Report No. 109

Report on a Semi-Detailed Soil Survey of the STINGGANG - STUNGKOR AREA

1st Division

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2. Location and population

The area is found between the 12th and 19th mile Bau-Lundu road, and is partly located in the Bau District (the eastern portion) while the western portion belongs to the Lundu District. The trunk road dissects the area in a northern and southern part, the former being almost 2/3 of the area. The eastern boundary is formed by Sungei Tapah and Sungei Stinggang (the latter from the point of confluence of the Tapah and Stinggang rivers up to the confluence of the Stinggang river with Batang Kayan). The northern boundary is formed by the Batang Kayan, the main waterway in the Lundu District which was the only means of access to the area before the trunk road Bau-Lundu reached the area in 1965.

The western boundary is formed by a small stream Sungei Janjan (on old maps wrongly spelt as Sungei Danian), while the southern boundary is formed by a line approximately 2,000 meters south of the main road. This boundary was chosen because the terrain south of this line was generally considered too steep for Oil Palm planting and also because it formed a sheet boundary of the 1:10,000 topographic map prepared by the Lands and Survey Department which was used as the topographic base for the soil map.

The area is populated by mainly Land Dayaks (Sau and Jagoi origin) with only a few recent Chinese settlers on leased land (mainly in the Stungkor area). The area is wholy owned through Customary Rights by two Kampongs namely the eastern half by Stinggang (Sau origin), while the western half is owned by Stungkor (Jagoi origin). the latter Kampong has a Christian settlement in Kampong Bokah near the western border of the area but this Kampong should as far as Customary Rights is concerned be regarded as part of Kampong Stungkor since through still existing family ties no cutting up of the land has taken place. It should here be mentioned that in the middle of the area is located approximately 1,500 acres of disputed land (~~see Potentiality Map~~) which according to old records was allocated to Stungkor by the then District Officer of Lundu in a court ruling. Until now Stinggang does not recognise this ruling which is giving rise to much friction between the two Kampongs and which may jeopardize attempts to initiate a scheme in the area unless means can be found to bring the two parties together.

3. Geology

The whole area is underlain by sedimentary rocks of Upper Cretaceous to Eocene Age which are combined under the name of the Plateau Sandstone Formation. Although the name may indicate that the formation largely consists of sandstone, in the surveyed area large portions are underlain by greenish-grey and greyish red mudstones and in some places carbonaceous silty shales. According to Wolfenden (1963, p.36-39) this area forms part of the Upper Division of the Plateau Sandstone formation in which the sandstone lenses form small scarps while the argillaceous members of the formation tend to form long dipslopes. The sandstones are lithic sandstones and most fall in the quartzose subgreywacke class containing between 10 to 25 percent unstable constituents (rock fragments and feldspar). The typical sandstone is a fine-grained or medium-grained moderately sorted rock, consisting of subangular grains of quartz and some feldspar, fragments of chert and shale, small flakes of muscovite, and a few grains of zircon, tourmaline and iron ore.

The sandstones are frequently interbedded with conglomerates which consist of rounded pebbles mostly 1 to 3 cm but rarely up to 10 cm in diameter, in a sandy matrix. Most of the pebbles are of sedimentary rocks. Most of the conglomerates in the Plateau Sandstone formation are cemented by quartz.

Quaternary sediments in the area are rare since very little deposition of riverine alluvium appears to have taken place or most of it must have been eroded after deposition in possibly Pleistocene periods during which the sea level was much higher and terraces could well have formed in the area as is the case in many other areas in the First Division. Since most of the land in the area lies between the 100 and 25 foot level it could well be that after a fall in sea level most of such deposits have again been eroded. Recent riverine alluvium is mainly found along the Batang Kayan where it forms a thin strip along the river and in the western portion of the area where the land is below the 25 foot level. Here through backflooding during the landas season clayey alluvium is accumulating in places, covering deep peat deposits. These may give evidence of former much higher water levels than at present. Whether this is in some way related to the reported relative fall in sea level in the Lundu coastal area (Wolfenden, 1963, p.102) is difficult to say but this may well be possible since the accumulation of clay deposits on former peat swamps takes place all along the Batang Kayan as was noticed during the reconnaissance survey of 1965 (Andriesse, 1965).

Since the material derived from the local occurring rock formations (particularly the sandstones and conglomerates) if occurring below 150 feet is so similar to old terrace deposits found elsewhere in the First Division it is extremely difficult if not impossible to distinguish between the two. This difficulty is reflected in the soil classification where frequently association of families had to be mapped since no subdivision could be made between the families based on origin (residual or alluvial). A similar difficulty arises with the soils derived from mudstones occurring at levels below 50 feet. Here the weathered mudstone (unconsolidated clay deposits) is not to separate from recent clay deposits and since the soils derived from both are quite similar and the topography does not provide a clue to their derivation, they had to be mapped as one unit.

