. <u>Structure</u>:

The structure is weakly developed, blocky in moist conditions but moderately well developed blocky when dried.

4. <u>Consistency</u>

The consistency is firm to very firm, tending to extremely firm in the subsoil.

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5. Inclusions:

Very dark brown to black ferro-manganese concretions are a common feature of Kabuloh soils and are especially abundant in the subsoils occurring on flattish and undulating terrain. The concretions are nodular and occur at 20 to 30 inches depth in the horizon immediately above the weathering parent rock. Loose nodules probably of colluvial origin are also found on the surface of footslopes of some undulating hills and may indicate that rapid truncation of soils on upper hill slopes.

6. Depth:

Kabuloh soils are generally within 20 to 48 inches to bed-rock, with depth of 20 to 30 being the most common. Compared with the other hills soils occurring on similar topography, Kabuloh soils are shallow. Moreover, Kabuloh soils commonly lie directly over the weakly olive grey shale and thus lack the thick weathering zone found between the solum and the bedrock in most other hills soils occurring on gentle slopes. The soil-rock interface consists of 2 to 3 inches of olive grey, wet, plastic clay and suggests that active weathering by soil solution is taking place on the bedrock surface.

7. Surface litters:

The ground surface of Kabuloh soils are generally bare of forest litters and this feature is considered unusual for the subdued topography of Kabuloh soils where surface erosion is minimal. Forest litters probably break down rapidly under the alkaline and well drained conditions and hence accounts for their absence from the surface of Kabuloh soils in many places.

Chemical characteristics

Three profiles of Kabuloh soils were sampled and analysed. The locations of these profiles are shown in map 1 and the chemical analyses are shown in Table 1.

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TABLE 1

Analytical Data for Profiles of Kabuloh Soils.

Lab. No.	Field No.	Depth inches	pH	% (O.D.)			Exchangeable (M.E/100g)						P (P.P.M)		Mn	Fe (6NHCl)
			H_2O	C	N	C/N	Ca	Mg	K	Na	C.E.C.	%B.S.	Av	Total	Ext. P.P.M.	Fe %
	C1	0 - 5	5.1	1.99	0.267	7	8.39	0.81	0.42	0.20	19.05	52			158	3.40
	C2	5 - 14	6.0	0.89	0.163	6	11.90	0.73	0.16	0.17	20.10	69			114	5.10
	C3	14 - 20	5.8	0.55	0.124	4	9.62	0.52	0.15	0.22	18.13	58			31	5.80
	C4	20 - 28	6.2	0.54	0.122	4	20.99	0.46	0.14	0.24	19.96	100			7	5.99
	C5	28 - 36	6.2	0.51	0.127	4	31.06	0.40	0.18	0.29	22.03	100			3	6.65
	C6	36 - 42	6.5	0.45	0.123	4	26.27	0.40	0.19	0.27	27.13	100			3	6.39
S7807	BP1	0 - 1	6.3	3.84			29.18	2.03	0.53	0.29	32.14	99	5	356	5	
808		1 - 12	6.5	1.02			22.87	1.40	0.20	0.26	25.17	98	2	246	3	
809		12 - 18	7.5	0.83			34.31	1.37	0.20	0.32	27.44	100	6	275	8	
810		18 - 30	7.7	1.37			54.35	1.52	0.23	0.38	25.87	100	2	405	494	
S7822	LF20	0 - 1	6.0				35.78	8.41	0.74	0.31	46.93	96	5			
23	21	1 - 3	5.0				14.09	3.57	0.43	0.17	23.53	78	2			
24	22	3 - 10	5.0				5.82	2.32	0.25	0.15	22.71	38	2			
25	23	10 - 16	5.3				8.03	1.65	0.19	0.18	26.11	38	2			
26	24	16 - 26	6.2				26.18	1.62	0.18	0.27	27.05	100	2			
27	25	26+	7.9				64.25	1.03	0.14	0.35	25.05	100	4			

The analyses show that Kabuloh soils have a pH ranging from 5 in the topsoil to 7.9 in the horizon immediate above the weathering bedrock.

