SOUTH EAST JOHORE PROJECT

WORKING PAPERS.

SOILS AND
SOIL CLASSIFICATION
IN W. MALAYSIA

SOILS AND SOIL CLASSIFICATION IN W.MALAYSIA

CONTENTS

LABORATORY DATA AND CLASSIFICATION OF MALAYAN SOILS

By

NG SIEW KEE

Soil Science Division,
Department of Agriculture,
States of Malaya.

A scientific soil classification system would display a logical arrangement and interrelationship of the soils therein and their differentiation should be based on definable and measurable soil properties. The genetic system of soil classification begins from the top and pre-ordains that certain soils must exist under a certain set of environmental conditions. While the general concept is sound enough, its rather inflexibility has led to much confusion and controversy which was also partly due to the lack of comprehensive soil data. The 7th approximation (1960) can be said to be a notable landmark in the evolution of soil classification because it places greater emphasis on the soil morphological characteristics and quantitative data than on the factors of soil formation.

Unfortunately for us, the 7th approximation and its amendment deal more with soils of the temperate regions than those in the tropics. This largely reflects the meagre amount of analytical data with pedological significance available to aid the classification of tropical soils and can be partially accounted for by the fact that most soil laboratories in the tropics are geared to studies on soil fertility and plant nutrient requirements. However, in Malaya, it has been increasingly felt that a great opportunity will be lost if current soil surveys are not complemented by soil analysis so that quantitative criteria can aid classification of the soils mapped.

The data presented in this paper, although not as detailed as desired, are used to evaluate the classification of Malayan soils by Leamy (1966). This separate treatment is done deliberately in order to ascertain the degree of correlation between field and laboratory data.

Choice of Analytical Data

Prior consideration of available data has indicated that the following criteria are most useful in differentiating Malayan soils at this stage. These are:-

(a) Clay content in relation to movement
(b) 'Total' iron content
(c) 'Total' element contents
(d) Cation exchange capacity and base saturation
(e) Clay mineralogy.

Clay Content

Field assessment of texture by experienced soil surveyors is usually reasonably accurate but laboratory determination is necessary to confirm this as well as features such as presence of Bt horizons. Clay distribution in profiles of Malayan soils belonging to various great soil groups in the Oxisol and Ultisol Orders (Leamy) is depicted in Figure 1. Bt horizons are distinctly to moderately developed in the red yellow podsolics (RYP) and yellow grey podzolics (YGP) but are not detectable in the dark red ferralsols (DRF) and red yellow ferralsols (RYF). In the reddish brown lateritic group (RBL), there is no evidence of a Bt horizon in Munchong but in Jerangau and Kg. Kolam, clay illuvial horizons are weakly to moderately developed suggesting their proximity to RYP. In the pale yellow ferralsols (PYF), a Bt horizon is distinct in Harimau, indicating that it would be better classed with the RYP.

'Total' Iron Content

Colour has a dominant place in classification as evidenced by the nomenclature of the Great Soil Groups in the Oxisols and Ultisols, and since it is usually related to iron content (not per se because the form of iron compound is also significant), the iron content is considered next to clay. Morever, evidence of iron movement besides that of clay is one of the conditions for the RYP.

'Total' iron was estimated by extraction with 6 N HCl after ignition. Free iron oxide determination would have been preferable but circumstances did not permit this. However, in view of the fact that most of the non-alluvial soils of Malaya are highly weathered and the iron is rather well dispersed over the soil particles, the 'total' iron content would probably comprise a preponderant portion of free iron oxides.

'Total' iron oxide (Fe_2O_3) contents in Oxisols and Ultisols are shown in Figure 2. Values of ferruginous tropical soils (FTS) are not given but in view of the dominance of laterite or iron concretions in these soils, they can be safely assumed to have the highest contents of total iron oxides. The descending order of total iron contents in Malayan soils is as follows:-

FTS > DRF > RYF > RBL > RYP > YGP > PYF/LHG.

The alluvial soils contain 2.5 - 5.0% Fe_2O_3 and would fall with the RYP in this iron sequence.

It can be seen that total iron oxide content is a good general differentia of Malayan soils. The iron enrichment in the Bt horizons of Rengam and Serdang is clearly shown and the data also confirm the earlier opinion that Harimau should be in the RYP. In addition, iron enrichment in the B horizon of Jerangau (RBL) is also prominent, again indicating its close relationship with the RYP. The iron distribution in the Kg. Kolam and Jempol suggests that their grouping in the RBL needs review and further confirmatory data.

Clay Content

Field assessment of texture by experienced soil surveyors is usually reasonably accurate but laboratory determination is necessary to confirm this as well as features such as presence of Bt horizons. Clay distribution in profiles of Malayan soils belonging to various great soil groups in the Oxisol and Ultisol Orders (Leamy) is depicted in Figure 1. Bt horizons are distinctly to moderately developed in the red yellow podsolics (RYP) and yellow grey podzolics (YGP) but are not detectable in the dark red ferralsols (DRF) and red yellow ferralsols (RYF). In the reddish brown lateritic group (RBL), there is no evidence of a Bt horizon in Munchong but in Jerangau and Kg. Kolam, clay illuvial horizons are weakly to moderately developed suggesting their proximity to RYP. In the pale yellow ferralsols (PYF), a Bt horizon is distinct in Harimau, indicating that it would be better classed with the RYP.

'Total' Iron Content

Colour has a dominant place in classification as evidenced by the nomenclature of the Great Soil Groups in the Oxisols and Ultisols, and since it is usually related to iron content (not per se because the form of iron compound is also significant), the iron content is considered next to clay. Morever, evidence of iron movement besides that of clay is one of the conditions for the RYP.

'Total' iron was estimated by extraction with 6 N HCl after ignition. Free iron oxide determination would have been preferable but circumstances did not permit this. However, in view of the fact that most of the non-alluvial soils of Malaya are highly weathered and the iron is rather well dispersed over the soil particles, the 'total' iron content would probably comprise a preponderant portion of free iron oxides.

'Total' iron oxide (Fe_2O_3) contents in Oxisols and Ultisols are shown in Figure 2. Values of ferruginous tropical soils (FTS) are not given but in view of the dominance of laterite or iron concretions in these soils, they can be safely assumed to have the highest contents of total iron oxides. The descending order of total iron contents in Malayan soils is as follows:-

FTS > DRF > RYF > RBL > RYP > YGP > PYF/LHG.

The alluvial soils contain 2.5 - 5.0% Fe_2O_3 and would fall with the RYP in this iron sequence.

It can be seen that total iron oxide content is a good general differentia of Malayan soils. The iron enrichment in the Bt horizons of Rengam and Serdang is clearly shown and the data also confirm the earlier opinion that Harimau should be in the RYP. In addition, iron enrichment in the B horizon of Jerangau (RBL) is also prominent, again indicating its close relationship with the RYP. The iron distribution in the Kg. Kolam and Jempol suggests that their grouping in the RBL needs review and further confirmatory data.

FIG. 1. CLAY PROFILES OF MAJOR MALAYAN OXISOLS AND ULTISOLS

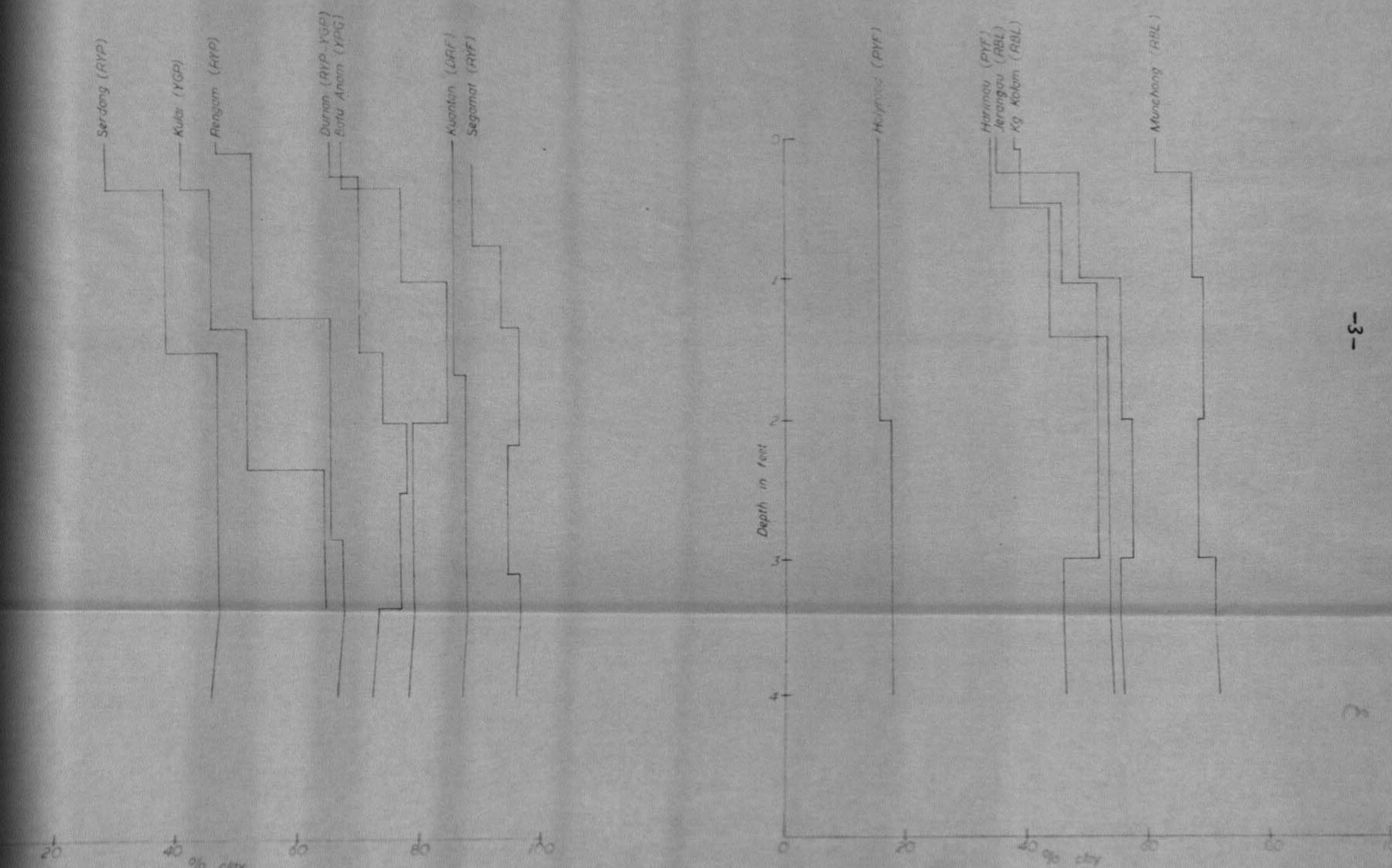
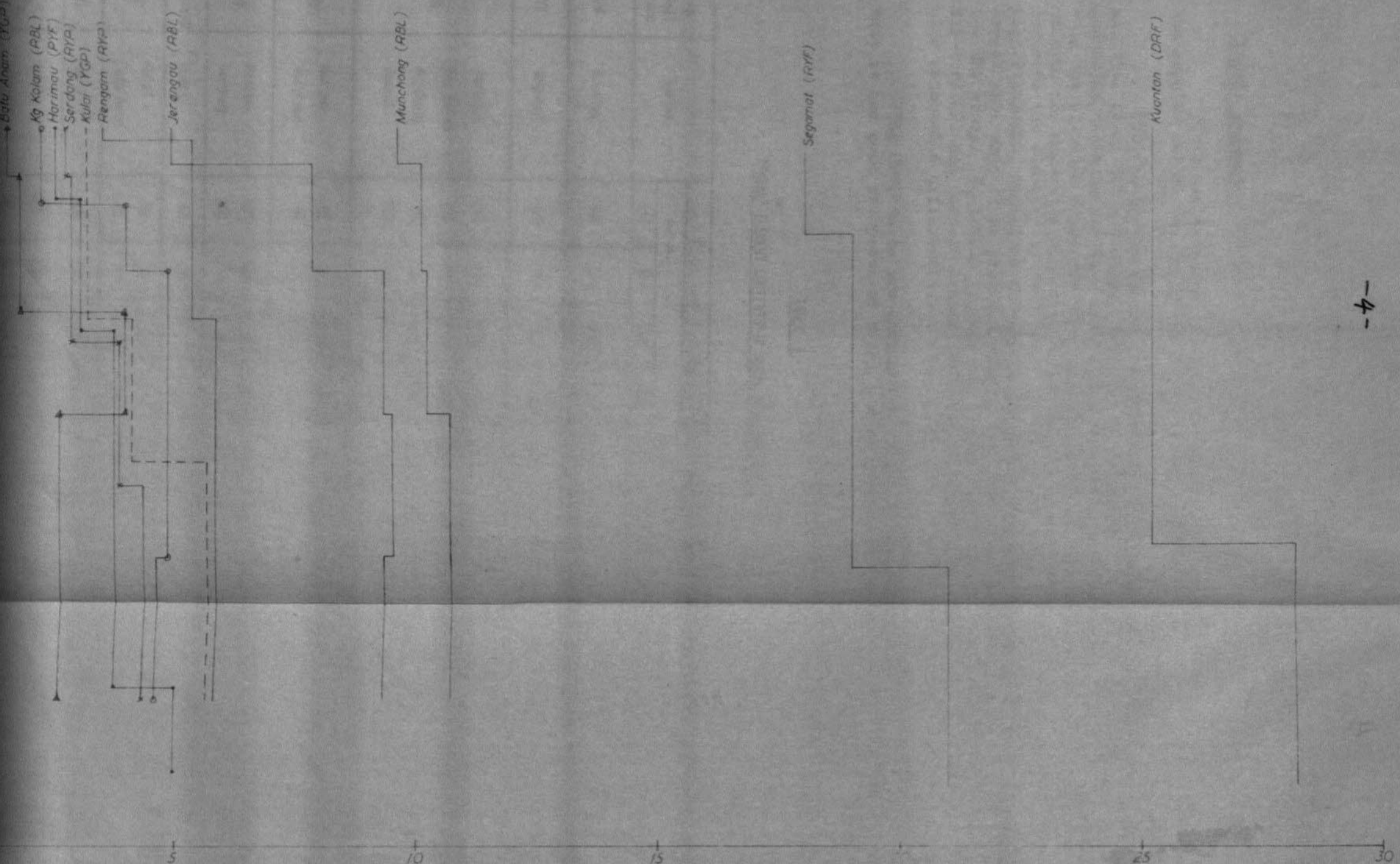


FIG: 2 TOTAL Fe_2O_3 CONTENT IN OXISOLS AND ULTISOLS.