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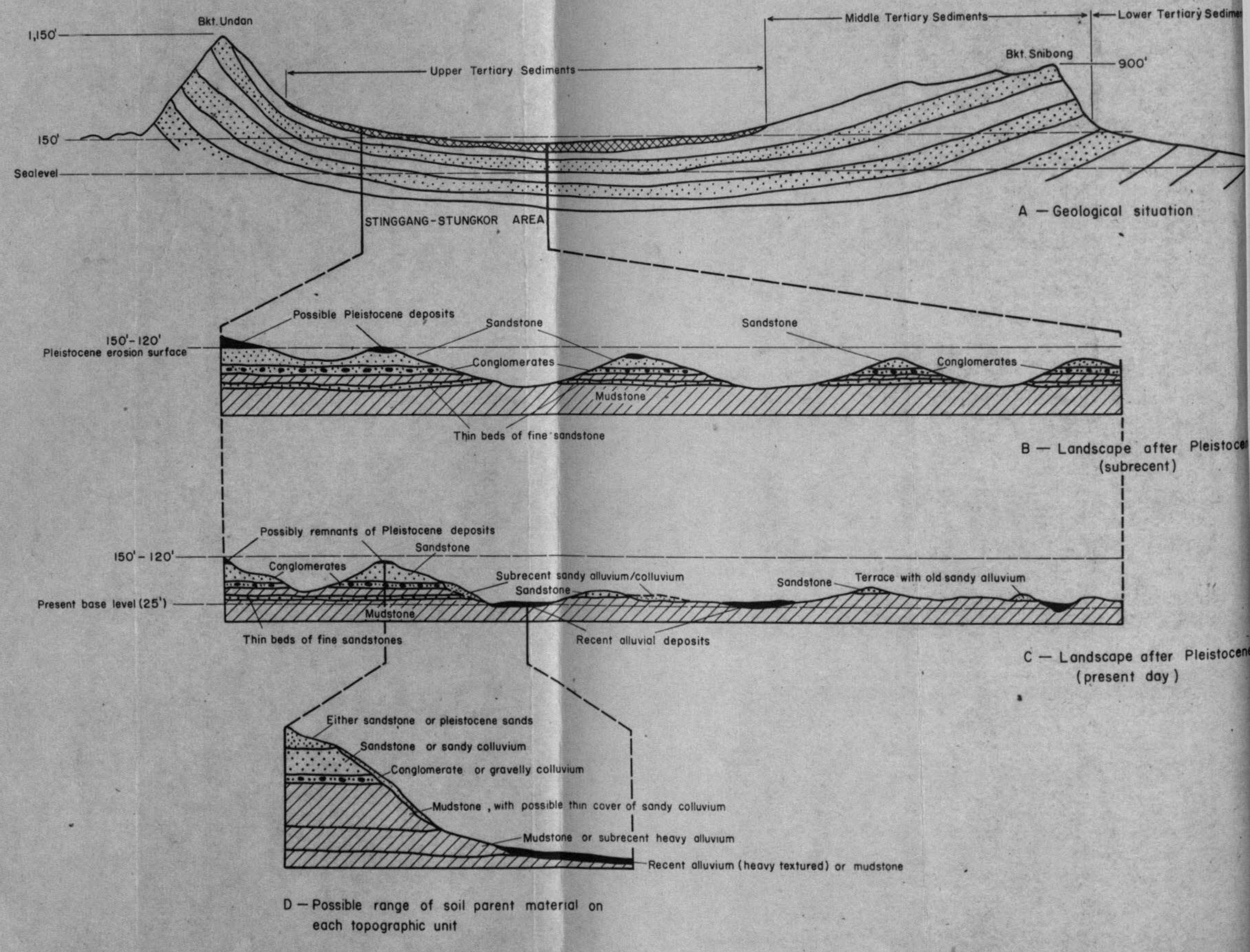
Fig.

Diagrammatic cross section of the Stinggang — Stungkor Area showing stages in the development of the present landscape



4. Physiography

During the reconnaissance survey of 1965, it was found that the information gathered using reconnaissance methods was insufficient for getting an insight in the rather complex soil pattern. The subdued topography in general did not allow a separation into well-defined physiographic units which in Sarawak often provides the basis for soil mapping units.

The close rentis net used in the semi-detailed survey together with enlarged photographs (scale 1:15,000) revealed, however, that a close relationship exists between the physiography combined with the underlying geology and the soil pattern. Because of this the physiography of the area is described rather in detail so that the complex soil pattern shown on the soil map is better understood.

Cross section A in figure 1 illustrated the geological position of the area in relation to its surroundings. As described in the section on geology the area is underlain by the upper division of the Plateau sandstone formation which in this area is almost flat-bedded. Towards the south the beds of sedimentary rocks have been uplifted and form the Undan range (the southern boundary of the area), towards the north a similar uplift comprising mainly the middle division of the Tertiary deposits has resulted in the formation of the Snibong escarpment. The northern boundary of the area lies south of this middle division.

Thus an almost basin shaped area, almost flat in the middle was formed and the Stinggang-Stungkor area is found almost in the centre of it.

The basin was peneplained during Pleistocene periods, the erosion base level being between 150 and 120 feet, remnants of which are represented by the summits of the highest ridges found in the area. The height of this level corresponds well with the 120 to 150 feet high erosion base levels found elsewhere in the First Division (Andriesse, 1964, p.10).

During the survey it was found that most of the higher ridges were formed by sandstones underlain by conglomerates which in turn are overlying thick beds of greenish grey mudstones. This is illustrated in cross section B. It must not be ruled out that during the Pleistocene alluvial deposits were covering parts of the peneplain and in accordance with findings elsewhere in First Division these old deposits were mainly quartzsands and gravels. The material covering the hills and ridges with summits of a height between 150 and 120 feet appear to be covered with such quartzsands underlain by gravels but since the tertiary sandstone beds and conglomerates (them being of an unconsolidated nature) are also outcropping at this elevation it is impossible to say whether this material is old alluvium or of a residual nature. Soils derived from this material therefore had to mapped as associations of both, residual and old alluvial families.

After peneplanation the area was dissected during post-Pleistocene periods to a level of approximately 25 feet which is the present erosion base level at which deposition takes place. Much of the original sandstone beds and conglomerates than well old alluvial deposits were eroded thus exposing the underlying mudstones. Fine grained sandstone lenses in the mudstones give now rise to the formation of low undulations and small escarpments in the area while remnants of the thicker and more coarse textured sandstone beds overlying the mudstones form nowadays more pronounced hills and ridges. (see cross section C).

The mudstones are found exposed on the middle and lower parts of very gentle sloping terrain which grades into present day riverine valleys. At a level between 50 and 25 feet these mudstones are partly covered with recent alluvial deposits which if of a heavy textured nature are indistinguisable from the weathered mudstones since these alluvial deposits are themselves derived from these mudstones and a separation between soils derived from the mudstones and the recent alluvium is not possible.

Subrecent small riverine terraces were formed at about a level of 50 feet and can be recognised by their location near secondary present day river courses. During the period of dissection in places much colluvial material mainly derived from the sandstone beds was deposited at lower slopes and they have given rise to the formation of bisequent soils with a strong texture contrast. Such material was also deposited in nearby small bottomlands. (see cross section D). The dissection has never reached the stage whereby large inland valleys were formed as is the case in most dissected area in the First Division. Only in the extreme western part of the area valleys were found below a level of 25 feet which at one stage where filled up by peat which in turn are now being covered by clayey deposits through back flooding during times of high water in the Kayan river. Along the secondary and major rivercourses small levees were built up during recent times.

The absence of interior valleys is probably caused mainly by the soft nature of the tertiary sediments which prevented deep dissection and the absence of vertical bedding planes which could have enhanced the formation of deep v-shaped valleys. Probably any deep dissection was followed by a filling in process through slump of poorly consolidated material of bordering hill sides which could also be one of the reasons why the soil pattern of these lowlying areas is so complex.