The cation exchange capacities are generally high, ranging from an average of 20 me.% in the topsoil to over 60 in the subsoil.

The exchangeable cations are dominated by calcium which is probably present as free calcium carbonate and thus accounts for the high base saturation. Exchangeable magnesium is also high, which exchangeable potassium and sodium closely resemble those encountered in other hill soils.

Extractable manganese is very high in the topsoil, being 158 p.p.m. and under the prevailing soil pH of 6, it is not known how manganese can be present in such high levels. In the subsoils, the figures are 6 or lower and represent the average levels for soils derived from calcareous parent materials.

Remarks

The distribution of Kabuloh soils in Sarawak are localised and so far they have been mapped only in the First and Fourth Divisions. In the Fourth Division, these soils were first mapped by Wall in 1964 (Report No.35/2) and were classified as a member of the Nyalau Family belonging to the Red-Yellow Podzolics Great Soil Group. In the 1966 Classification of Sarawak soils, Kabuloh soils were differentiated from the Red-Yellow Podzolics by virtue of the calcareous parent materials and were placed in the Brown Forest Great Soil Group instead.

In the Kabuloh Agricultural Satation, Kabuloh soils were mapped both as a single unit and as a compound unit comprising Kabuloh soils and Malang soils derived from recent alluvial deposits. The Kabuloh soils as mapped here are similar to those described in this report in both their physical and chemical properties.

So far, no oil palm experiments have been conducted on Kabuloh soils in the Agricultural Satation at Kabuloh although oil palms grown on the mixed Kabuloh and Malang soils have shown no physiological and deficiency symptoms.

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In view of the extensive occurrence of Kabuloh soils in Block C and the adjacent area, and the possibility of using this land for this crop in the future, an observation trial of oil palm on Kabuloh soils in Kabuloh station has been suggested.

Physically, Kabuloh soils appear suitable for oil palm; the main limitations are the shallowness of the soils which are commonly between 20 to 30 inches but this depth is probably adequate for oil palm. The topography is generally favourable, being rolling and low hilly. The common occurrence of rock outcrops may reduce the actual acreage of suitable land the area.

Chemically, the high pH and the presence of high exchangeable calcium and possibly calcium carbonate may give rise to deficiencies of potassium and or magnesium as well as lime-induced chlorosis due to the unavailability of iron. However, there is at present no agronomic information on oil palm grown on Kabuloh soils or similar calcareous soils in Sarawak on which recommendations for oil palm cultivation can be based.

7c. GREAT SOIL GROUP: RECENT ALLUVIAL SOILS

SOILS OF SEDUAU FAMILY

Recent alluvial soils mapped as Seduau Family are found along the main streams and parts of interior valleys. The parent matérial is mainly derived from the weathering of shale and the predominantly argillaceous hill soils. Along the main streams, the extent of occurrence varies, ranging from 50 to 200 feet being the most common.

Vegetation:

The areas under Seduau soils are largely under primary forest, but patches under secondary growth are morecommonly found on this soil type than on others.

Soils:

A common profile description of Seduau soil is as follows

Location: at tape 6 along Rentis C12, Mile 51, of Miri-Bintulu Road, about 100 feet from Sungai Tangap.

Topography: On flattish levee.

Vegetation: primary forest.

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Profile description

Lab. No:

Lab. No.	Depth	Description
	½ - 0"	Dead leaves and twigs.
S7811	0 - ½"	Brown - dark brown (10YR 4/3) loam, moist, friable; crumbly structure; many fine and medium roots, soil contains much organic matter, smooth boundary change to
S7812	½ - 10"	Dark yellowish-brown (10YR 4/4) loam to clay clay loam, with few faint pale yellow mottles; moist, friable; weakly developed subangular blocky structure; few fine to medium roots, also with few fine black organic manganese streaks; few worm holes; abrupt change to,
S7813	10 - 20"	Dark yellowish-brown (10YR 4/4) clay loam with few distinct pale yellow mottles; moist, friable; weakly developed subangular blocky structure; few fine black organic/manganese streaks; few fine to medium roots; weak subangular blocky structure.
S7814	20 - 32"	Yellowish-brown (10YR 5/4) clay loam to clay, with common medium distinct pale yellow and few fine light grey mottles; moist, friable to firm; common fine organic-manganese staining; weak subangular blocky structure; indistinct boundary change to,
S7815	32 - 52"	Dark yellowish-brown (10YR 4/4) clay loam to clay, containing many distinct pale yellow and few fine light grey mottles; moist, firm; common fine black incipient manganese nodules; weak subangular blocky structure.