'Total' Elements

These are extracted in the same manner as for iron and the results for P, Ca, Mg, K and Cr are given in Table 1.

The phosphorus values can differentiate the DRF, RYF and alluvial soils but not easily the other soil groups. Calcium and magnesium contents are less effective as criteria for differentiation only the alluvial soils are clearly distingusihed. The rather low calcium and magnesium contents in the Kuantan are striking and indicate the senility of this soil. On the other hand the relatively higher calcium, magnesium as well as potassium contents in the Jempol show that it is probably younger than the other soils in the RBL group. Potassium figures are a more useful guide - Allu./ RYP-YGP/YGP > RBL (except Jempol) > RYF/LHG > DRF/PYF/RYP. There is also reasonable differentiation within the Allu. and YGP groups.

The Cr results are included in order to demonstrate that it has good prospects of being a very useful differentia.

TABLE 1

'TOTAL' ELEMENT CONTENTS IN MODAL SOIL PROFILES

G. Soil Group	Series	P		Ca		Mg		K		Cr //
		p.p.m.		m. e. / 100 g.						
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	p.p.m.
DRF	Kuantan	535	534	3.08	2.74	2.38	2.07	.64	.48	420-930
RYF	Segamat	480	290	3.36	2.61	5.36	4.88	1.97	1.34	-
RBL	Jerangau	211	229	2.72	2.56	3.80	3.80	3.13	3.01	10-37
	Kg. Kolam	155	88	3.52	3.45	5.16	4.94	1.28	0.58	-
	Munchong	92	83	0.71	0.43	2.75	2.98	4.86	4.32	40-210
	Jempol	115	106	6.64	4.45	7.68	9.36	3.25	15.5	-
PYF	Harimau	52	71	1.36	1.97	4.56	3.83	0.64	0.32	-
	Holyrood	98	75	1.36	1.36	4.20	1.92	0.32	0.32	1-10
RYP	Rengam	190	127	1.68	1.47	4.12	3.26	0.96	0.64	3-11
	Serdang	60	52	1.36	4.05	4.78	3.91	0.32	0.43	5-40
RYP-YGP	Durian	46	36	3.28	3.42	4.96	6.02	13.4	18.8	-
YGP	Kulai	86	87	2.88	1.87	7.16	3.15	4.74	6.09	-
	Batu Anam	80	41	0.68	1.23	2.84	2.15	12.5	13.8	-
LHG	Manik	83	137	1.00	0.41	2.75	4.44	1.82	1.66	13-27
Allu.	Briah	225	130	5.88	5.04	12.4	18.5	7.09	7.68	65-93
	Selangor	580	393	7.68	7.51	4.16	16.6	12.5	15.6	90-120

Cation Exchange Capacity and Base Saturation

Figure 3 (a) indicates generally that C.E.C. values have limited scope as a differentia. The Allu. soil group is well demarcated and the lowest values tend to be found in the PYF and RYP. The remaining soil groups fall into a sub-intermediate category although the top soils of Kuantan, Segamat and Jempol tend to have higher values.

Base saturation values follow the general pattern given by C.E.C. values but are slightly less distinctive. Only the alluvial soils are well differentiated. The remainder have values between 4-11 in the sub-soil horizons and intra-variation rules out any meaningful segregation.

Clay Mineralogy

Very limited data on clay minerals are available but from the foregoing, it can be foreseen that in most of the soils, kaolin would be the dominant mineral in the clay fraction. Some approximate semi-quantitative results are given in Table 2.

Table 2

Clay Minerals in some Malayan Soils

	Kaolin %	Mica %	Montmorillonite %	Vermiculite %
Kuantan	>50	n.d.	n.d.	n.d.
Munchong	>50	n.d.	n.d.	n.d.
Jerangau	>50	n.d.	n.d.	5
Segamat	>50	5	5-10	5-10
Serdang	>50	n.d.	n.d.	11-25
Holyrood	>50	5	n.d.	5
Durian	26-50	26-50	n.d.	5
Manik	>50	5	n.d.	n.d.
Selangor	11-25	11-25	>50	n.d.

(n.d. = not detected)

The Selangor (Allu.) and Durian (RYP-YGP) are well segregated and explain their higher potassium contents soluble in hydrochloric acid and C.E.C. of the former. Further data is required to ascertain whether the YGP soils have similar clay suites as the Durian. The preponderance of kaolin in the other soils points to their advanced stage of weathering, irrespective of parent material. Goethite and haematite are only barely detectable even in the DRF and indicates that iron oxides are amorphous. Gibbsite too is mostly absent. In view of the highly leached condition of Malayan soils, clay mineral analysis is unlikely to be effective at low levels of classification but it can deliver conclusive evidence at appropriate instances.

FIG: 3 (a) CATION EXCHANGE CAPACITY

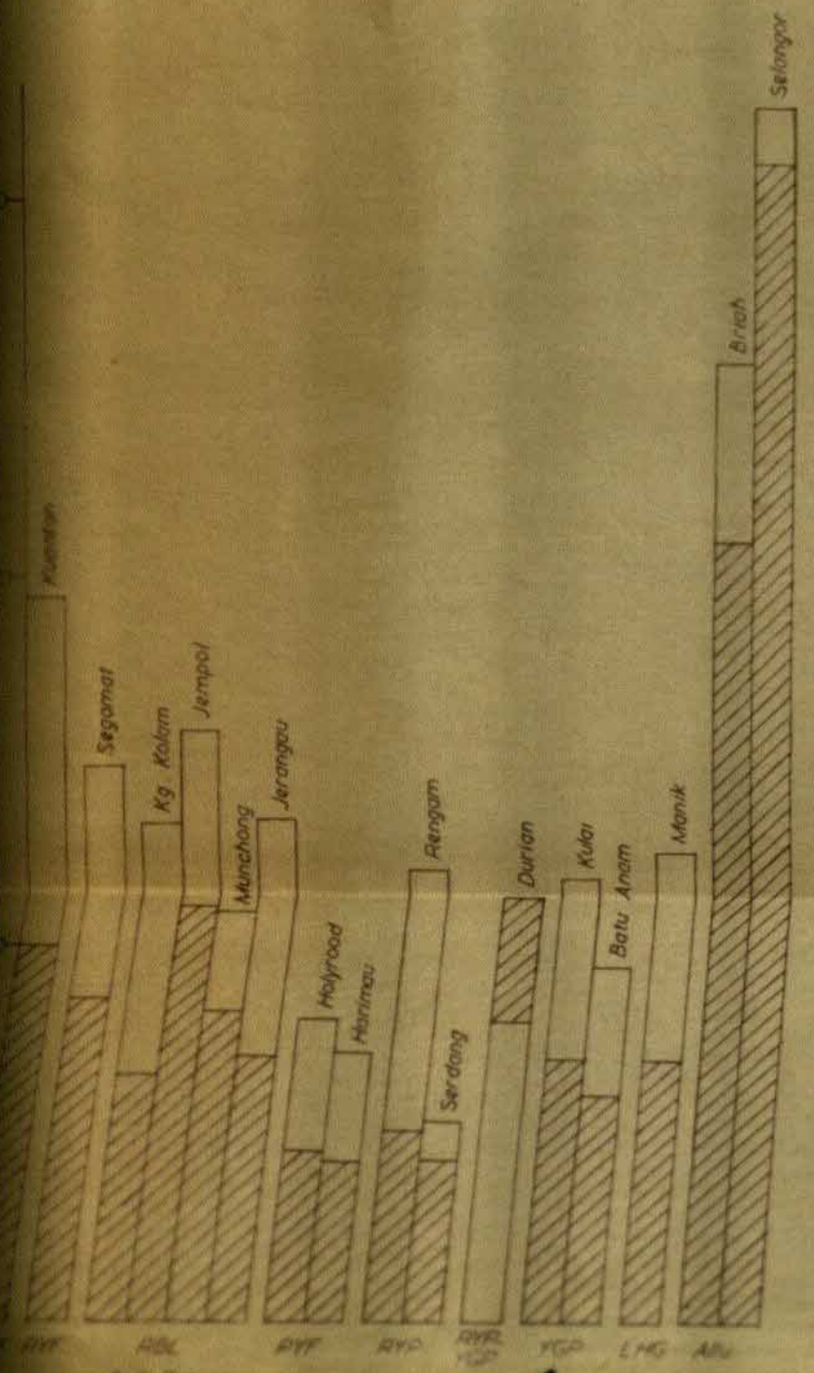
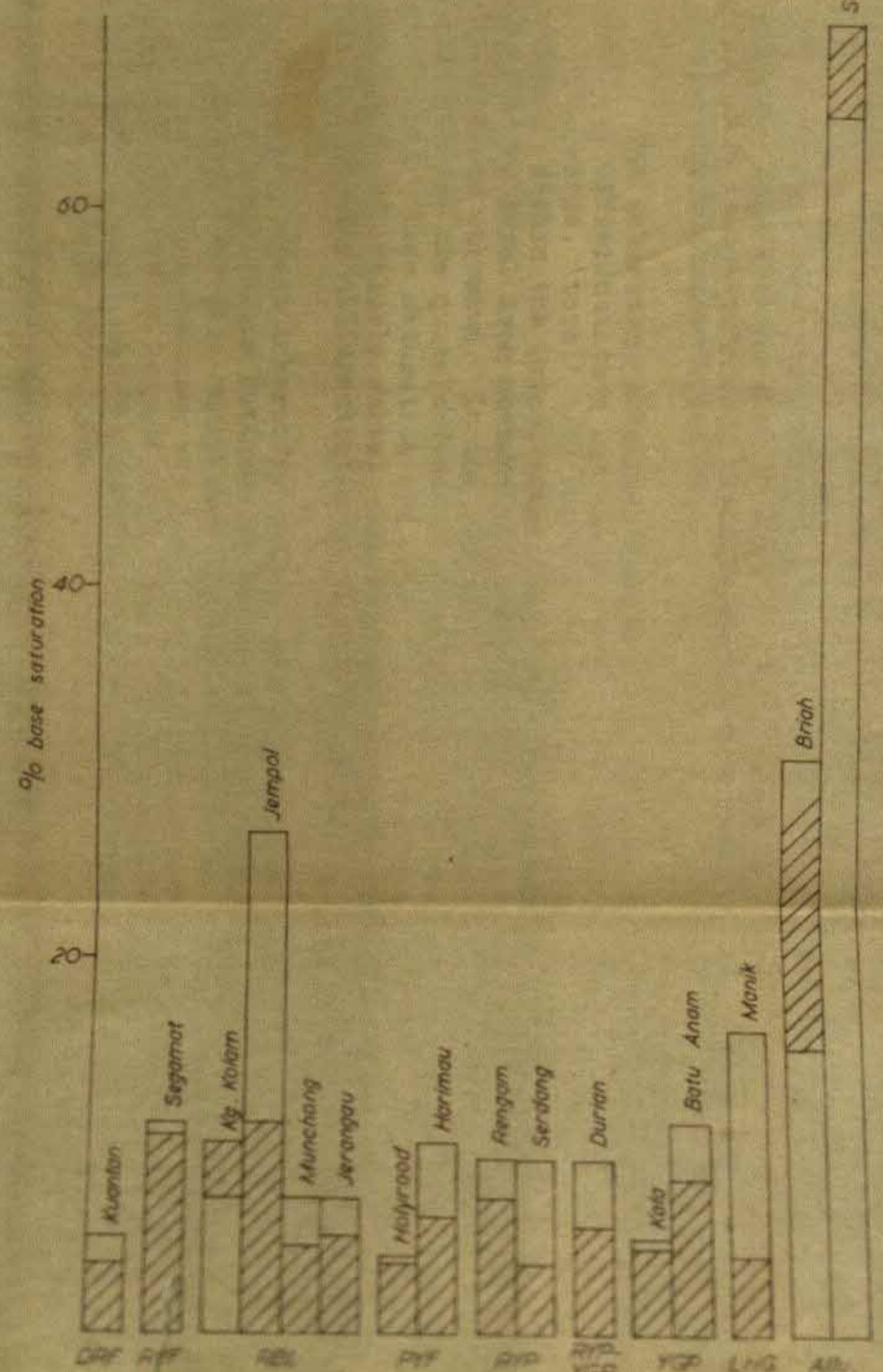


FIG: 3 (b) % BASE SATURATION



Discussion

It is implicit from the foregoing that the majority of Malayan soils do not lend themselves easily to classification by common analytical data pertaining to 'available' nutrients principally because they have reached a very advanced stage of pedogenesis. This means that environmental and morphological criteria would have great weightage in classification. However, it is shown here that the combination of analytical criteria of pedological significance such as some of those examined can increase the objectivity of a prior classification based mainly on morphological characteristics.

The laboratory criteria assessed here vary in their efficacy of differentiation but their effects are cumulative. Of the five differentia, 'total' iron content is the most discriminatory on the whole. Within the Oxisol order, the great soil groups are well segregated by total iron content and partially by contents of phosphorus and chromium. In the Ultisols, 'total' potassium and clay mineralogy are quite effective differentiae. In the Entisol Order, C.E.C., base saturation are operative and so would pH, conductivity and soluble salts. The soil groups in the remaining orders are readily differentiated by laboratory data.

The present laboratory data in general support the scheme of classification outlined in Leamy's paper. The main points arising from this analytical appraisal pertain to the validity of certain families and great soil groups in some great soil groups and orders respectively, the distinction between Oxisols and Ultisols, and the nomenclature for great soil groups used by Dudal and Moorman (1964).

A major conclusion is that the Harimau (PYF), according to its properties should go into the RYP group by definition of the latter. The PYF group should be dropped as the soils do not quite fit in with the others and Holyrood can be tentatively grouped in the grey podzolic group. Rasau can be accommodated in the RYP. In the RBL group, Jempol and Kg. Kolam might form an intergrade group between RBL and RYP.

Hantjens (1965) has proposed a relaxation of the rather stringent criteria for an oxic horizon in the 7th Approximation. While this proposal is generally welcome, Hantjens has completely omitted the condition on the ratio of free sesquioxides to 1:1 minerals to be 1:8 or less in the clay. This condition, in my opinion, is an important criterion and should be preserved although the ratio may be slightly modified if it is found to debar soils with all the other characteristics of Oxisols.