5. <u>Drainage</u>

The main drainage channel in the area is the Batang Kayan forming the northern boundary of the area and which is tidal up to the crossing of the Bau-Lundu road (20th mile).

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The water level in this river is heavily dependent on rainfall since its upper drainage basin is almost totally composed of porous sandstones which enable quick drainage. This is the reason why during the wet season high floods frequently occur along this river followed by a quick fall in the water level. During the dry season the water level is very low since the storage capacity of the rock types in the upper river basin is low. The same can be said for the surveyed area. During the dry season the water can be drained rapidly into the Kayan river which has then a low level which consequently results in low water levels in the secondary streams. Most secondary streams follow a south-east to northwest direction and are superimposed to the normal strike of the sedimentary rocks which is southwest to northeast. They were probably formed after the peneplanation of the area during Pleistocene periods. Tertiary river courses generally follow the strike of the underlying rocks, but are poorly developed probably due to slumping of hill sides as previously explained. True wet bottomlands are only found in the west where because of the lowlying nature of the land drainage throughout the year is slow and in some small areas where outlets have been blocked either by deposition of a secondary river course or by land slides.

Superficial drainage in the whole area is rapid and permanently wet soils are rare.

Areas underlain by mudstones have rather slow interior drainage and especially during periods of high rainfall; this results in permanently saturated conditions in soils found at lower slopes. During the dry season they were invariably found in dry condition but gley features reveal this condition during other periods of the year.

The situation whereby coarse textured material overlies heavy textured material accentuates such conditions.

Areas below the 25 feet level are liable to heavy floods during periods of heavy rainfall because of back flooding from the Kayan river. During the 1963 wet season these floods were catasthropic but normally they are of short duration.

In general it can be stated that the area for Sarawak conditions is rather dry and that during the peak of the dry season a general shortage of water exists. Tertiary streams are generally dry and only secondary streams carry sufficient water for the domestic use of the population centres.

6. Vegetation and Agriculture

Most of the area is covered by secondary forest and is under shifting cultivation. A small area of swamp forest occurs in the west (Sungei Putus) while Riperian forest is found along parts of the Batang Kayan and some of the secondary streams. Wild fruit trees are common in the latter forest type. The area was once famous for its dense stand of belian trees for which the people had no use but which were spared out when clearing forest for shifting cultivation practises. During recent years most of this valuable timber has been transported out of the area when the Lundu road reached it, mainly in the form of pepper poles.

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Small areas of Kerangas forest cover poor soils on hill summits. The secondary vegetation is rather poor because of overfarming in the past, this is especially the case near the Batang Kayan (confluence with Sungei Stinggang) were Kampong Pangkalan Stinggang was settled some years ago. A dense cover of ferns (Resam) usually marks the areas of generally poorly drained conditions such as found on the lower parts of long dipslopes. Lalang seems to favour rather better drained conditions and is found mainly on hills covered with better soil types. The incidence of lalang is however low as compared with that of resam.

Shifting cultivation practises are rather unusual in the area in that a much larger amount of maize and tapioca is planted with the rice than is the case with other areas in the First Division. Maize is specifically planted in abundance were old secondary jungle is cut down and a number of weeks in advance of the dibbling in of the padi seeds. This practise, according to the local population is related with the rather late inset of the rains (November). On sandy poor soils much tapioca is planted. The light texture appears to favour the formation of large tubers. Tapioca is generally regarded as part of the normal diet of the people.

The ladangs are generally large in size and every bilik concentrates only on one area. Wet padi is not grown because suitable bottom lands are not found in the area.

In the last ten years the population has put great emphasize on the growing of rubber and R.P.S. 'A' gardens are found in abundance. These are mainly concentrated around the villages and in the case of Stinggang are found east of the area surveyed and they would not form a hindrance to any future development. The rubber is doing well on the light textured soils and the growth rate is very satisfactorily. During recent years a general shifting to pepper cultivation is taking place. This has followed the arrival of the road in the area and pepper gardens, mainly non-bearing, are prolific along the Lundu road, they are partly owned by the local population and partly by Chinese who appear to have made certain arrangements with the local inhabitants. The pepper is doing well particularly on the heavy textured but well structured hill soils.

An oil palm pilot plot was established in February 1967 at the 15th mile on the Merit family by the Departments Soil Agronomist to study the behaviour of this crop on this soil type using various levels of fertiliser. In Appendix 2 a report can be found on the first year's performance of this crop.

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II. SOILS

1. Classification

The classification of soils is outlined in detail in 'A Classification of Sarawak Soils' (1966, Soil Survey Staff). Certain amendment to this classification were made following fieldwork during 1966 and 1967 which are outlined in Appendix I. They concern the classification of Gley Soils which, with the amendments, is considerably simplified.

In the following section, the, from a development point of view, most important soils are discussed in more detail than other less important soils.

In the map legend use is made of mapping units which are in a number of cases composed of associations of various families which may either belong to one Soil Group or may form parts of different Soil Groups.

The use of mapping units is necessary since the accurate delineation of individual soil families is not well possible when relying only on soil observations carried out along parallel running observation lines.

2. Soil descriptions

2.1. MERIT family

Soil Group:	Red-Yellow Podsolics
Origin:	Residual, mainly derived from mudstones and shales in the area
Phases distinguished:	Well-drained and imperfectly drained.

The well-drained Merit soils are usually found on hilly terrain approximately 50 feet above local valley bottoms and gentle slopes not exceeding 15 degrees. Profile 1 (Appendix 3) is a description of the typical well-drained Merit soil found in the area. It is likely that the well-drained Merit soils are dominantly derived from shales but the parent material has never been seen in unweathered form. Weathered shale fragments do, however, occur in some profiles.

Characteristic of the soil is the good structure and the friability which is unusual for most Merits in other parts of the First Division.

Present use is mainly shifting cultivation, but the soil is preferred above others for pepper cultivation. The soils are considered suitable for oil palm and rubber and do not require improvement other than fertilisation depending on the crops grown.

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The imperfectly drained Merit soils are found in low undulating terrain typical for mudstones and the soils cover long gentle slopes, to almost flat land in places. The latter are indistinguishable from recent alluvium mapped as Malang family and they had to be mapped in association with the latter. Profile 2 (Appendix 3) is a typical imperfectly drained Merit showing strong mottling below a depth of 2 feet. It is thought that the flat terrain together with the compactness of the clays induces the imperfectly drained condition rather than that high ground-water tables are involved. The soils are generally compact and lack the friability of the well-drained phase. Textures are commonly heavier. The soils are mainly used for shifting cultivation but pepper is grown on them with apparently good results.