Physical Characteristics

1. Colour:

Seduau soils are generally uniformly coloured yellowish-brown down to a depth of 24 inches. The subsoil may contain mottles of light grey or pale yellow indicating imperfect drainage or occasional high water table.

2. Texture:

Texture is generally clay loam merging to clay at depth. In places there may be thin lenses or pockets of sandy admixture derived from local sandstone outcrops.

3. Structure:

Seduau soils are only weakly structured because of the juvenile nature.

4. Consistency:

Consistency is friable to firm in the topsoil and firm in the subsoil.

5. Inclusions

As shown in the profile description, the presence of incipient organic or manganese concretions are a common feature in the subsoil, and this is particularly so in Seduau soils occurring in areas dominated by Kabuloh soils derived from calcareous shale.

Chemical characteristics

The chemical analyses of the profile described (S7811/15) are shown in Table 2. It can be seen that Seduau soils are acidic and low in exchangeable cations and available phosphate.

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TABLE 2

Analytical Data for a Profile of Seduau Family.

Lab. No.	Field No.	Depth inches	pH H_2O	C%	P. P.P.M.		Exchangeable (M.E./100g.)						TEB
					Total	Avail	Ca	Mg	K	Na	%BS.	C.E.C.	
S7811	BP 2	0 - ½	4.4	2.31	372	11	1.54	1.54	0.25	0.11	28	12.38	3.43
12		½ - 10	4.3	0.08	268	2	0.09	0.55	0.11	0.11	10	8.58	0.86
13		10 - 20	4.8	0.42	556	1	<0.01	0.76	0.11	0.16	12	9.30	1.04
14		20 - 32	4.8	0.32	268	< 1	<0.01	0.72	0.11	0.14	9	10.43	0.98
15		32 - 52	5.2	0.19	257	1	<0.01	0.85	0.10	0.14	12	9.28	1.10

Remarks:

Seduau soils are physically suitable for most crops but they are liable to occasional floodings lasting two to three days. The soils are low in nutrients.

It should be noted that Seduau soils mapped along streams draining calcareous shale on which Kabuloh soils develop are generally darker in colour and have higher content of tiny manganese specks or soft nodules throughout the profile. Such observed field differences may reflect possible chemical differences and need further detailed studies to characterise Seduau soils in the area adequately.

7d. GREAT SOIL GROUP: GLEY SOILS

SOILS OF BIJAT FAMILY

Bijat soils commonly occur in narrow valleys and in areas lying between stream levees and foothills. The soils consist of light grey to grey clay mottled with common strong brown or yellowish-brown; a high watertable is frequently encountered as shallow depth and this may rise to the sruface during parts of the year.

In the natural conditions, most areas under Bijat soils are too poorly drained for oil palm. However, it is thought that these soils can be converted into moderately suitable soils for this crop with only modeeate drainage efforts because of the proximity of these areas to the main streams.

8. THE LAND SUITABILITY MAP

The Land Suitability Map was compiled from the combined soil and topographic information and aims at indicating suitable areas for oil palm cultivation. The topographic data were derived from the 1:10,000 contoured maps prepared by Land and Survey Department, but the slope limits in most places were actually checked in the field. The land suitability classes as used here have no relation with those devised by I. Wong in 'A Soil Suitability Classification for Malaysia' now adopted for use throughout Malaysia. The land suitability classes used here are mainly intended for oil palm

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cultivation which is dictated by two factors: the soil suitability and the nature of the terrain. Thus, an area with poorly drained soils is given a low grade (Class 5) for oil palm cultivation, whereas it would be up-graded if it is considered for padi cultivation. The suitability classes and their limitations for oil palm are briefly discussed below.