The nomenclature of Dudal and Moorman and adopted by FAO certainly need revision. Terms like 'lateritic' which has common connotation, should be avoided if hardened, iron-rich materials are not present. Similarly, pale yellow ferralsols are self-contradictory because they do not actually possess the amount of iron oxides which the name implies. This rather loose usage of terminology leads to much confusion. Why name it a History Club when it is meant for bridge players? In the light of these, the nomenclature of the 7th Approximation offers an objective way out. Undoubtedly, petraplox conveys deeper meaning than Ferruginous tropical soils.

In conclusion, it can be stated that laboratory data can play a contributory role in the classification of Malayan and other tropical soils. The need for more data including those on physical properties is warranted although existing data have yielded a very satisfactory appraisal.

FIG. 1. CLAY PROFILES OF MAJOR MALAYAN OXISOLS AND ULTISOLS

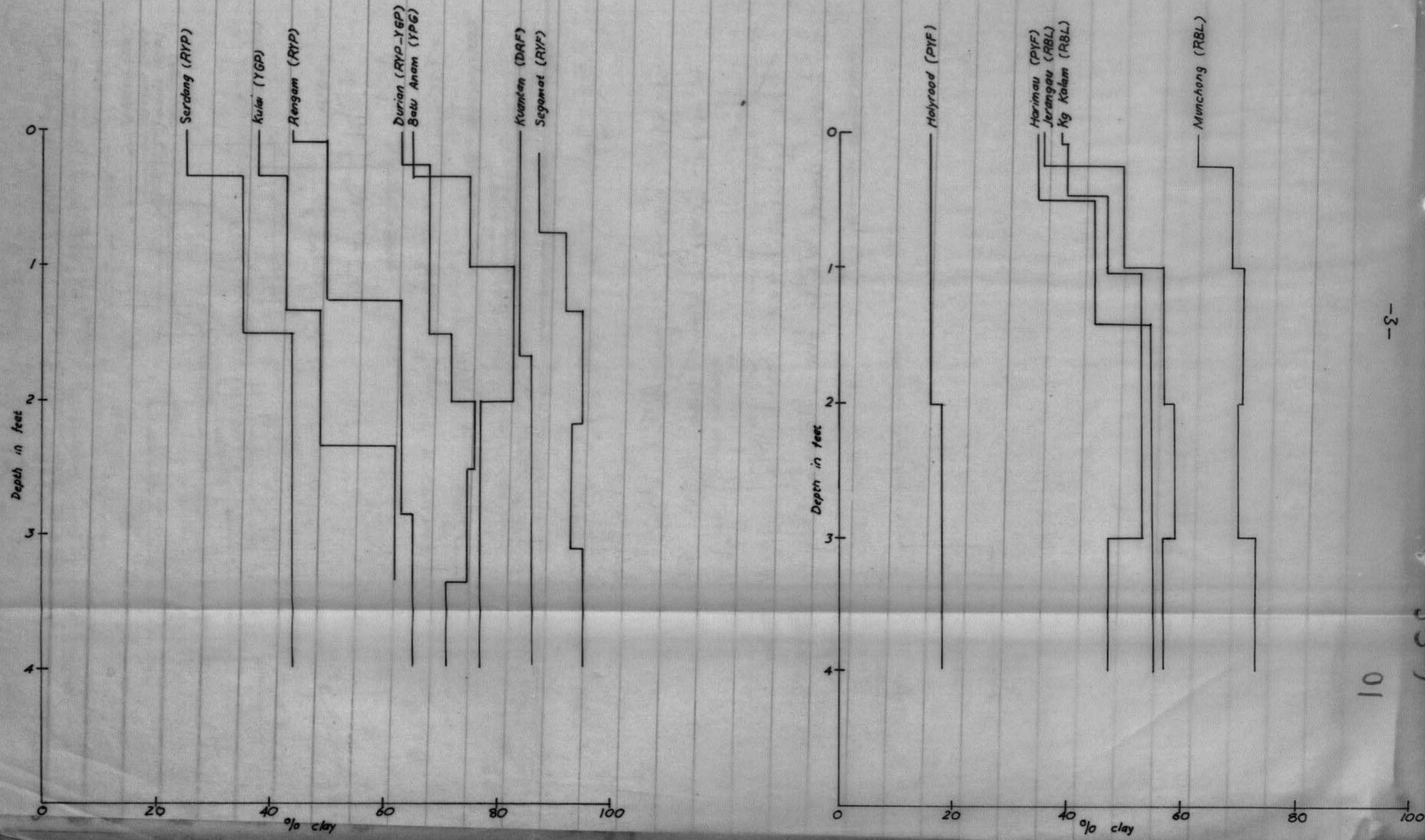


FIG:1 CLAY PROFILES OF MALAYAN SOILS AND ULTISOLS

10

FIG: 2. TOTAL Fe_2O_3 CONTENT IN OXISOLS AND ULTISOLS.

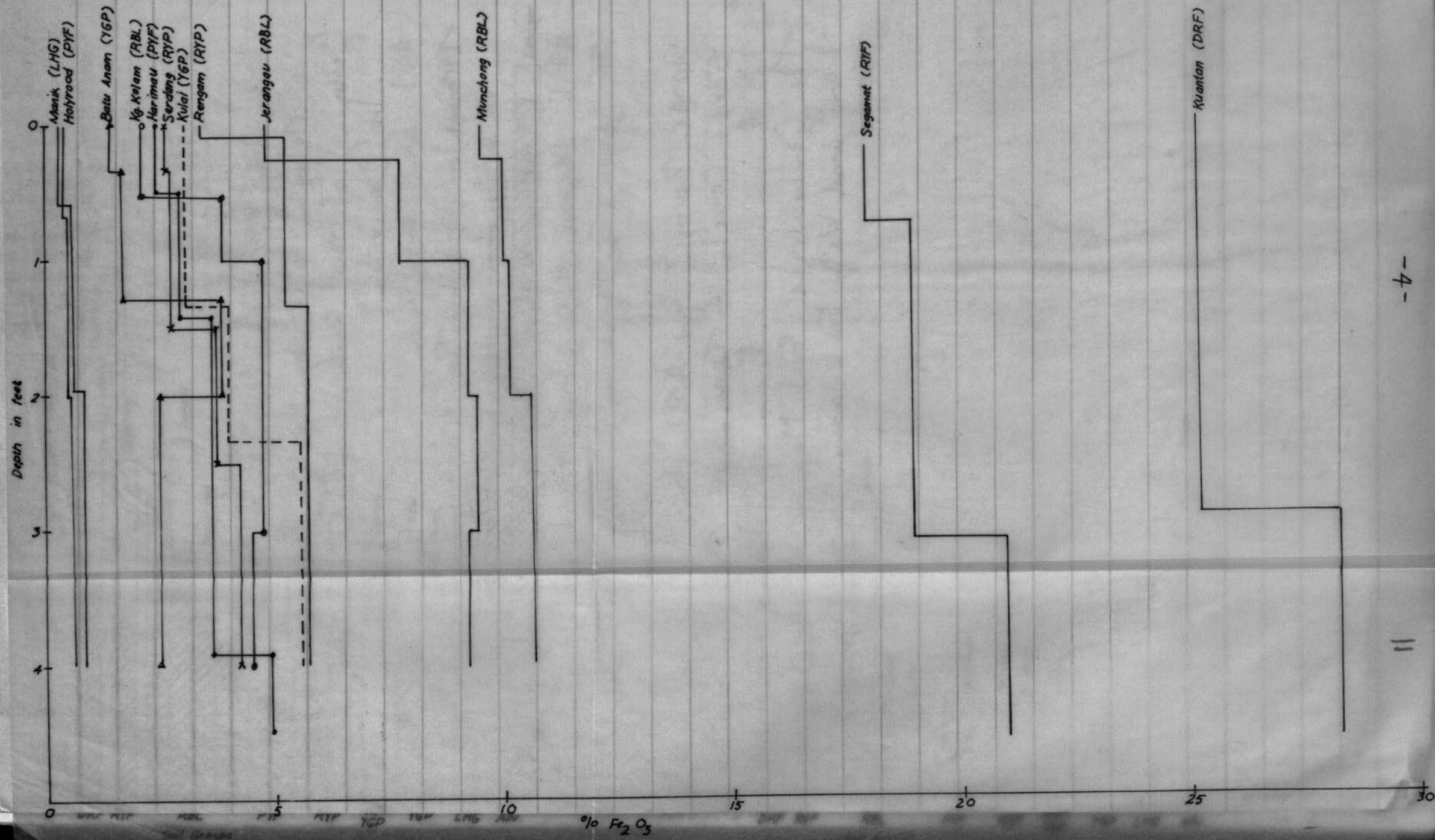


FIG:5. TOTAL Fe_2O_3 CONTENT IN OXISOLS AND ULTISOLS.

FIG. 3 (a) CATION EXCHANGE CAPACITY

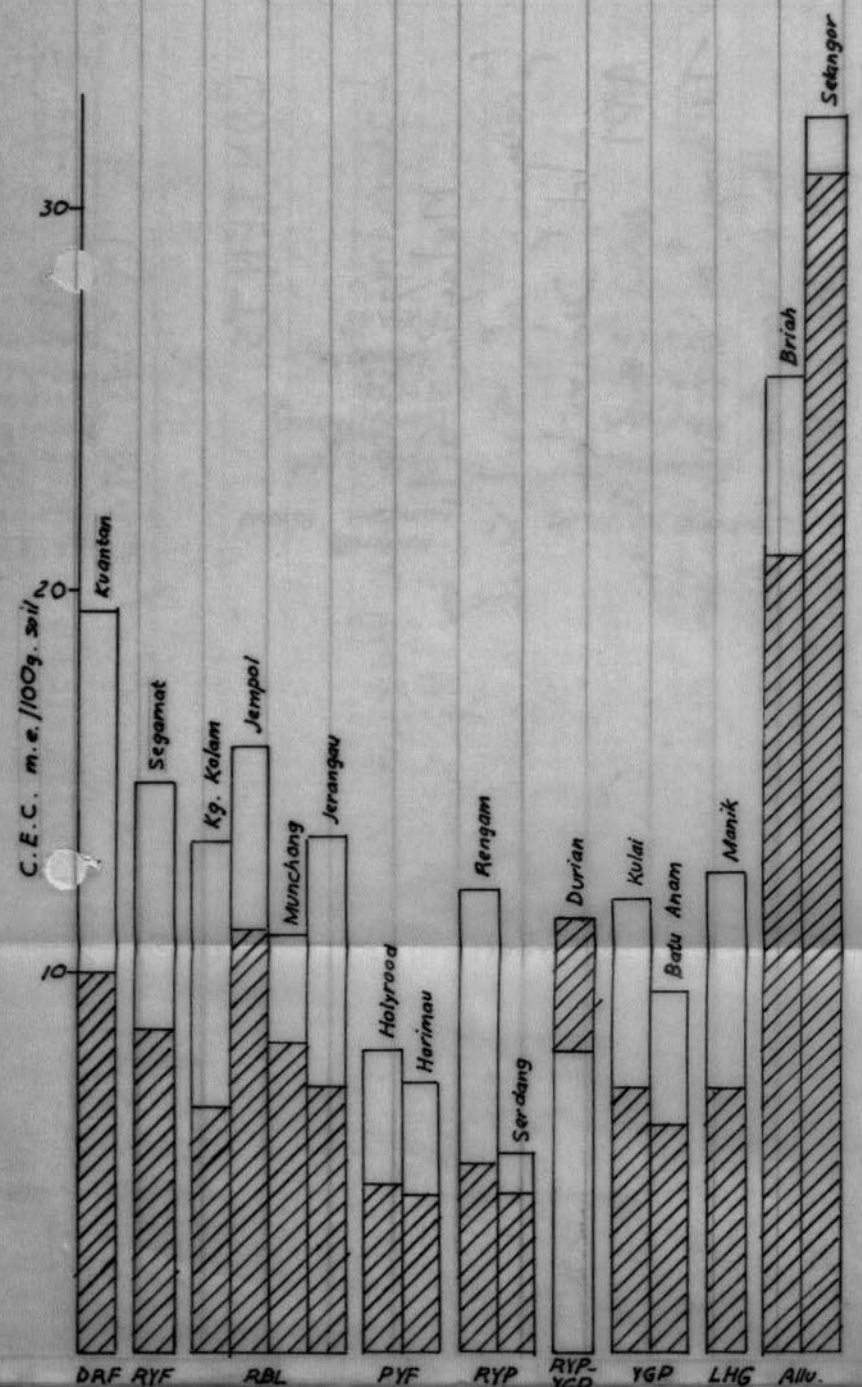


FIG. 3 (b) % BASE SATURATION.