The pilot plot of oil palms referred to on Page 7 is established on this soil type which is considered suitable for oil palm and rubber. In places some shallow drains will have to be dug in order to avoid excessive wetness during the wet season; this is mainly the case with soils having gley horizons between 2 and 3 feet which unfortunately could not be separated using semi-detailed methods from the other soils in this family. For oil palms therefore it may be necessary to drain such areas superficially to allow surface water to drain off rapidly.

2.2. <u>BEKENU family</u>

<u>Soil Group</u>: Red-Yellow Podsolics

<u>Origin</u>: Residual, mainly derived from fine grained sandstones.

No phase differences were mapped although both well-drained and imperfectly drained phases do occur.

The Bekenu family soils are visually very similar to the Merit family but have lighter textures. Commonly the topsoils are sandy loams while with depth the clay content increases gradually reaching clay to sandy clay textures at a depth of 4 feet. Profile 3 (Appendix 3) represents a common well-drained Bekenu soils while Profile 4 (Appendix 3) is a description of an imperfectly drained phase. The soils are usually occupying well defined ridges and hills and their occurrence can commonly be predicted by small rises in the low gentle undulating terrain characteristic for the imperfectly drained Merit family. In the south where the country is more dissected they occupy higher ridges with moderately steep slopes not exceeding 20 degrees. The terrain of the latter is, however, of small acreage. As with the Merit family, the well-drained phase without gley features is found on more hilly terrain, while the imperfectly drained phase showing gleying and mottling below 2 feet of the surface occupies long dipslopes. The imperfectly drained phase occurs dominantly in the extreme western part of the area but is of a subordinate nature in the rest of the area.

Both phases are considered suitable for oil palm and rubber but for the same reason as stated for the imperfectly drained Merit soils, improvements in drainage are required for the imperfectly drained Bekenu.

2.3. NYALAU family

Soil Group: Red-Yellow Podsolics

Origin: Medium grained sandstones

No phase distinction.

The Nyalau family comprises soils with light textures throughout the profile but are otherwise very similar to the Bekenu soils. The texture range is commonly a fine loamy sand to sandy loam overlying weathered sandstone. A typical profile is Profile 5 (Appendix 3). Usually the Nyalau family is found on distinct ridges and scarp-slopes. The total area of single occurrences is small but larger areas had to be mapped in association with Bekenu family soils; they concern areas in which small lenses of medium grained sandstones are interbedded with thicker beds of fine grained sandstones on which the Bekenu has formed. The Nyalau soils are all well-drained but are chemically considered poorer than Bekenu soils because of the lower clay content. The soils are almost for 100% in use for shifting cultivation. With adequate fertilisation they can be used for oil palm and rubber. Outside the terrain some good stands of rubber were noticed on this soil type which is probably due to the porosity of the soil which offers no hindrance to root development once fertilisers are applied.

2.4. SARATOK/TRIBOH families

Soil Group: Grey-White Podsolics

Origin: Either from quartzitic sandstone or old alluvium.

No phase distinction made.

These families are described together since the profiles are identical, the difference being in origin; the Saratok family is derived from sandstones while the Triboh is derived from old alluvial deposits. The origin in many areas cannot be assessed for reasons given in the section on the Physiography of the area (see section 4, general description). This is particularly the case for the majority of the soils occurring on summits of distinct ridges. In fact the highest parts of the area representing an old erosion base level are covered with these soils. A representative profile is given as Profile 6 (Appendix 3). In this particular case it could be assessed that the soil belongs to the Saratok family since it occurred on one side of a hill built up by sandstones and conglomerates. Generally, the soils are very sandy to a depth of more than 3 feet, and often gravel layers are interbedded with the sands. They may either indicate conglomerates occurring in the sandstones or they are gravel deposits in old alluvium. Common is also a certain texture contrast below 2 feet where sands rest on sandy clay loams. This invariable causes the development of very weak spodic horizons, either continuous or intermittent and such soils must be regarded as intergrades with the Podsols. For this reason these intergrades were mapped together with the Saratok and Triboh families in one mapping unit because separation is impossible. The bisequent nature of such soils is either due to sandstones resting on mudstones sectioned in one profile or in the case of true old alluvium, sandy alluvium resting on heavy textured deposits.

The Saratok and Triboh soils are of low agricultural value because of poor inherent fertility. They are mainly in use for shifting cultivation and rubber shows poor stands although with proper fertilisation moderate results can be obtained. The rate of growth is invariably retarded if compared with the performance of rubber on the previously described families. For this reason they are not recommended for oil palm development but in some cases they could be used for rubber if no other soils are available. In a large scheme they should, however, be avoided.

Triboh family occurs as a single unit on small areas as remnants of subrecent river terraces. They are low-lying and are invariably found near present day rivers. Their origin can therefore be assessed with some confidence. The general remarks given above are also applicable to these soils.

2.5. SILANTEK/BUSO families

Soil Group:	Podsols
Origin:	Either quartzitic sandstones and conglomerates or old alluvium.

No phase distinction made.

These families are mapped together for the same reason as given for the Saratok/Triboh families. They are derived from the same parent materials but are found on more or less flat terrain which induces waterlogged conditions. This is particularly the case where bisequent profiles are involved. Soft humus pans occur in these soils but where exposed (in road cuttings) they tend to harden. The soils are commonly found on flat summits of hills or very gentle sloping dipslopes of hills built up by quartzitic sandstones and conglomerates than well covered by old alluvium. The soils are agriculturally of no importance. The local population avoids them for shifting cultivation and for any large-scale development they should be regarded as unsuitable for cultivation because of very poor inherent fertility, and poor drainage conditions.

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2.6. MALANG family

Soil Group: Red-Yellow Podsolics

Origin: Recent alluvium

The Malang family soils are found on flat terrain bordering main rivers. They generally are heavy loam to clay soils which are well-drained in the surface horizons but which show gley features such as grey and red mottles below a depth of 2 feet commonly merging into a grey gleyed horizon within three or four feet from the surface. Most of the soils are occasionally flooded during the wet season, but floods are usually of short duration. Since the profile characteristics are very similar to those of the imperfectly drained Merit family soils found on mudstone, the Malang soils are difficult to separate from these especially in localities where the Malang soil is underlain by mudstones. The Malang soils have therefore been mapped together with the imperfectly drained phase of the Merit soils if the latter occur in flat terrain.