Class 1

This class comprises area with rolling and low hilly terrain in which the slopes are less than 20^{o} and the elevations are generally less than 50 feet above local base level. The soils are dominantly of Merit Family developed from dark grey shale, and possess no physical or chemical limitations for oil palm and other crops.

Class 2

This class of land is confined to well drained and moderately well drained levees occurring along the main streams and inland valleys which are not waterlogged. The soils are mainly free draining, moderately heavy textured, and suitable for oil palm and most other crops such as fruit trees, coffee and rubber. The only limitation is the liability to flash flooding during periods of heavy rainfall, but these floodings are only of short durations.

Class 3

This class consists of all those areas where the soils are derived from calcareous shale parent material and are mapped as the Kabuloh Family. Topographically, these areas are low hilly and suitable for oil palm cultivation. The soils are physically suitable though in places somewhat shallow, with depths of less than 24 inches being common. The soils are calcareous by Sarawak standards, with pH ranging from 6 to 7 in the subsoils and may be saturated with calcium carbonate. The lack of information of oil palm grown on this soil type makes their suitability for this crop uncertain. The very poor primary vegetation invariably associated with this soil type is a good indication of possibly toxicity or nutrient imbalance existing in the soil and the need for some observation trials before these are planted up with oil palm.

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Class 4

Class 4 land comprises hilly terrain and differs from Class 1 land by the steeper slopes which range from 20 to 27°. For this reason, Class 4 land is considered marginal for oil palm because of the physical difficulties involved in using it. The soils are dominantly of Merit Family and are suitable for oil palm and rubber. Where Class 4 land occurs in small extent and in association with Class 1 land, it can be included for cultivation of oil palm.

Class 5

Class 5 land comprises all the poorly drained interior valleys and small swamps where the soil water table is high and are liable to frequent flooding. However, with moderate drainage efforts, these soils can be used for oil palm.

Class 6

Class 6 land includes those areas which are poorly drained but differs from Class 5 land in that the soils have at least more than 10 inches of organic topsoil over mineral soil. The soils include peat soils of the Mukah Family which has up to 40 inches of peat and Anderson Family which has peat ranging from 40 inches to over 10 feet deep. Class 6 land occurs in minor extent and is not significant in the area surveyed.

Class 6A

This class of land comprises all those hilly areas in which more than 50 percent of the hill slopes are in excess of 30° and the amplitude of the hills exceeds 50 feet above the local base level in most places. The soils include all the families mapped in the Red-Yellow Podzolics for this area, and comprises dominantly of Merit soils derived from shale, with minor Nyalau soils derived from sandstone and Bekenu soils from sandstone and shale admixture. The steepness of the slopes is the main limitation of this land for oil palm cultivation. Probably large parts can be used for rubber should there be a pressing need for land in the future.

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Suitability Class	Block			
	C	F	G	H
1	2,258	2,690	1,557	4,334
2	858	1,005	62	988
3	706	447	1,737	1,123
4	294	117	187	374
5	457	212	387	334
6	-	-	-	-
6A	494	5	18	1,707
Total	5,070	4,480	3,950	8,860

Table 3 : Acreage of Suitability Classes as measured from the Land Suitability Map.

9. CONCLUSIONS

The soil survey shows that approximately 16,000 acres can be recommended for oil palm cultivation. Generally, the area is too broken by the presence of patches where the suitability of the soils for oil palm remains uncertain or by the steep hilly terrain. Moreover, illegal occupation of suitable areas along the road front has greatly reduced the acreage of suitable land.

However, the topography and soils in the area as a whole offer much scope for development or settlement schemes involving intensive and more diversified forms of agriculture. All those areas along the Miri-Bintulu Road placed in the Land Suitability Map as Classes 1, 2, 4 and 5 can be used intensively to take full advantage of the communication provided by the new road. Many of the timber tracks which traverse the area can be repaired and maintained for use in the initial development of the area.