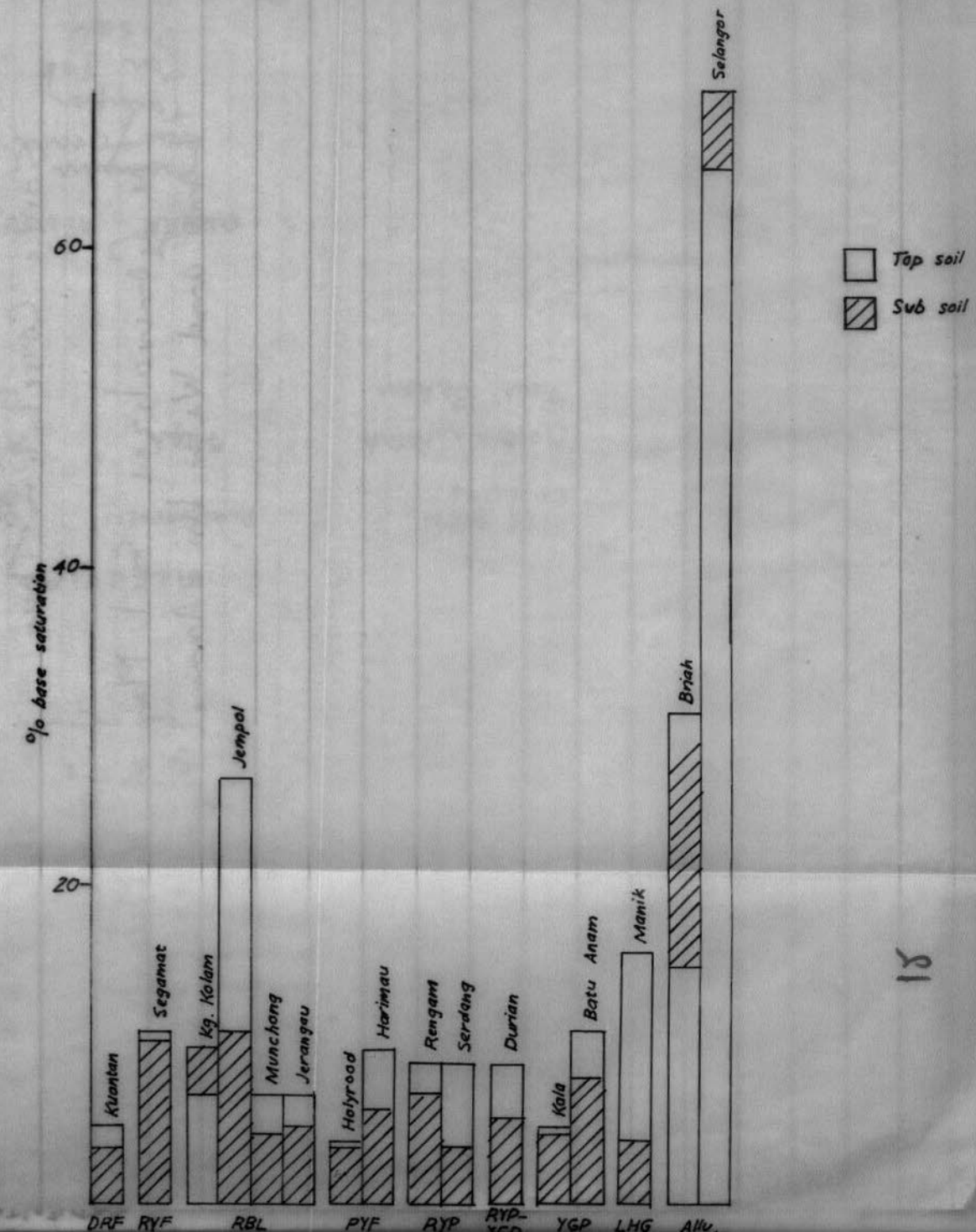


FIG. 5. TOTAL Fe_2O_3 CONTENT IN OXISOLS AND ORDERS

SEDENTARY

Grouping of series according to Derivation

GRANITE	RHYOLITE QUARTZ PORPHYRY	GRANODIORITE	ANDESITE	SCHIST	ARGILLACEOUS SHALES & SANDSTONES	ARENACEOUS SANDSTONES, QUARTZITE
Bukit Temiang	Kulai	Bukit Ajil	Segamat	Batang Mesbau	Malacca	Serdang
Rengam	Yong Peng	Kampong Kolam	Serai		Durian	Marang
Tampin		Jerangan	Katong		Bungor	Kedah
Bukit Lunchar		Masai			Munchong	
					Tavy	
					Jempol	
					Batu Anam	
					Apek	
					Pohoi	
					Bukit Resam	

ALLUVIAL

FLOOD PLAINS & RECENT TERRACES	RIVER BASIN DEPOSITS	PLAIN TRACTS	COLLUVIUM IN VALLEYS	MARINE ALLUVIUM	MARINE COASTAL PLAIN	SUB-RECENT ALLUVIUM
Telemong	Merbau Patah	Briah	Kampong Kubor	Jambu	Selangor	HOLYROOD
Telaga	Tian Bahru			Rudra	Kangkong	SUNAEI BULO
Halu				Kranji	Telok	SITIAWAN
Akob				Rusila	Liman	Mamk
Jarum					Penor	Sogomana

OLDER ALLUVIUM

Harimau
Ulu Tiram
Tampoi
Toi Tak
Rasau
Segari

Some Groupings of Sedentary Soils.

Soils with Laterite within 24"

Masai - granodiorite
Senai - andesite
Malacca - shales & sandstones

Soils with well developed laterite > 24"

Tawy - shales + sandstones
Bukit Resam - " "

Soils with weak laterite development

Durian - shales & sandstones
Munchong - " "
Kampong Kolam.

Soils with mottled or variegated sub-soils

Durian
Bungor
Tempol
Batu Anam
Apek
} Shales & sandstones

Friable, well structured soils

Yong Peng - Dacite
Kampong Kolam - granodiorite
Segamat - andesite
Senai - "
Katong - "
Bungor - argillaceous sediments
Tempol - " "
Pohoi - " "

coarse or medium textured soils

Bukit Temiang
Tampin
Rengam (coarse variant).
Bukit Lunchu
Batang Merkam (on schist).
Tawy (SCL)
Serdang
Marang

clay, FSC or SiC textures

Kampong Kolam
Segamat
Senai
Katong
Durian
Bungor
Tempol
Batu Anam

Pale sub-soils

Tampin
Batu Anam
Apek.
Marang
Kulai

Red sub-soils (5YR or redder).

Rengam (red variant).
Yong Peng
Bukit Ajil
Kampong Kolam.
Segamat
Senai
Tawy
Munchong (red variant)
Tempol
Serdang (red variant).

Brown sub-soils (7.5YR or yellow

Bukit Temiang
Rengam
Bukit Lunchu
Terangan
Masai
Katong
Batang Merkam
Durian
Bungor
Bukit Rasam
Munchong.
Serdang.
Kedah

Steep-land or hilly soils

Bukit Temiang
Bukit Lunchu
Bukit Ajil
Kampong Kolam
Katong
Bukit Resam
Kedah

SERIES GROUPED ACCORDING TO SOIL GREAT GROUPS (tentative).

Red Yellow Podzolic	Pale yellow Podzolic	Laterites	Latosols	Lithosols - shallow	Skeletal Soils A/C profiles
Rengam	Batu Anam.	Masai	(Kampong Kolam)	(Bukit Temiang)	Bukit Lunchu
Tampin	Apek	Malacca	Segamat	Bukit Ajil	Bukit Temiang
~~Bukit Lunchu~~	Marong	(Durian)	(Serai)	Kedah	
Kulai		(Munchong)	Katong		
(Jerangau)		Tawy	Yong Peng		
Batang Merbau		Bukit Resam	Bungor		
(Durian)		(Serai)	(Munchong)		
Serelang			Jempol		
			(Jerangau)		

Groupings of Alluvial Soils

Drainage groups

WELL- EXCESSIVE	MODERATE	IMPERFECTLY	POOR	VERY POOR
TELEMONG	Akob	Jaran	Kranji	Tian Bahru
Telaga	~~Jaran~~	Merbau Patah	Rusila	Telok
Halu		Briah	Selangor	Linau
Jambu		Kampong Kubor	Kangkong	Penor
Rudna			Manik	
Holywood			Sogomana	
Sungei Buloh				
Sitiawan				

TEXTURAL GROUPS

Fine	MEDIUM	coarse
SC - C - CL - SiC	SCL - L - Si	LS
Merbau Patah	Telaga	Telemong
Briah	Halu	Kampong Kubor
Kranji	Akob	Jambu
Selangor	Jaran	Rudna
Kangkong	Tian Bahru	Rusila
Telok	Penor: →	Holywood
Linau		Sungei Buloh

~~Source~~ origin of Alluvium

Riverine (valleys + basins)	Riverine (plains)	Marine (recent)	Marine (coastal plain)	sub-Recent
Telemong	Briah	Jambu	Selangor	Holywood
Telaga		Rudna	Kangkong	Sungei Buloh
Halu		Kranji	Telok	Sitiawan
Akob		Rusila	Linau	Manik
Jaran			Penor	Sogomana
Merbau Patah				
Tian Bahru				
Kampong Kubor (colluvial)				

Older Alluvia

Red sub-soils	Pale sub-soils	Friable top-soils
Tampoi	Segari	Hariman Ulu Tiram

Textures

Fine	medium	coarse
Tai Tak Rasam	Hariman Ulu Tiram Tampoi	Segari

Rengam / Hariman Bores Pasak

F = Quartz grains few or fine
* = Abrupt increase qtz abundance / size
A = Quartz abundant (other than *)
LN = Laterite nodules
LL = "Soft laterite"

			API	B horizon	C horizon
	C018	* LN.	A2	7.5yr 6/6 CL-C	5YR 5/6 CL-C
	C019	*	A2	10yr 6/6 CL	7.5 5/6 CL
	C020	A (*)	A2	7.5 6/6 CL	5 5/6 CL
	C021	* ? Pebbles	A2	10YR 6/5-7/3 hSL	— SL-LS
	C022	*	A2 check	10 6/5 SCL	7.5 6/6 & red hSL
	C023	(A* L)	A2	7.5 6/6 CL	5 6/6 CL
	C024	* Qtz pockets	A2	7.5 6/6 SCL	→
	C025	* Colluvial SL			
	C026	L	A2	10YR 6/6-6/8 CL	10yr 6/8 C
Sedim.	C027	Hard L 75cms.	A2	" "	" "
	C032	A(*) LN Qtz pockets	T2	7.5-5YR 5-6/6	CL-C
	C033	A	T2	7.5YR 6/6 CL-C	Mottled CL-C
	C034	—	T2	" CL	→ 5YR-7.5R
Sedim.?	C035	L pocket qtz.	A2/T2	5YR 5/6 FSCL	2.5YR 5/6 FSCL
	C044	A very gritty	A2	10YR 6/6 CL	5YR 5/6-8 CL
	C045	A	A2	7.5-10YR 5/8-6/8 CL(h)	7.5YR 6/8 CL
	C046	A (few L)	A2	10YR 6/8 CL-C	10YR 6/6 C
	C048	A L pocket Qtz	T2	7.5YR 5/8 CL	→ (5YR-7.5YR)
RGM	C058	—	A2	10YR 6/6-6/8 SCL	→
RGM	C059	—	A2	10YR 6/6 SCL/SC	→
	C067	A	T2	7.5YR 6/6-6/8 CL	→
	C068	A Rotten granite 90cms.	T2	5-7.5YR 6/6 CL	→
	C069	A Pockets granite 70cm.	T2	7.5YR 6/6-68 CL	7.5YR 7/6 CL

Rengam / Hariman Bores Pasak

F = Quartz grains few or fine
* = Abrupt increase qtz abundance / size
A = Quartz abundant (other than *)
LN = Laterite nodules
LL = "Soft laterite"

		API	B horizon	C horizon
C018	* LN.	A2	7.5yr 6/6 CL-C	5YR 5/6 CL-C
C019	*	A2	10yr 6/6 CL	7.5 5/6 CL
C020	A (*)	A2	7.5 6/6 CL	5 5/6 CL
C021	* ? Pebbles	A2	10YR 6/5-7/3 hSL	— SL-LS
C022	*	A2	10 6/5 SCL	7.5 6/6 & red hSL
C023	(A* L)	A2	7.5 6/6 CL	5 6/6 CL
C024	* Qtz pockets	A2	7.5 6/6 SCL	→
C025	* Colluvial SL			
C026	L	A2	10YR 6/6-6/8 CL	10yr 6/8 C
Sedim. C027	Hard L 75cms.	A2	" "	" "
C032	A(*) LN Qtz pockets	T2	7.5-5YR 5-6/6	CL-C
C033	A	T2	7.5YR 6/6 CL-C	Mottled CL-C
C034	—	T2	" CL	→ 5YR-7YR
Sedim.? C035	L pocket qtz.	A2/T2	5YR 5/6 FSCL	2.5YR 5/6 FSCL
C044	A very gritty	A2	10YR 6/6 CL	5YR 5/6-8 CL
C045	A	A2	7.5-10YR 5/8-6/8 CL(h)	7.5YR 6/8 CL
C046	A (few L)	A2	10YR 6/8 CL-C	10YR 6/6 C
C048	A L pocket Qtz	T2	7.5YR 5/8 CL	→ (5YR-7.5YR)
RGM C058	—	A2	10YR 6/6-6/8 SCL	→
RGM C059	—	A2	10YR 6/6 SCL/SC	→
C067	A	T2	7.5YR 6/6-6/8 CL	→
C068	A Rotten granite 90cms.	T2	5-7.5YR 6/6 CL	→
C069	A Pocket granite 70cm.	T2	7.5YR 6/6-68 CL	7.5YR 7/6 CL

C071	A LN LL (LN stoneline)	A3	7.5 6/6-5/8 MSCL	5YR5/8 SC
C072	(LN, LL) Pocket Qtz.	A3	2.5—5YR 5/8 SCL-SC	Variegated C
C073	A coarse	A1	10YR6/4 SC	10YR7/4 etc. CL
C074	(LN, LL)	A1	7.5YR6/6 SCL(h)	5YR5/7 FSC
C075	A(LL)	A3	7.5YR6/6 SC	5YR5/6 etc. SC
C077	(LN) A	A3	7.5YR 5/7 SCL	Variegated SC-C
C078	(LN)	A3a	7.5YR5/8 MSCL-MSC	→
C079	(LN) LL A (*)	A3b	10YR6/5 SCL-CL	10YR5/6 mottled C
C086	F	T2	5YR5/6-5/8 MSL	→
C087	A (* L)	T2/A3	7.5YR 6/6 SCL	Mottled SC
C088	LN (F)	"	5YR5/8 SCL	Reddish SC
C089	LN LL	"	7.5YR5/8 SCL(h)	5YR5/8 SCL-SC
C090	A (*)	"	10YR6/6-6/8 SL(h)	7.5YR5/8 SCL

	API			
C028	A2?	? Rengam over Serdang (7.5YR 6/8 LMS at 105)		
C029	A1	SiCL-SiC 7.5YR 5/6-6/6 Mica shales, thick laterite -		Tawy / Munchong
C030	A1	light-10YR CL. CoSL-LS at 70. Qtzite/s'st A/c		
C031	A1	FSL-SCL 5-7.5YR 6/6 Laterite, Quartzite.		? Serdang
C036	A2	VFSL 10YR 6/6 over CL 5-7.5YR 6/6 Micaceous, laterite		Batang Merbau / Bt. Rosam
C037	A2	VFSCL over CL 7.5YR 6/6 Micaceous laterite.		"
C038	T2	FSL - FSCL 7.5YR 6/6	good	Serdang
C039	A2	SCL 7.5YR 5/8 (Redder sc at depth)	good	Serdang
C040	A2	VFSCL 7.5YR 5/6 over laterite		? Masai
C041	A1	SL → SCL 7.5YR 6/6	good	Serdang
C042	A1	VFSCL 7.5YR 6/6 over laterite & mica schist		? Durian
C043	A1	SiCL 7.5YR 6/6 Laterite. Mica schist.		? Durian
C047	A1	FSL → SCL 7.5YR 5/6 Some laterite.		? Serdang
C049	A1	SCL 7.5YR 5/8 compact.		Serdang
C050	A1	MSL(H) 7.5 → 5YR 5/7		?? Serdang
C051	A1	SL 5YR 5/6 weathered rock 60 cms.		? Kedah
C052	A1	VFSCL → VFSC 10YR → 7.5YR 7/6 - 6/6 Micaceous		Durian / Bunga / Batang Merbau
C053	A1	h VFSL 10YR → 7.5YR 6/5 Shallow		? Kedah
C054	A1	7.5YR 5/8 - 6/8 SCL - SC compact	good	Serdang
C055	A2	"	good	Serdang
C056	A2	SiCL → SiC 2.5Y 6/4 mottled.		? Batu Arang
C057	A2	SCL - SC 7.5YR 5/7 Soft laterite, sandy.		Serdang / Mong Gajah
C060	A2	VFSC 7.5YR 6/7 Hard laterite 70 Mica schist		Tawy / Rotaeca
C061	A2	SCL - CL over weathered sand, + lat. 7.5YR 6/6		Serdang
C062	T2	li MSL 2.5Y 6/4 - 7/4		Holyrood / colluvial
C063	T2/3	LS - SL 2.5Y 6/2 - 6/3		Holyrood
C064	T2	SCL 7.5YR 5/8 Fine pebbly laterite 85+. Colluvial?		Serdang / Mong Gajah.
C065	T2	SL - SCL 2.5YR (2.5Y) 7/3 etc.		Serdang ≡ Marang
C066	T2	SL - - → SC 7.5 - 5YR 5/8		Serdang
C070	T3	VFSL 7.5YR 5/2 - 6/1 over LCoS 10YR 5/3		Holyrood
C076	F1	VFSL - LMS alluvial Gleyed below 60 cms.		? Kampong Kuber
C080	F1	Gleyed SiCL over Peat at 50		? Tian Bahru
C081	T3	MSL 10YR 6.5/6		Holyrood
C082	F4	Gleyed SiC over mottled C		? Merbau patch
C083	F4	— — — — — — — — —		Peat
C084	T3	h MSL 10YR 6/4 (over granitic at depth)		Holyrood
C085	T3	MSL - CoSL 10YR 6/5 → 7/4		Holyrood.