The Malang soils have a high potential for agriculture since the inherent fertility is generally somewhat better than the related Merit soils. However, flooding and imperfect drainage conditions are limitations for certain crops such as pepper and oil palm. They should not be used for the former but with improvement in drainage entailing the provision of a shallow drainage system they can be used for oil palm, but the risk of flooding should be assessed for each locality since this varies much. The soils are suitable for rubber without further qualifications.

2.7. BIJAT family

Soil Group: Gley soils

Origin: Recent alluvium

This family occurs in small bottomlands where drainage is empeded. In such locations the parent material is mainly local alluvium or colluvium derived from neighbouring hill slopes underlain by mudstones. Watertables are high throughout the year and frequently are at the surface. During the wet season the Bijat soils are emerged for long periods. Characteristic is the greenish grey to grey gley horizon found within a depth of 20 inches from the surface. Where occurring in small bottomlands the soils can be used for wet padi cultivation but the acreage is very small.

A larger acreage of the Bijat soils is found in the northwest of the area, the lowest part of the region surveyed. Here Bijat soils are found in some river valleys and are backing levees. In these areas Malang soils grade into Bijat soils, the former being found at somewhat higher ground. The difference in elevation may not be more than a foot or so but sufficient to bring the gley horizon within the 20 inches limit from the surface. This variation is unmappable and in such areas soils/mapped as an association of Malang and Bijat.

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Finally, Bijat soils are found covering old peat deposits, mainly in the Sungei Putus valley. The clay cover varies from 2 to 4 feet over and since depth of the clay deposits is very irregular Bijat soils have there been mapped in association with the Anderson soils described below.

Because of the high flooding risk and the high watertable the use of Bijat soils is very restricted. Rubber and oil palm must be ruled out since although drainage could be provided to some extent, flooding is difficult to control. They may be suitable for some local use such as small wet padi plots or vegetables.

2.8. SEMADOH family

Soil Group:	Gley soils
Origin:	Probably mudstone and siltstones.

The Semadoh family soils are characterised by their location and typical colour range. They are commonly found at the lower ends of long dipslopes where much lateral drainage water tends to accumulate. During the wet season, the soils are therefore in an almost saturated condition. This is also caused by the fact that the internal drainage is very slow because of the heavy texture (silty clays mainly) and the compactness of the soils. The soils have pale colours throughout the profiles and are strongly gleyed. Strong red mottles in a grey matrix are characteristic for soils derived from mudstones, but others have brownish yellow to yellow mottles in a grey matrix. This frequently coincides with a more silty texture and probably the parent material may be a siltstone. During the dry season the soils are commonly quite dry and are moist to wet only in the subhorizons. The vegetation is generally poor and ferns commonly occur dominant in the undergrowth. Typical is a sort of park landscape in which scattered, possibly fire-resistent large trees occur with a sheet cover of ferns, generally climbing up the trees and overgrowing them. The Semadoh family is regarded as a poor soil having a low potential for agricultural development. Possibly rubber might be grown on these soils but it is thought that the performance will be poor. The soils are not recommended for oil palm.

2.9. TATAU family

Series:	Bokah and Gong
Soil Group:	Gley soils
Origin:	Quartzitic sandstone and/or conglomerates, (Bokah)-low iron content, light-textured alluvium (Gong).

The Tatau soils (see Appendix 1) are light-textured Gley Soils in which the Gong series represents quartzitic, light textured alluvium while the Bokah series is formed by quartzitic light textured soils derived from sandstones and conglomerates. The Gong series is found in bottomlands where local alluvium and colluvium from neighbouring hills underlain by mainly sandstone has been deposited. The Bokah series is found on the lower slopes of small hills thus in the same position where the Semadoh family would occur if the parent material were mudstone.

Since the profiles of Gong and Bokah series are very similar (the areas where they occur merge into each other) it is impossible to map them separately. This is also done for practical reasons since the small areas of bottomland in which the Gong soils are found comprise in total a very small acreage.

The Bokah series is the dominant soil in this family and is characterised by pale colours throughout the profile. Strong gley features occur within a depth of 20 inches from the surface, yellow to strong brown mottles in a grey matrix which grade into a grey gleyed horizon. In some cases light textured horizons overly heavier textured subhorizons, the change being quite abrupt. It is possible that such profiles are bisequent, the lighter material having derived from up slope areas through outwash. It is likely that the bisequent nature of these soils is true for most profiles but that the texture contrast may be found below augering depth (4 feet). This may explain the gleyed conditions in these soils since the light textured material should normally be able to drain off surplus rainwater quite rapidly if not a more or less impermeable layer in the subsoil were not causing a perched ground watertable to form.

The Bokah soils are the light textured equivalents of the Semadoh family soils but are considered of lower fertility because of the low clay content. They are not recommended for general agriculture.

The Gong series occurring in bottomlands have a true ground watertable at or near the surface for most of the year. The areas are flooded during the wet season. No recommendations are made for their agricultural use, the potential being very low.

2. 10. <u>ANDERSON</u> family

<u>Soil Group</u>: Peat soils

<u>Origin</u>: Organic deposits

The Anderson soils are a very minor group in the area. They are only found in the west of the area, in very low lying valleys which are continuously wet with the watertable at or above the surface during the wet season. The organic deposits range in depth but are generally deeper than 80 inches. In the area the Anderson soils are in most places covered with a veneer of clay which was deposited in quite recent times owing to back flooding of the Kayan river. The thickness of these clay deposits vary but when less than 2 feet in thickness they have been mapped as Anderson family. These clay deposits are chemically quite fertile but their location makes proper use difficult because of the high flood risk during the wet season. (The local population indicates that floods of 6 feet or more are quite normal). Use of this land during the dry season is limited because of the wet state of the land and drainage is thought to be difficult, the expense of which is probably not justified for the size of the area. The soils are mainly covered with Primary jungle which forms a source of timber and rattan for the local people.