AWC(y) = 2·17 − 0·018a + 0·0042b

where y = AWC (in./ft), a = per cent coarse sand (2·0—0·2 mm) and
b = per cent fine sand (0·2—0·02 mm)

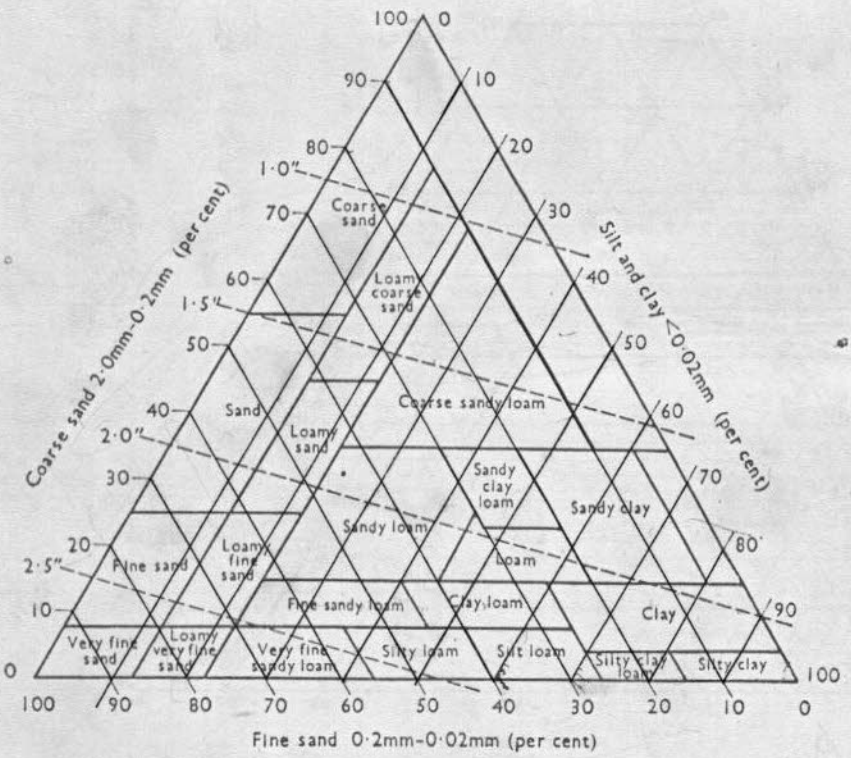


FIG. 1. Modified triangular co-ordinate diagram. The estimated values of AWC are superimposed as contours (broken lines) at intervals of 0·5 in./ft. depth.

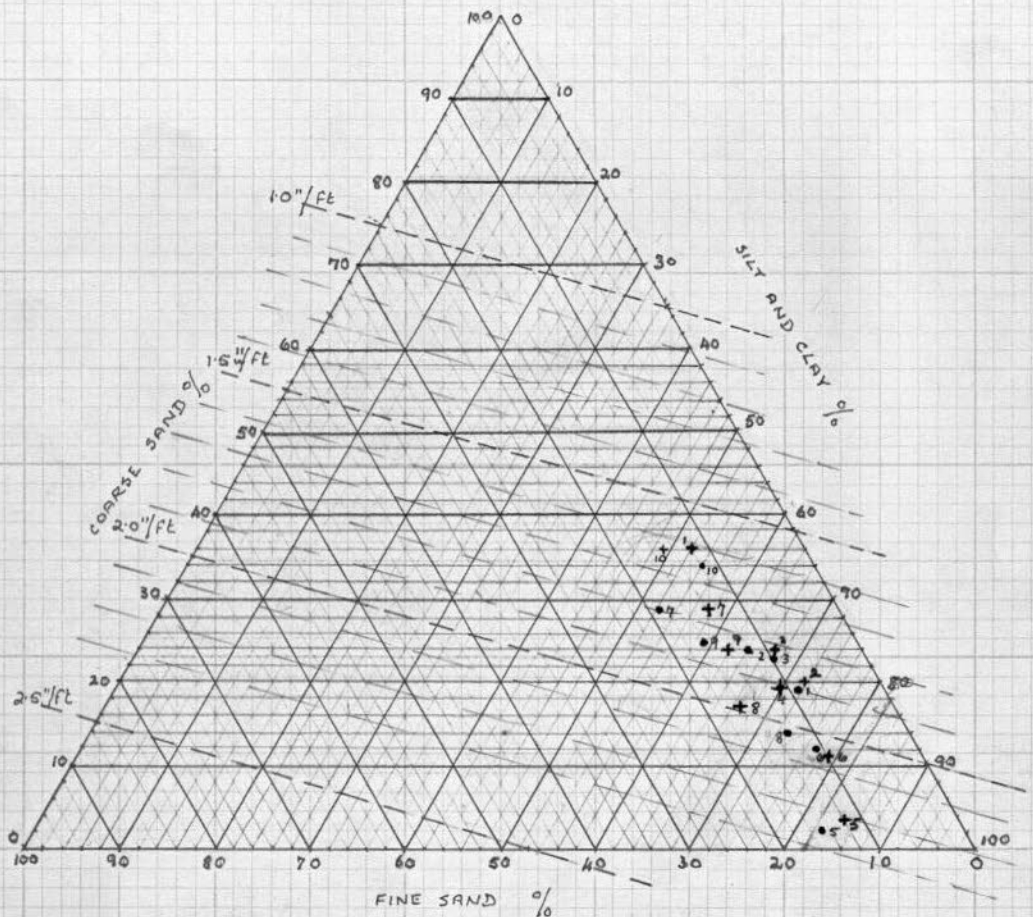
For textural classes based on size grades used by the Soil Survey. From the average particle-size composition for each textural class (U.S.D.A., 1951) the mean AWC per class (Table 1) was calculated using the following equation:

$$y = 1{\cdot}86 - 0{\cdot}011a + 0{\cdot}018d, \qquad (2)$$

where y = AWC (in./ft), a = per cent coarse sand (2·0—0·2 mm),
and d = per cent silt (0·05—0·002 mm).

Comparisons of estimated and measured values of AWC for 39 soils

The AWC of 2 profiles of each of the original 27 soils (for textural classes and series see Salter and Williams, 1965) and of 2 profiles each of a further 12 soils (i.e. a total of 78 profiles) were estimated by the above methods and compared with the measured values. The latter 12 soils were not representative of all textural classes; they were all silt loams, very fine sandy loams, or clay loams and in general were highly retentive of available-water.

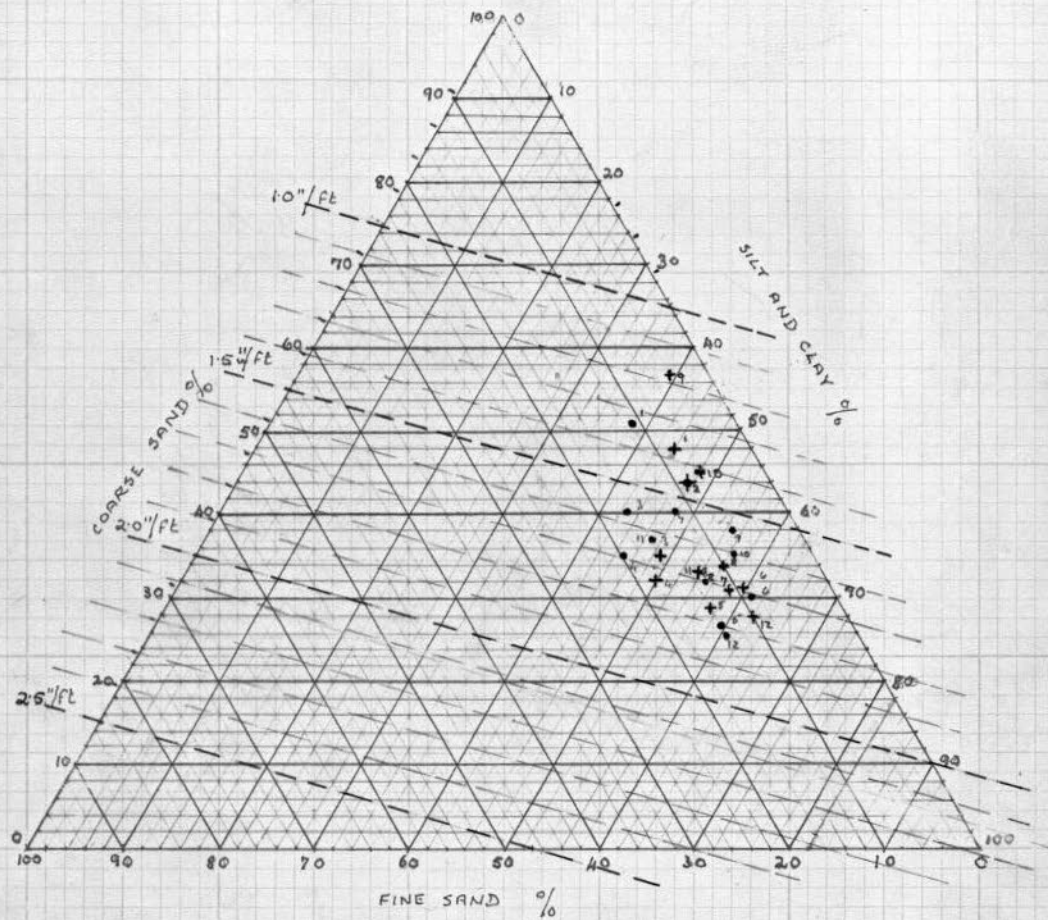


AWC OF YONG PENG series.

0-12" •

12-24" +

values for 0-12" probably slightly underestimated

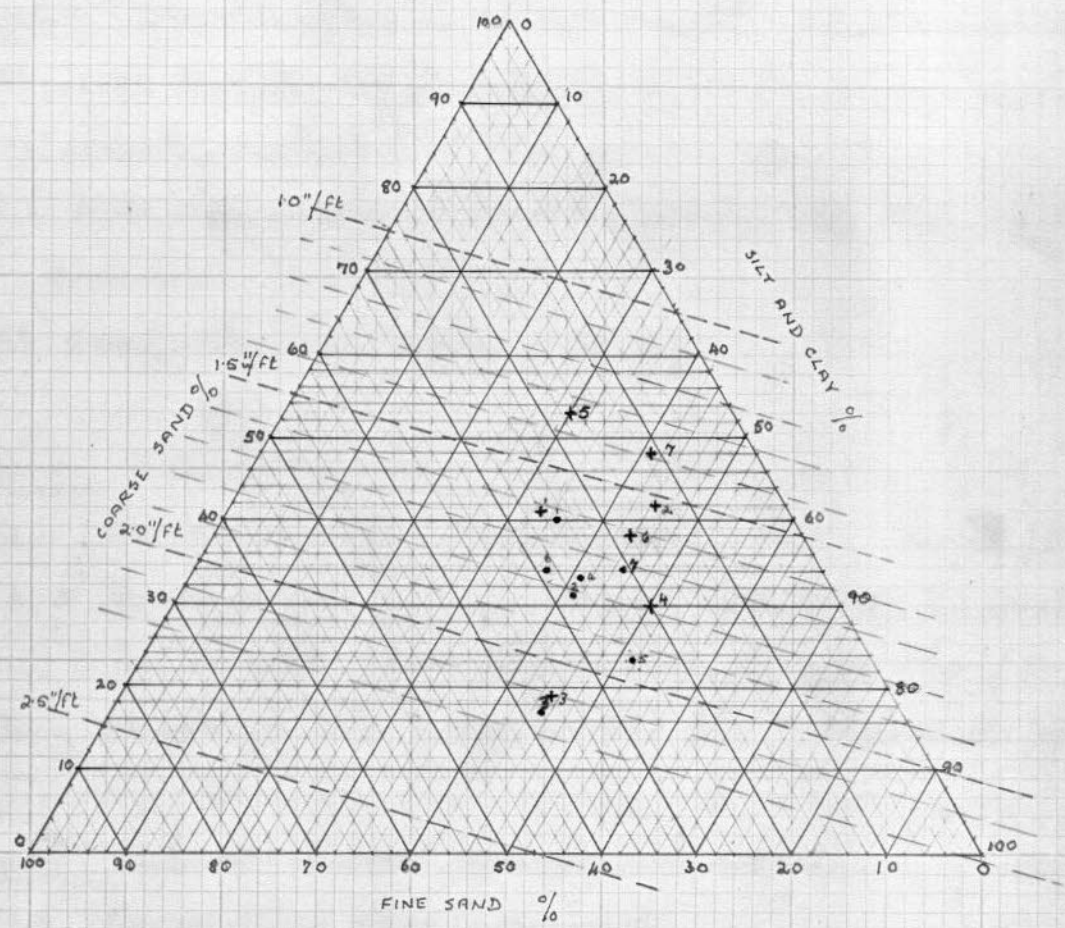


AWC of RENGAM SERIES

0 – 12" •

12 – 24" +

values for 0–12" probably underestimated



AWC of HARIMAU SERIES

0 - 12" •

12 - 24" +

Values for 0 - 12" probably underestimated

Terrain H Not yet encountered in field. Elevation ranges of H1 – H3 as for terrain A, but slope ranges may be steeper, especially H1 & H2. Extrusive igneous rocks (e.g. Pahang Volcanic Series).

Terrain R Ridged landforms on sedimentary rocks. Not yet encountered in field.
R1 and R2 have elevation generally above 300 ft., and are steep (above 12° generally, mostly above 18°).
R3 Lower ridges, comparable in elevation & possibly slopes to A2, but not yet encountered.
R4 Broad valley areas between ridges.

Terrain T Alluvial terraces.
T1 Elevation > 130 ft. strongly dissected, >12°. Harimau / Ulu Tiram soils
T2 Elevation approx. 50–150 ft. Landforms similar to A2, but sometimes less dissected (smoother). & generally slightly less steep (5–8°)
T3 Elevation < 50 ft. slopes less than 5°. Holyrood soils (pale coloured sand

Terrain F Fresh-water alluvium. Generally poorly drained.
F1 Narrow valleys, generally non-peaty
F2 Broader valleys, may be peaty
F3 Main river valleys – levees etc. generally non-peaty.
F4 " – backswamps. Generally peaty.
F5 Brackish.

Terrain M Saltwater alluvium (mangroves)

Terrain S Beaches & sub-recent beaches.
S1 Present day beach
S2 Recent beach. White sands or humus podzols; peat in depressions.
S3 Old beaches. Peat overlying white sand. No peat on highest beach ridges.

Terrain W Permanent fresh-water swamps. All are expected to be deep peat.

Suffix X (e.g. A1x) to denote particularly steep hills,
" Z to denote disturbed land (e.g. bauxite extraction, mine tailings).

A.P.1. Legend

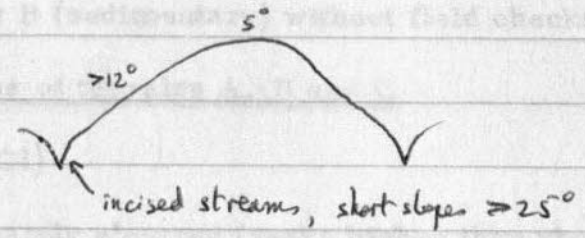
Terrain A Undulating with rounded, sub-conical hill forms & sub-rectangular drainage pattern. Granitic bedrock.

Terrain B Undulating: similar to above but conical hill forms & regular drainage patterns less clearly expressed. Sedimentary bedrock.

Terrain C Intermediate, indeterminate between above.

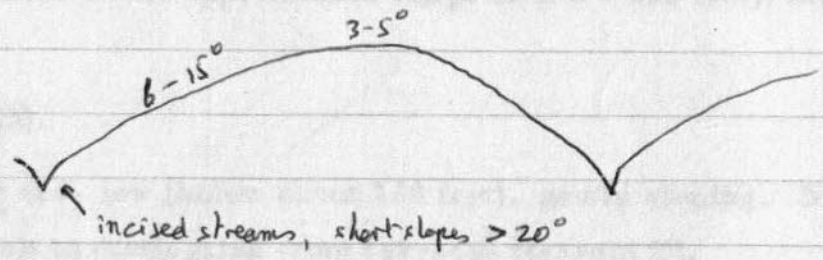
In practice, this differentiation is indeterminate, and types of slope will not vary greatly between terrain types.

Landtype A1 (B1, C1) Elevation of summits > 200 ft. Average condition :-

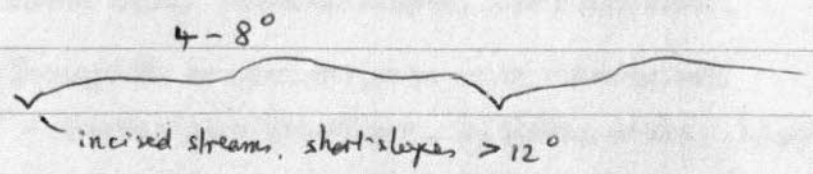


A1(H) & A1(X) are isolated steeper, higher hills.

Landtype A2 (B2, C2) Elevation of summits 130 - 200 ft. Average condition :-



Landtype A3 (B3, C3) Elevation of summits < 130 ft. Average condition :-



Landtype A4 (B4, C4) Footslope areas etc. Comparable A3. Unimportant.

S.E. JOHORE (Tg. PENGERANG) - A.P.I. LEGEND (LANDTYPES)

Terrain A, B and C. Undulating terrain

Terrain A.

Undulating, with rounded conical hill forms; regular (rectangular or sub-rectangular) drainage pattern, probably joint-controlled, although valleys tend to be crescentic in plan view. Granite bedrock.

Terrain B.

Undulating terrain without the characteristic regularity of terrain A: i.e. conical hill forms not clearly expressed, drainage not rectangular (dendritic or sub-dendritic). Sedimentary or metamorphosed bedrock.

Terrain C.

Undulating terrain that cannot be differentiated into types A (granitic) or B (sedimentary) without field checks.

Sub-divisions of terrains A, B and C

A1 (B1 and C1)

Moderately elevated (peaks higher than about 200 feet), rather steep. A1(H) or A1(X) used for steep isolated hills with an elevation of greater than about 350 feet.

A2 (B2 and C2)

Low (peaks in the approximate range of 130 - 200 feet); moderately steep.

A3 (B3 and C3)

Low or very low (below about 130 feet), gently sloping. In some cases, difficult to distinguish from terraces (terrain T).

A4 (B4 and C4)

Broad valley areas, used principally in A1 (B1 and C1) landtypes, which include lower hills, colluvial slopes, some alluvium.

Sub-landtypes (mappable in sample areas or in cultivation).

a. (e.g. A2a) - convex/straight slopes, including peaks. Light tones where vegetation thin, and sheet erosion probably active. Soils likely to be shallower than in b).

b. (e.g. A2b) - concave/straight slopes, including lower slopes and colluvial/alluvial valleys. On cleared land, indicated by darker tones, indicative of deeper soils and/or poorer drainage, and on slopes, of colluvial infilling of previous drainage depressions, with a general smoothening of slope form. Active gully erosion very common along valley bottoms, so that the stream flows along a notch (indicates a lowering of base level - valley incision and headward erosion).

Terrain type H. Concave Conical Hill terrain

Conical hills with straight to concave slopes, generally standing isolated. Probably granodiorite.

Landtype H1

High cones; peaks higher than 250 feet. Steep.

Landtype H2

Low cones, elevation about 130 - 250 feet. Moderately steep.

Landtype H3

Very low cones, of less than about 130 feet. elevation.

Landtype H4

Very low undulating areas (less than about 50 feet) between cones. Slopes negligible.

Terrain type R. Ridged terrain

High ridged terrain, e.g. the "Mid-Pengerang Ridge". Sedimentary or meta-sedimentary bedrock. Drainage generally sub-parallel to sub-trellis, but variable.

Landtype R1

High, rugged, ridged terrain, with dense drainage pattern. Steep (landtype R1(X)).

Landtype R2

Ditto, but drainage pattern less dense. Less dissected.

Landtype R3

Lower elevated ridges, comparable in elevation to A2. Rather rugged and dissected, but slopes moderate or less than moderate.

Landtype R4

Footslope areas of ridged terrain, including broad valley areas within R1 and R2 landtypes - these may include colluvial slopes and colluvial and alluvial valleys, as well as some low convex areas.

Terrain type T. Alluvial terraces

Identified on topography (with help of reconnaissance soil map).

Landtype T1

High terraces, comparable to A2 in elevation. The main area of T1 is very strongly dissected by gully erosion, this being the main distinguishing character.

Landtype T2

Terraces of about 100 - 150 feet elevation. Smooth rounded forms, almost plateau-like, with parallel drainage being the main distinguishing feature in the area where it is present (may indicate tilting?). Where this pattern is not developed, very difficult to separate from terrain A.

Landtype T3

Very low terraces, or sub-recent alluvium. Elevation from a few feet to about 100 feet. Identified in floodplains (e.g. around Kota Tinggi) by being slightly ráised above the floodplains, with lighter colour tones. Such areas cannot be distinguished under forest. Higher terraces cannot satisfactorily be distinguished from A3, except perhaps by drainage.

Terrain Type F. Freshwater alluvium (non-swampy)

Landtype F1

Narrow flat-floored valleys (width up to about 15 mm on 25,000 scale).

Landtype F2

Broader flat-floored valleys (in A, B, C, H or R terrain). F2(W) if canopy or position suggests permanently swampy conditions.

Landtype F3

Floodplains - meander belt and levees.

Landtype F4

Backswamp areas (i.e. back of levees; not permanently swampy).

Landtype F5

Transitional to terrain type M.

Terrain type M. Mangrove swamps

No sub-divisions at present.

Terrain type S. Sand beach and sub-recent beach.

~~Sub-divisions likely to be made into recent and sub-recent, also ridges and swales.~~

Landtype S1

Present day beach in tidal zone.

Landtype S2

Recent beach, no longer in tidal zone, adjacent to present beach. Light-toned except in swales.

Landtype S3

Sub-recent beach, either adjacent to S2 (in which case the boundary is a transitional ~~ore~~ one) or separated from it by areas of terrain type W. In the latter case, recognised by crescentic form roughly parallel to the present coastline, and by different canopy from adjacent swamps (or light tones if cleared). S3 may be separated from the present coast by several miles of swamp.

Terrain type W. Permanent swamp (freshwater)

Landtypes not readily distinguishable where the forest is secondary.

Landtype W1

Mod. coarse textured, uneven canopy.

Landtype W2

Mod. fine textured, dark toned, rather uniform, lower canopy.

Landtype W3

Fine, light grey, uniform, low canopy.

Terrain type X. Steep land. Sometimes as a suffix e.g. (A1(X)

Terrain type Z. Disturbed land. e.g. mining, tailings, etc.

Sometimes as a suffix e.g. (Z).

Slope Ranges per A.P.I. Units

A) Pasak and Siput Sample Areas and Teloh Sengat Area :-
Bores C 018 - C 211 (D.A.H.)

Landtype	A1	30 bores	slope range 6-34°	Mean	19.5°
"	A2	21 bores	" 4-28°	"	12.3°
"	A3	75 bores	" 2-18°	"	6.6°
"	T1	2 bores	13° and 22°		
"	T2	26 bores	slope range 2-15°	Mean	5.5°
"	T3	20 bores	" 0-8°	"	3.8°

106

B) Rentis AW/AE1 — AE7
Bores A 054 - 113 (ILY)
B 194 - 277 (RDL)
C 212 - 284 (JAH)

Landtype A1 27 bores Range 3-30° Mean $\frac{395}{27} = 15°$
60% 12° or above, 78% 8° or above

Landtype A2 104 bores Range 2-24° Mean $\frac{864}{104} = 8°$
21% 12° or above, 52% 6°-11°

115

Landtype A3 30 bores Range 1-10° Mean $\frac{143}{30} = 5°$
77% 1-5°

Landtype A4 2 bores 3° and 4°

Landtype R1 2 bores 14° and 24°

Landtype R2 1 bore 14°

Landtype T3 8 bores Range 1-4° Mean 2.5°

SIPUT

C099	Peaty alluvium						-F2
100	JRG	7.5YR 6/8	SC-SCL	deep	JRG	7-8°	T3
101	MSI	10YR 6/6	CL	Lat 35-90+	MSI (volcanic)	7°	A3
102	JRG	7.5YR 6/8	SiC-C	deep	YPG	3°	A3 PIT (C116)
103	?JRG	10YR 6/8	CL	gritty at 100	YPG (see pit)	7°	A3 PIT
104	?JRG	7.5-10YR 6/6	CL	gritty at 55	YPG (gritty)	3°	A3
105	Serdang				SDG	4°	T3
106	JRG/MSI	7.5YR 6/6	CL	Laterite 70-80+	? YPG	7°	T3
107	Pale Hariman				HMU	2°	T3
108	Holyrood				HYD	3°	T3
109	Pale Hariman				HYD (intergrade HMU)	4°	T3
110	?K. Kolam	7.5YR 5/8	C	Laterite 65-75+	MSI (volcanic)	7°	A3
111	JRG	7.5YR 6/8	CL	deep	? YPG (interg. JRG)	5°	A3
112	Serdang/JRG	7.5YR 5/6-6/8	FSCL(h)	deep	JRG?	5°	A3
113	?JRG	7.5YR 6/7	SiCL	deep Little Qtz	YPG	3°	T3
114	Holyrood (7.5YR 7/6)				? SDG	6°	T3
115	Serdang				SDG	3°	T3
116	PIT at C102						~~4° A3~~
117	JRG	7.5YR 5/8	CL	deep Rather silty	YPG	4°	A3
118	JRG/MSI	10YR 6/8	CL-SCL	Laterite 65-75+	MSI	4°	T3
119	Pale Hariman				HMU	5°	T3
120	JRG	10YR 6/7	FSCL-FSC	deep	KLI/YPG ?	3-5°	A3
121	? Kg. Kolam	5-7.5YR 6/8	C	Laterite 90+	YPG	<10°	A3
122	JRG	7.5YR 6/8	CL-VFSC	Laterite 95-105+	YPG	5°	A3