2.11. SEDUAU family

Soil Group: Recent alluvial soils
Origin: Recent alluvium

The Seduau family soils are found on incipient levees along secondary streams which drain areas in which the geology varies from sandstones to mudstones. The sediments of such rivers are commonly loams to clay loams. The soils show stratification in the profiles and light and heavy textured materials may alternate, the generalised texture of the profile being on the heavy side. The soils are commonly imperfectly drained with brown and grey mottles below a depth of 2 feet but a gley horizon within 4 feet of depth rarely occurs. The soils are probably wet in the subhorizons during the wet season but during the time of survey (September) the soils were moist throughout. They are distinguished from the related Malang soils by their lighter texture (the Malang has a higher clay content), their position (on levees) and colour (which is yellowish brown with no red mottles, while the Malang, possibly because of higher iron contents, displays strong red mottling).

The Seduau soils are mainly under Riperian Forest with many wild Durian and Rambutan trees and some Illipe nut. They are useful for the growing of fruit trees but they do not play a role in a development scheme for rubber or oil palm because of their small acreage. They are, however, considered suitable for both crops.

III. CONCLUSIONS

1. Land potential

The area was surveyed for purposes of large-scale development planning with particular reference to Oil Palm and Rubber.

The potential of the land is viewed with these aspects in mind and the potentiality rating used is only of value for these crops.

The initial selection of the area was based on the favourable topography and location of the area together with the knowledge that suitable soils for both oil palm and rubber cultivation did exist in the area in some measure.

The semi-detailed soil survey confirmed that indeed the topography in the whole area is favourable while boundaries of soil units with potential for the crops envisaged could be drawn with some accuracy.

The land potential classification is based on three limitations which exist in the area, they are:-

(a) the risk of flooding	(a locality problem)
(b) drainage conditions	(a locality and soils problem)
(c) fertility of soils	(a soils problem)

The risk of flooding must be regarded as a permanent one since the cause cannot be remedied at economic costs. A high risk of flooding is therefore preventive to the growing of crops which cannot bear inundations of long duration.

Drainage conditions can be improved comparatively easy if it is a soils problem only while the problems of providing proper drainage increase if the locality is unfavourable. The first improvements are considered as not cost preventive while the latter generally are cost preventive. Much of this is based on assumptions and these statements may need revision if more knowledge is gained on this subject but it is thought to be unwise to declare areas as suitable for certain purposes if the costs of improvements are debatable, and specifically so if better soils do exist which can be utilised with advantage.

This has been considered in the rating of soil units in the potentiality classification.

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Table 1

Land Potential for Oilpalm and Rubber (1)
(Stinggang-Stungkor Area)

Class	Limitations			Soil types
	Flooding risk	Drainage requirements	Fertilizer requirements	
High potential	nil	nil	normal (2)	Merit (well-drained) Bekenu
Moderate potential	nil	nil	moderately high	Nyalau
	nil	moderate (3)	normal	Merit (imperfectly drained)
	moderate (4)	nil	normal	Seduau
	moderate	moderate	normal	Malang
Low potential	moderate	nil	moderately high	Kayan
	nil	nil	high	Saratok/Triboh
	nil	moderate	high	Semadoh, complex unit
	high (5)	high (6)	normal	Bijat
Very low potential	nil	moderate	very high	Silantek Buso, Miri
	moderate	moderate	high	Tatau (Bokah, Gong series)
	high	high	very high	Anderson

(1) Since topography appears to be the main factor in classifying land for oilpalm and rubber cultivation separately and topography in the whole area is not considered a limitation for oilpalm, this distinction is, therefore, not maintained for this area.

(2) Requirements for the Malang family at Luak Oilpalm Station in Fourth Division: higher requirements are relative to these basic dressings.

(3) Disposal of surface water mainly.

(4) Floodings of short duration, not necessarily every year.

(5) Floodings of long duration, yearly occurring.

(6) Involving lowering of ground water table.

The fertility of soils is again a debatable point. No soil in the area is capable to sustain high yields of any crop if no fertilisers are used. A fertility rating is therefore totally of a relative nature and a soil rated as moderately fertile may be considered a poor soil in other countries where much better soils are available. To enable to scale the fertility rating fertiliser requirements for oil palm in Luak Station in the Fourth Division have been taken as normal for Sarawak conditions. Since very little knowledge is at present available on the performance of oil palm on other soils occurring in the area experience gained with rubber has been used as an indication to the fertility levels of these soils so that they can be placed in the fertility scale with some measure of accuracy.

Finally, since topography is not considered a limitation for the crops envisaged it has not been used as a classifying factor in the potentiality classification.

It must be noted that since the range of conditions under which rubber can be grown is considerably wider than those required for oil palm, a greater number of soil units are recommended for rubber than for oil palm. Factors playing a role in this are mainly drainage condition and fertility level.

Table 1 gives in a condensed form the considerations which form the basis of the potentiality classification.

Table 2 gives the acreage for each potentiality class as shown on Map 2. Acreages for each individual soil unit were not calculated since many soil units occur as complexes and associations the individual members of which cover areas of unknown acreage and the total figure given for these individual soil units would be very inaccurate.

Table 2 therefore is for practical purposes considered to be sufficient since in planning development one would be more interested in the potential of the soil than in the soil type.

Table 2

Acreages of Land Potential Classes

Class I	-	High potential	7,630 acres
Class II	-	Moderate potential	3,325 acres
Class II/III	-	Mixed Moderate and Low Potential	1,883 acres
Class III	-	Low potential	3,215 acres
Class IV	-	Very low potential	1,630 acres

APPENDIX II

(Information extracted from a note on oil palm fertiliser experiments in First Division by Soils Agronomist)

Stungkor

Oil Palm Fertiliser Experiment

Preheated germinated seed obtained from H & C. Malaya in February 1966. Sown in poly bags - nursery. Transported to the field and planted out in February 1967. (NB. same material of same age and size was used in all the expts. - Stungkor, Samarahan, Stapok, Temudok, Nonok and Semongok - all planted out in February 1966 - except Nonok - where delayed planting till March when floods subsided).

Palm material — Elaeis guineensis var. Tenera
(Var. Tenera = var Dura crossed var. Pisifera)

Experimental Layout: - Randomised blocks

Blocks = 4 inno. (replications)
Levels of Fertiliser = 3 inno. (treatments)
Plot size = 9 palms (3 x 3)
Spacing = 30' x 30' square
(commercial planting would be triangular 32' x 32' or 30' x 30' or 29' x 29')

Guard rows - only on perimeter of blocks

Guard drains - yet to be dug between plots (in 2nd year - i.e. 1968).