123	Alluvial	Imperfectly d°	VFSCL			–	F1
124	Serdang/JRG	10YR-7.5YR 6/8	CL	? quartzite (sampled)		3-5° A3	KL1/YPG
125	JRG	7.5YR 6/8	CL ~~deep~~	Laterite 60-90+		8° A3	YPG/MS1
126	?JRG	7.5YR 6/8	SiC-hCL	deep	Much white "quartz"	5-8° A3	YPG
127	JRG	7.5YR 5/8	CL(h)	deep	Granodiorite sampled	5° A3	JRG? ?? YPG
128	JRG	5YR 5/8	CL	gritty at depth.	Red variant. Granodiorite P.M.	18° A3	JRG red var
129	JRG	7.5-10YR 6/8	CL(sc)-tC	deep.		7° A3	" ? YPG
130	JRG	7.5YR 6/8	CL-C	deep		7° A3	? YPG
131	JRG	7.5YR 6/8	CL-C	(over gty C 5YR)		7° A3	? YPG
132	?K. Kolam	10YR 5/8-6/8	C	deep	Silty. Some laterite	4-7° A3	KL1/YPG
133	JRG/MS1	7.5YR 6/8	tC	(silty)	75+ laterite	8° A3	YPG shallow
134	K. Kolam?	7.5YR 5/8-6/8	C	(silty)	60+ laterite	2-3° A3	MS1 vole.
135	"	"	C		65+ laterite	12° A3	MS1 "
136	?JRG	5-7.5YR 6/8	tC	(silty) deep.	White "quartz"	8° A3	YPG
137	JRG	7.5YR 6/8	FSC	deep		6° A3	JRG
138	Pale Harimau					3° T3	HYD (heavy)
139	JRG	7.5YR 6/8	FSCL-CL	deep		11° A3	JRG
140	JRG/MS1	7.5YR 6/8	CL	laterite 65-105, Hen qtz		2° A3	YPG/MS1
141	Pale yellow	10YR 7/7	SiC-C			4° A3	KL1
142		7.5YR 6/8	tC	laterite nodules from 25 cm		3-12° A3	YPG
143		7.5YR 6/8	C	lat. nodules from 50 cm.		4° A3	YPG
144	JRG/MS1	7.5YR 6/6	C	lat. 55-105 cm.		9° A3	YPG/MS1
145	~~JRG~~ MS1	10YR 6/8	C	lat. 55+		7° A3	MS1
146	JRG/MS1	7.5YR 6/6	C	Lat 75-105		3.5° A3	YPG/MS1

C147		10YR-7.5YR 6/6	VFSC-S:C	soft-laterite, white minerals	7° A3	KL1
148	JRG/MU	7.5YR 5/8	bC	deep	5° A3	YPG
149	Holywood type				5° A3	HYD heavy
150	"				2° A3	" "
151	"				3° A3	HYD over HMU?
152	MS1/HMU	7.5YR 5/8	CL	Lat. 40-95, gritty-ish below	4° A3	MS1
153	Holywood type				3° A3	HYD heavy
154	Peaty alluvium				– F1	
155	MS1	7.5-10YR 5/8	C	Lat 60+	10-20° A3	MS1
156	MS1	"	C	Lat 50-110	3° A3	MS1
157	MS1/PR	10YR-7.5YR 6/8	C	Lat 60-75+	8° A3	MS1
158	JRG/MS1	7.5-10YR 6/6	C	Lat 75-115	11° A3	YPG/MS1
159	JRG	7.5-10YR 6/8	CL-C	Lat. 95-115	13° A3	YPG
160	JRG	7.5-5YR 5/8	C	Lat 65-105, then gritty	15° A3	YPG/MS1
161	MS1	7.5-5YR	CL	Lat 35-85+	13-18° A3	MS1
162	MS1	7.5YR 6/8	CL-C	Lat 45-105, then more qtz	15° A3	MS1
163	JRG	10YR 6/8	C	deep, uniform, on lower slope	7° A3	KL1/YPG
164	HYD/HMU				2° T2-3	HYD/HMU
165	"				6-7° T2-3	HMU
166	Recent alluvium				– F2	
167		7.5YR 5/8-6/8	C	laterite from 40cm, nodular then fresh	2-3° A2	YPG
168						
169						
170						

PASAK

2018	HMU ~~2TPT~~	6-7°	~~A2~~ A1
19	HMU	17°	~~A2~~ A1
20	HMU	5-6°	~~A2~~ A3
21	VTM	20°	~~A2~~ A1
22	HMU	~ 20-25°	~~A2~~ A1
23	HMU	26° (→30°+)	~~A2~~ A1
24	HMU – VTM	10°	A1
25	Coll. HMU	4°	F1
26	HMU – ? RGM	8°	A1
27	HMU – could be RGM but too lateritic at 75cm +	BGR ?	17° A1
28	PHI ?	14°	A1
29	TVY	28°	A1
30	BGR ?	~ (25-30°)	A1
31	DRN ? could be TVY	25°	A1
32	HMU	–	T2
33	HMU brsequum	~ 2-3°	T2
34	HMU	5°	T2
35	TVY	10-17°	A2/T2
36	PHI shallow	20°	A2
37	TVY	7°	A2
38	BGR	13° (→20°)	T2
39	BGR	10°	A2
40	TVY shallow	28°	A2
41	SDG/BGR	25-28°	A1

042	TVY shallow.	Equally could be DRN	28°	A1
43	"	"	20-25° ∩	A1
44	HMU ?	This hill conceivably RGM	10°	A2
45	HMU ?		8° ∩	A2
46	HYD ?		14°	A2
47	HMU		13° ∩	A1
48	HMU	: ~~beequum~~	8°	T2
49	BGR ?	Similar to 55	12° (low)	A1
50	SDG	(pit?)	22° (29°)	A1
51	SDG shallow		33°	A1
52	DRN		23° (steeper)	A1
53	BGR ?		28°	A1
54	BGR ?	good pit sites — Pit	11° (low)	A1
55	BGR ?	→ Pit	7°	A2
56	BTM	" Pit	12°	A2
57	BGR		14°	A2
58	RGM		9°	A2
59	RGM		14°	A2
60	TVY	(possibly VPG ?)	15°	A2
61	TVY ?	Pit ?	10°	A2
62	HYD		3°	T2
63	HYD	fine at depth	2°	T2-3
64	TVY		5°	T2
65	HYD ?		5-7°	T2

CO66	MUN?	Topographically TPI HMU but lacks quartz.	7° T2
67	HMU		10° T2
68	HMU		– T2
69	HMU		– T2
70	HYD grey	but almost a recent alluvial	level T3
71	(TPI) 7.5-5 YR 6/8	colour 50cms - 100cms	4° A3
72	TPI ✓	gets finer at depth	2° A3
73	UTM		14° A1
74	(TPI) 7.5 YR 6/6		10° A1
75	(TPI) 5 YR 5/6		5° A3
76	Rec. Alt. off HMU		– F1
77	(UTM)?		8° A3
78	(TPI) 7.5 YR 5/8		5° A3
79	(UTM)?		5° A3
80	Peaty alluvium		– F1
81	HYD		3° T3
82	Alluvial		– F4
83	Peat		– F4
84	HYD		4° T3
85	HYD		3° T3
86	(TPI) sandy 5 YR 5/8		6-7° T2
87	(TPI) 7.5 YR 6/6 - 5 YR 5/8	finer at depth	2° T2/A3
88	(TPI) 5 YR 5/8		3-4° "
89	(TPI) "		" "

0090	HMU	5°	T2/A3
91	(TPI) 7.5YR 5/8	6°	T2
92	HMU ? UTM	5-7°	T2
93	HMU	4°	T2
94	UTM	3°	T2
95	(TPI) 5YR over mottled	2°	T2
96	? UTM	2°	T2
97	UTM	2°	T2
98	? UTM	8°	T2

Pasak

168	TVY/DRN ? shallow	20°	A1
169	BGR ?	19° (30°)	A1
170	BGR	10° (low)	A1
171	SDG	24-34°	A1
172	MSI/MCA !	14°	A1
173	KLI	4° (12°)	
174	RGM	5°	
175	RGM ?	7°	
176	HMU	3-5°	

TELOK SENGAT

C 177	LVA	—	F2
178	RGM	< 8°	A3
179	YPG	3-7°	A3
180	RGM red var.	3°	A3
181	" "	3°	A3
182	YPG	5°	A3
183	"	15°	A3
184	HYD (Podjolized)	1°	F2
185	RGM	3-4°	A3
186	HYD	0-2°	T3
187	RGM/YPG	3-4°	A2
188	KLI	3-4°	A3
189	RGM	5°	A3
190	HMU	3-12°	A3/T2
191	HMU ?	4-9°	A3/T2
192	UTM	20-23°	T1
193	RGM red var.	5-10°	A3/T2
194	UTM	13°	T1
195	HMU (TP1) ?	3-4°	A3/T2
196	RGM red var.	15°	A2
197	" "	14°	"
198	RGM	11°	"
199	RGM red var.	12°	"
200	RGM	7°	"

C 201	YPG	6°	A3
202	RGM red var.	6°	"
203	" "	12°	"
204	JRG	4°	"
205	"	3°	"
206	RGM	—	"
207	YPG	4°	"
208	BLU	4-8°	"
209	KLI	6°	"
210	JRG	5-6°	"
211	"	3-7°	"

Average slope ranges per A.P.I. unit (C018 - C211)

A1	19.5°	(30 bores, range 6 - 34°)
A2	12-3°	(21 bores, " 4 - 28°)
A3	6.6°	(75 bores, " 2 - 18°)
T1	17.5°	(2 bores, " 13 - 22°)
T2	5.5°	(26 bores, " 2 - 15°)
T3	3.8°	(20 bores, " 0 - 8°)

23rd September,

SOILS CORRELATION JOHORE

19th - 23rd. October, 1970

The Soils Correlation Tour for 1970 is to the State of Johore. The main purpose is to acquaint Soil Surveyors and other Soil Scientists with as many of the soils mapped in this country. In previous soils correlation tours, profile descriptions and analysis results are given of each of the pits/sites. But we have found that this had not brought forward much discussions at the pits/sites. In view of this we propose to adopt a slightly different approach. Profile descriptions and analysis results of most of the pits/sites will be given out to participants. However, the nature of the parent material/rock and the name of the soil series will not be included. Participants should endeavour to identify the soils from the morphological characteristics and the analysis results.

..... Attached to the profile descriptions and analysis results are blank forms (2 to each pit/site). We seek the co-operation of all participants to fill one form for each pit/site examination, and to hand this to the organisers. The other form is for your own use. The comments will be compiled, edited and eventually added to the text for a formal publication by the Soil Science Division. The names however will not be included.

LWM/spd.

Law Wei Min

(LAW WEI MIN)
Ag. Senior Soil Scientist.

DAR. 4/4.

23rd September, 70.

SOILS CORRELATION JOHORE

19th - 23rd. October, 1970

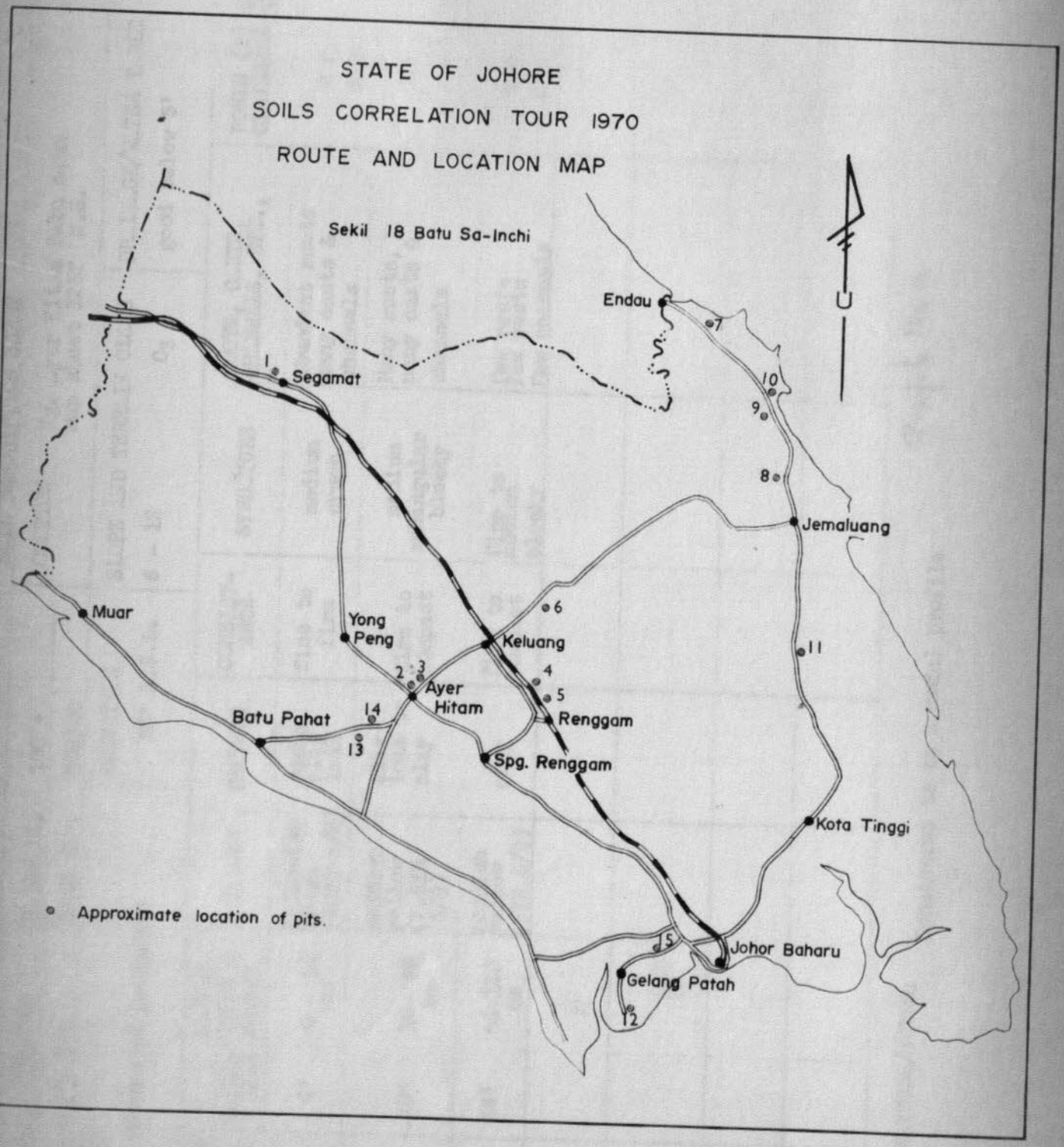
The Soils Correlation Tour for 1970 is to the State of Johore. The main purpose is to acquaint Soil Surveyors and other Soil Scientists with as many of the soils mapped in this country. In previous soils correlation tours, profile descriptions and analysis results are given of each of the pits/sites. But we have found that this had not brought forward much discussions at the pits/sites. In view of this we propose to adopt a slightly different approach. Profile descriptions and analysis results of most of the pits/sites will be given out to participants. However, the nature of the parent material/rock and the name of the soil series will not be included. Participants should endeavour to identify the soils from the morphological characteristics and the analysis results.

..... Attached to the profile descriptions and analysis results are blank forms (2 to each pit/site). We seek the co-operation of all participants to fill one form for each pit/site examination, and to hand this to the organisers. The other form is for your own use. The comments will be compiled, edited and eventually added to the text for a formal publication by the Soil Science Division. The names however will not be included.

LWM/spd.