NB. Above applies to Stungkor, Samarahan and Stapok

Temudok and Nonok = 2 blocks each only with levels of ferts. 3 + 2 only (not level 1)

Semongok = 4 blocks with levels of ferts. 3 + 2 only (not level 1).

Cover Crops — Sown in rows 6' apart as a mixture of

Pueraria javanica
Centrosema pubescens — at 7 lbs/acre
Calopogonium mucunoides

with Fertilisers applied in 1st year (1967)

			Compound Fert.
as per	Treatment 3 =	C.I.R.P. 6lbs &	15/15/6/4 - 8 ozs.
30' x 30'	Treatment 2 =	" $4\frac{1}{2}$lbs &	15/15/6/4 - 6 ozs.
	Treatment 1 =	" 3lbs &	15/15/6/4 - 4 ozs.

<u>Fertilisers for Palm circles applied in 1967</u>

	Compound Fert. 15/15/6/4	Compound Fert. 12/12/17/ 2 + TE.	Kieserite (26% MgO)	Total Ferts.
Treatment 3	18 ozs.	30 ozs.	$4\frac{1}{2}$ ozs.	3 lbs $4\frac{1}{2}$ oz
Treatment 2	" 12 ozs	" $21\frac{1}{3}$ ozs.	$3\frac{1}{2}$ ozs.	2 lbs 5 "
Treatment 1	" 6 ozs	" $12\frac{2}{3}$ ozs.	$2\frac{1}{2}$ ozs.	1 lb 4 "

and all palms 8 ozs. C.I.R.P. in planting hole. Fertiliser applications split/4 in 1st year (at 3 month intervals and in increasing amounts).

The following table compares the growth of oil palm on the Merit family at 15th mile Lundu road (Stungkor) with those in other experiments in First Division, all records on the first year of growth.

<u>Records</u> - December 1967: (before last fert. application).

Palm height - i.e. height of the most recent fully opened frond tip (held up) above ground in inches.

Expt.	Soil family	-	Treatment figs - height in inches	
		1st level	2nd level	3rd level
Semongok	Merit	-	86	86
Temudok	Merit (shallow)	-	81	82
Nonok (estimated fig.)	Pendam	-	(92)	(95)
Stungkor	Merit	82	82	84
Samarahan	Bekenu?	76	82	84
Stapok	And. III	90	87	85

A comparison with the oil palm grown at Luak Oil Palm Experimental Station in the Fourth Division (Malang family) which was planted two months in advance of the trials in First Division shows that the performance of the Merit family in Stungkor is certainly not inferior than the soil used at Luak. Treatments refer to fertiliser treatment (3 levels). The treatment used in Luak is comparable to the first level of fertilisers given at Stungkor.

September 1967		Palm height in inches			Frond length in inches		
Luak.	Dura x Tenera	63			51		
	Dura x Pisifera	65			54		
Treatments		1	2	3	1	2	3
Semongok.	(Dura x Pisifera)	-	76	76	-	60	59
Temudok	"	-	65	64	-	50	51
Nonok	"		77	78		62	63
Stungkor	"	70	69	72	55	54	56
Samarahan	"	70	72	73	54	56	57
Stapok	"	76	74	73	59	57	56

From first year growth records, the performance of oil palm on these soils in the future is difficult to judge, but for the Merit family in the Stungkor area, the results can be called encouraging.

Series assignment
of profiles poss?

APPENDIX III

Profile 1

MERIT family - well-drained phase

Location:	Rentis 20B.
Topography:	Low hilly terrain, very gentle slope.
Vegetation:	Secondary growth.
Parent material:	Probably shale.
0 - 3 inches	Yellowish brown (10YR 5/4) clay loam, strong fine angular blocky, firm, dry, many roots, diffuse boundary to
3 - 16 inches	Yellowish brown (10YR 5/8) clay, fine crumb structure, friable, slightly moist, slightly plastic, well rooted, diffuse boundary to
16 - 45 inches	Brownish yellow (10YR 6/6) clay with faint common reddish yellow and yellow small mottles, increasing with depth, plastic, compact, moist, tendency to blocky structure when dried out. (Cracks in profile indicate macro prismatic structure). Distinct over
45 - 50 inches	Light yellowish brown (2.5Y 6/4) clay with common strong reddish yellow mottling and few grey mottles, slightly moist slightly plastic, tendency to friability. Some platy iron concretions and thick pieces at 45/46 inches depth.

Analyses

Lab.No.	Fld.No.	Depth	pH H_2O	P Total	Ca 'Res'	Mg 'Res'	K 'Res'	%o.d. Fe_2O_3 (6N HCL)	% o.d. Gr.III
S.5208	J.21	0-3"	4.5	198	645	1346	2337	3.47	13.07
S.5209	J.22	3-16"	4.6	140	663	1446	2683	4.00	11.65
S.5210	J.23	16-45"	4.8	121	265	1563	2568	5.93	16.83
S.5211	J.24	45-50"	5.1	150	224	2683	4982	7.62	16.58

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Profile 2.

MERIT family - imperfectly drained phase

Location:	Rentis 23A - pole 6.
Topography:	On top of small hill about 15 feet above local valley bottom almost flat.
Vegetation:	Jeramei with lalang undergrowth
Parent material:	Probably mudstone.
Remark:	Very little litter on top.

0 - 4 inches	Light yellow brown (10YR 6/4) silty clay loam, fine angular blocky, firm, dry, only small roots, much worm activity, porous, gradual boundary to
4 - 12 inches	Reddish-yellow (7.5YR 6/8) silty clay loam, weak friable, firm, weak crumb structure upon pressure of clods, many small roots, slightly moist. Wormcasts with material from top horizon in worm channels, gradual but distinct over
12 - 23 inches	Brownish-yellow (10YR 6/6) silty clay with faint pale yellow and reddish yellow mottles, firm, tendency to blocky structure, few roots, slightly moist, distinct change to
23 - 37 inches	Reddish-yellow clay with strong red (2.5YR 4/8) mottles and small grey and yellow mottles (corned beef effect) moist, plastic, large cracks develop upon drying out. Along old cracks much illuvial clay from horizon above. Very compact, few roots. In some parts of this horizon few pebbles. Maximum reddish colouration occurs at 30-33 inches. Below less strong red, gradual change to
38 - 60+ inches	White (10YR 8/1) clay with strong large yellow and few small red mottles. Oxidation along old root channels. Very compact, moist. Few quartz pebbles at 60 inches.

Rapak Series

Analyses

Lab.No.	Fld.No.	Depth	pH H_2O	P Tot.	Ca 'Res'	Mg 'Res'	K 'Res'	%o.d. Fe_2O_3 (6N HCL)	% o.d. Gr.III
S.5194	J.7	0-4"	4.1	117	382	980	1575	2.30	5.78
S.5195	J.8	4-12"	4.2	84	106	1107	1864	2.40	6.76
S.5196	J.9	12-22"	4.3	72	42	1438	2074	3.15	9.33
S.5197	J.10	28-35"	4.1	106	119	2539	4634	6.66	15.67
S.5198	J.11	49-54"	4.2	134	326	3166	5375	5.25	16.17

Profile 3.

BEKENU family - well-drained phase

Augering description

Location:	Rentis 19A (L. and S.) pole 10.
Topography:	On medium high hill.
0 - 9 inches	grey brown loam, dry, friable.
9 - 27 inches	brownish yellow fine sandy clay loam, no mottles, slightly friable, moist.
27 - 38 inches	yellow fine sandy clay loam to clay, no mottles, moist, friable.

No samples taken

Profile 4.

BEKENU family - imperfectly drained phase

Location:	Near Sungei Stinggang.
Topography:	Low, undulating terrain. On gentle rise.
Vegetation:	Secondary jungle.
Parent material:	Fine grained sandstone.

0 - 4 inches	Dark yellow brown (10YR 4/4) fine sandy loam, crumbly, friable, many fine and medium roots. Moist. Smooth change to
4 - 20 inches	Yellow (10YR 8/8) fine sandy clay loam, few fine white to light grey and brown mottles, friable, angular blocky, clay-skins present. Slightly sticky, moist, few fine roots; wavy boundary to
20 - 32 inches	Yellow (10YR 8/8) fine sandy clay loam to fine sandy clay, few reddish brown, brown and light grey mottles, subangular blocky, sticky and plastic, few fine and medium roots, gradual change to
32 - 59+ inches	Yellow (10YR 8/8) fine sandy clay, mottling as above with increase in intensity and volume with depth. Subangular blocky (weak), moist, slightly sticky plastic.

No analyses carried out

Profile 5.

NYALAU family

Location:	Rentis 23A - pole 8.
Topography:	At side of moderately steep hill (scarp slope).
Vegetation:	Secondary growth with fern undergrowth.
Parent material:	Medium grained sandstone.
0 - ½ inches	Litter layer of twigs and fern leaves, abrupt over
½ - 3(6) inches	Yellowish brown (10YR 5/4) loamy fine sand, weak crumby, friable, few roots, dry (after pressure structureless and loose). Soil tends to turn white after exposure to sun for some time. Diffuse boundary (3 - 6 inches) to
3(6) - 15 inches	Yellow (10YR 7/8) sandy loam, weak friable, loose, structureless on pressure, few roots, slightly moist, gradual change to
15 - 30 inches	Brownish yellow (10YR 6/8) sandy clay loam, firm, weak fine blocky. Illuvial clay present. Faint reddish and grey mottling (from P.M.), moderately well rooted, quite distinct wavy boundary to
30 - 65 inches	Weathered sandstone. Thoroughly weathered sandstone with preserved structure. Sandstone is light grey with yellow and red coloured circular bands. Several beds can be distinguished. 30-46 inches medium grained sandstone. 46-50 inches sandstone mixed with pebbles and clay lenses. 50-62 inches medium sandstone. Large roots of trees penetrate to 60 inches+.

Analyses

Lab.No.	Fld.No.	Depth	pH H_2O	P Tot.	Ca 'Res'	Mg 'Res'	K 'Res'	% o.d. Fe_2O_3 (6N HCL)	% o.d. Gr.III
S.5199	J.12	½-3"	4.1	77	106	444	524	2.77	3.94
S.5200	J.13	3-15"	4.2	52	376	100	620	1.78	4.61
S.5201	J.14	15-30"	4.6	98	213	931	1157	4.03	10.48
S.5202	J.15	30-46"	4.6	60	106	1052	2458	3.33	9.52

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Profile 6.

SARATOK family

<u>Location</u>: Rentis 20B - pole 13.

<u>Topography</u>: Moderately high ridge, slope approximately 15 degrees.

<u>Vegetation</u>: Approximately 10 years old secondary jungle.

<u>Parent material</u>: Sandstone and conglomerate.

Twigs and leaves on surface.

0 - 6 inches Dark greyish brown (10YR 4/2) loamy fine sand, weak angular blocky, with slight pressure structureless, friable, well rooted. Clear, with slight wavy boundary over

6 - 22 inches Pale yellow (2.5Y 7/4) loamy fine sand, friable, weak crumby to structureless. At boundary with A1 many wormcasts, few faint large grey mottles, few roots, porous, many large holes (partly caved in soil fauna activity), gradual change to

22 - 40 inches Pale yellow (2.5Y 8/4) sandy loam with common large (2.5Y 7/2) light grey mottles and few yellow brown mottles, structureless, firm. Mottles increase with depth, very few roots. Gradual change to

40 - 58 inches Light grey (2.5Y 7/2) sandy clay with common small yellow brown mottles, compact, plastic, moist, no roots abrupt overlying

58 - 64+ inches Light grey (2.5Y 7/2) gravelly clay with many large yellow brown mottles. Rounded pebbles, mainly quartz (white, red and black), moist, no roots, very compact.

<u>Analyses</u>

Lab.No.	Fld No.	Depth	pH H_2O	P Tot.	Ca 'Res'	Mg 'Res'	K 'Res'	% o.d. Fe_2O_3 (6N HCL)	% o.d. Gr.III
.5203	J.16	0-4"	4.6	76	251	201	363	0.50	2.93
.5204	J.17	13-20"	4.9	34	206	247	459	0.73	4.22
.5205	J.18	27-33"	5.1	27	103	285	766	0.66	6.41
.5206	J.19	46-51"	4.8	40	104	712	1340	0.81	11.16
.5207	J.20	58-64"	4.9	52	261	633	1758	2.13	9.43

Soil Survey Drawing No. 182

Survey Area No. 109

Base map derived from Land & Survey Department, Sarawak

Compiled by J. P. Andriesse

Drawn by Sebli Mohamad Ap