Law Wei Min

(LAW WEI MIN)
Ag. Senior Soil Scientist.


STATE OF JOHORE
SOILS CORRELATION TOUR 1970
ROUTE AND LOCATION MAP
Sekil 18 Batu Sa-Inchi
U
Endau
7
1
Segamat
10
9
8
Jemaluang
Muar
6
Yong
Peng
Keluang
11
2
3
4
Ayer
Hitam
5
Batu Pahat
14
Renggam
13
Spg. Renggam
Kota Tinggi
Approximate location of pits.
15
Johor Baharu
Gelang Patah
12

SOIL DESCRIPTION SHEET

FIELD NO. NJ # 37	RAINFALL. 100"+	LOCATION Kg. Ayer Hitam Batu satu Map sheet 123f N.S.	VEGETATION Under belukar & resam
LAB NO. RS. 455	GRID REF. 302320		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
dissected peneplain	50' A.S.L.	6 - 12 C_3	good below 5'	negligible	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MATERIALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	4"	0 - 10 cm	Yellowish brown (10YR 5/4)	sandy clay loam	fine to firm	medium crumb	Abundant roots many casts & channels	2 P 3 C	-	-	-	sharp
Bt	18"	10 - 55 cm	reddish yellow (7.5YR 6/8)	clay loam to clay	firm to compact	medium subangular blocky	Many roots, many casts & channels	2 P 3 C (good)	fine quartz grains	mostly clay skin mottles	-	dist.
Bc	26"	55-120 cm	reddish yellow (5YR 6/8)	clay	firm to compact	fine to medium blocky	few roots few casts few channels	1 P 2 C	Laterite (soft) quartz grains	somewhat variegated	Quartz & laterite	dist.

SPECIAL FEATURES/NOTES: Considered to be a modal profile

Profile No 2

SERIES ESTABLISHED/TENTATIVE DURIAN

PHASE

GROUP

SURVEYOR: H. A. Smallwood, N. Mokhtar

DATE: 2/12/66.

45

Revised Edition, December 1964.

Origin of Sample: On Muar co-operated Lumber Company. Timber lorry track approx. 14 milestone from entrance. Map 117a. Grid 613817.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	CLASSIFICATION	MODAL PROFILES: Easily Sol. p.p.m.: P N/10 NaOH	K N/2 Acetic Acid	6N HCl Soluble: P p.p.m.	% Fe_2O_3	K meq/100g.	Ca meq/100g.	Mg meq/100g.
RS 304 T	Ah	0- 2	43	28	24	5	Nil	Nil		4.4		2		6.93	4.02	0.25	16		100	88		1.04			
Sa	Ae	2-10	47	28	28	2	"	"		4.8		1		1.03	0.60	0.06	10		84	10		1.21			
Sb	Bt	10-24	48	27	27	3	"	"		4.7		1		0.52	0.30	0.04	8		72	10		1.27			
Sc	Bc	24-48	59	24	20	2	0.3	"		4.6		1		0.21	0.12	0.03	4		70	10		2.14			

Soil No.	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K+Ca+Na+Mg.	Hydrogen	Percentage Saturation	Ratio
RS 304 T	23.15		0.27	0.31	0.19	0.68	1.45		6	
Sa	9.87		0.06	0.16	0.18	0.26	0.66		7	
Sb	8.85		0.06	0.16	0.19	0.26	0.67		8	
Sc	9.19		0.03	0.31	0.18	0.05	0.57		6	

Profile No. 2

FIELD NO. NJ/4	RAINFALL. 90 - 100"	LOCATION Pit located on small knoll north east of Agricultural Station Ayer Hitam on road to Kluang.	VEGETATION Lalang
LAB.NO.	GRID REF. 316 343		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Strongly dissected peneplain	50 A.S.L.	5 - 20°	below 5' - or at greater depth	very slight surface erosion	iron poor shale to mudstones.

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
A_1	0 - 10 cm		10YR 5/1 -5/2	clay	very firm	Subangular blocky	many fibrous roots with some earth worm activity	2 P 3 C		some brownish yellow 10YR 6/6	-	sharp to dist.
A_2	10- 31 cm		10YR 7/4	clay	very firm to extremely firm	massive	very few roots with some earth worm activity	1 P 3 C			-	dist.
B_2	31 -61 cm		10YR 8/4 to 7/4	clay	extremely firm	massive		1 C		some reddish yellow 7.5 YR 6/6	thinly disposed band of peasized laterite coal	indis
C	61-122 cm		10YR 8/3 to 8/2	clay	extremely firm	massive				many large weak red 2.5 YR 4/2 blotches and mottles	some 20 ft. laterite concretions	dist.

SPECIAL FEATURES/NOTES:

Below the C horizon there is the beginning of a pallid zone at 122 cm.+ The area appears to have been abandoned and lalang has encroached and become the dominant vegetation.

SERIES ESTABLISHED/ TENTATIVE Batu Anam.

PHASE | GROUP

SURVEYOR: H. Smallwood

DATE:

Profile No 3

PROFILE NO. 3

Origin of sample			North-east of Central Agriculture Station, Ayer Hitam - Kluang Road.																				
			Percentages				On original sample		pH		Percentages						CLASSIFICATION						
									Air dry								Easily Sol.		6N HCl Soluble				
Sample No.	Horizon Symbol	Depth (cm)	Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	Distilled Water	1N K Cl	Organic Matter	Carbon	Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. NaHCO$_3$ Soluble	0.5N CH$_3$ COOH Sol. Potassium p.p.m.	0.1N NaOH Sol. Phosphorus p.p.m.	Phosphorus p.p.m.	Iron Fe$_2$ O$_3$ %	Potassium meq./100g.	Calcium meq/100g.	Magnesium meq/100g.
		0-10	65	21	10	1	Nil	Nil	5.0		6.4	1.34	0.14	9.57			45	72	80		12.46	0.68	2.84
		10-31	75	14	6	1	"	"	4.8		4.6	0.37	0.09	4.63			20	16	46	0.92	15.64	0.92	2.42
		31-61	83	10	4	Trace	8.42	7.39	4.8		5.0	0.20	0.07	2.85			20	12	38	1.14	11.23	1.04	2.92
		61-122	77	16	5	"	Nil	Nil	4.8		5.2	0.15	0.07	2.14			20	10	40	3.47	14.61	1.94	2.02

	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
	9.40		0.09	0.42	0.05	0.46			11	
	6.50		0.06	0.21	0.04	0.23			9	
	6.33		0.06	0.10	0.05	0.31			8	
	4.96		0.06	0.10	0.05	0.15			7	

Profile No 3

PROFILE NO. 4

FIELD NO. 1	RAINFAL	LOCATION Pongam Forest Reserve Phase I Area. Map sheet 124.	VEGETATION Primary Jungle
LAB. NO.	GRID REF. 558348		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Dissected Peneplain	180'	slope 8°	Below 36"	Nil	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	0-3"	358	10YR 4/4	Silt loam	very finable	2msbk	many roots, many channels	many pores	-	-	-	dist.
Ae	3-13"	359	10YR 5/8	silty clay	mfr	f-msbk	many roots (1mm) few casts, few channels	few pores 2 - 3C	-	-	-	dif.
Bt	13-36"	357	7.5YR 5/8	silty clay	mfr	2-3fsbk	few roots (1 - 2cm)	2 P 2 C	-	-	-	dis.
Btcn	36-50"	RM 228	7.5YR 5/8	silty clay		fine granular Structure	Mixture of fragmental massive laterites (½" - 1")					

SPECIAL FEATURES/NOTES:

Btcn 80% laterite and 20% quartz.

SERIES ESTABLISHED/TENTATIVE Terangau

PHASE clay. GROUP

SURVEYOR: SSU/A. Hitam DATE: 6/4/69

Revised Edition, December 1964.

Profile No 4

PROFILE NO. 4.

Origin of sample: Rengar Forest Reserve, Johor. Correlation.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original sample: Gravel	Stones	pH Air-dry: Distilled Water	1N K Cl	Organic Matter	Carbon	Percentages: Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. NaHCO3 Soluble	Loss on Ignition	CLASSIFICATION: Easily Sol. 0.5N CH COOH Sol. Potassium p.p.m.	0.1N NaOH Sol. Phosphorus p.p.m.	6N HCl Soluble: Phosphorus p.p.m.	Iron Fe_2O_3 %	Potassium meq/100g.	Calcium meq/100g.	Magnesium meq/100g.
RV 28T	Ah	0-3	71	9	7	16	Nil	Nil	4.2	3.7	7.89	4.59	0.33	14			21	86	42					
Sa	Ae	3-13	77	7	7	13	"	"	4.5	3.8	2.10	1.22	0.10	12			15	16	24					
Sb	Bt	13-24	93	6	5	10	"	"	4.7	3.9	0.89	0.52	0.07	7			14	16	13					
Sc	Btcn	24-36	82	6	6	11	0.8	"	5.1	4.2	0.94	0.37	0.04	9			14	10	13					
Sd	"	36-50	73	9	6	15	29.5	15.7	4.8	4.2							14	8	17					

	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
RV 28 T	25.50		0.24	0.59	0.14	0.76	1.73		7	
Sa	11.19		0.06	0.19	0.05	0.05	0.35		5	
Sb	9.38		9.08	0.14	0.03	Nil	0.25		3	
Sc	7.74		0.04	0.08	0.05	"	0.17		2	
Sd	7.24		0.03	0.22	0.05	"	0.30		4	

Profile No 4

PROFILE NO. 5

SOIL DESCRIPTION SHEET

FIELD NO. Act No. 2	RAINFALL.	LOCATION Rengam Forest Reserve	VEGETATION Primary Jungle
LAB NO. RV 29	GRID REF.		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	0 - 2	355	10YR 4/3	Sandy loam	loose	1-m granular	roots abundant (1mm) cast few channels many	3 P 0 C	nil	nil	nil	dis
Ae	2 - 8	354	10YR 5	sandy clay loam	mfr	f-masbk	roots many (1-2mm) cast few	1 C 2 P	nil	nil	nil	df
Bt	8 -14	353	10YR 6/8	sandy clay	mfr	2msbk	roots very fine channels few	2 C 2 P	nil	nil	nil	dis
Btcn	14-38	352	5YR 6/8	lateritic bend in matrix SC-C	mfr	fine crumb	size of laterites (1 - 11mm.)	nil	nil	nil	nil	dis
C	33-53	C 726	5YR 6/8	co sc	mfr	1 co sbk breaking to msbk	roots nil cast and channels	1 C 2 P	nil	nil	nil	

SPECIAL FEATURES/NOTES:

SERIES ESTABLISHED/TENTATIVE Masai.

PHASE | GROUP 5

SURVEYOR: P.S.T.A.H. Klg. | DATE: 6/4/69.

Profile No 5

Revised Edition, December 1964.

PROFILE NO. 5.

Origin of sample: Rengam Forest Reserve - Johor - Correlation.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On original sample: Gravel	Stones	pH Air-dry: Distilled Water	1N K Cl	Organic Matter	Carbon	Percentages: Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. $NaHCO_3$ Soluble	Loss on Ignition	CLASSIFICATION: Easily Sol.: 0.5N CH COOH Sol. Potassium p.p.m.	0.1N NaCH Sol. Phosphorus p.p.m.	6N HCl Soluble: Phosphorus p.p.m.	Iron Fe_2O_3 %	Potassium meq/100g.	Calcium meq/100g.	Magnesium meq/100g.
RV 29 T	Ah	0 - 2	55	6	13	28	1.9	Nil	4.1	3.7	8.10	4.71	0.33	14			16	144	50					
Sa	Ae	2- 8	61	6	11	27	3.7	"	4.3	3.8	2.89	1.68	0.14	12			11	80	25					
Sb	Bt	8 -14	65	4	9	27	2.4	"	4.5	3.8	1.79	1.04	0.09	11			11	72	18					
Sc	Btcn	14 - 25	63	6	9	27	29.4	10.5	4.7	4.0	1.10	0.64	0.06	10			11	50	20					
Sd	C	25 -38	63	6	7	29	7.4	Nil	4.6	4.0							9	12	13					
Se		38 -53	63	6	8	27	26.1	8.5	4.7	4.0							11	16	13					

	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation
RV 29 T	21.40		0.40	0.68	0.14	1.24	2.46		11
Sa	12.84		0.24	0.16	0.11	0.11	0.62		5
Sb	9.71		0.19	0.11	0.05	0.46	0.81		8
Sc	8.23		0.15	0.14	0.07	0.11	0.47		6
Sd	6.58		0.03	0.16	0.05	0.08	0.32		5
Se	7.08		0.06	0.11	0.03	0.16	0.36		5

Profile No. 5

PROFILE NO. 6

SOIL DESCRIPTION SHEET

FIELD NO. NJ # 25	RAINFALL. 120	LOCATION On Endau sawmill timber lorry track following the Endau river. Approximately ¾ mls from log unloading depot. Map sheet 113a.	VEGETATION Primary jungle with some logging activity.
LAB NO. RS 299	GRID REF.		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
just off prominant sandstones 7 Quartz ridge. Near river channels.	50 A.S.L.	gently sloping A2	good water table below profile depth	-	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	0 - 5 cm	1½" 673	dark grayish brown (10YR 4/2)	sandy loam	loose to friable	very fine to fine crumb	Abundant roots some casts and channels	-	-	-	-	dis.
Ae	5 -75 cm	28½" 674	yellowish brown (10YR 6/8)	sandy clay loam	friable	fine to medium granular	many roots some casts and channels	1 P 1 C	-	-	-	diffuse
Bi	75-105 cm	12" 675	brownish yellow to yellowish brown (10YR 6/8 to5/8)	sandy clay loam	friable	medium granular	very few roots	-	some fine quartz grains	-	-	diffuse

SPECIAL FEATURES/NOTES:

This profile is normal in all respect and could be considered a modal profile for analysis.

SERIES ESTABLISHED/ TENTATIVE	Serdang.
PHASE	GROUP
SURVEYOR: H. Smallwood	DATE: 16/9/66

Revised Edition, December 1964.

Profile No 6

Origin of sample: On Endau sawmill timber lorry track following the Endau River, Approx. ¾ mile stone from log unloading depot. Map sheet 118a.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	on original sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	MODAL PROFILES: Easily Sol. p.p.m.: P N/10 NaOH	K N/2 Acitic Acid	6N HCl Soluble: P p.p.m.	% Fe_2O_3	K meq./100g.	Ca meq./100g.	Mg meq./100g.
Rs 299 T	Ah	0-1½"	28	2	28	45	3.7	Nil		4.00		1		3.47	2.01	0.14	14	102	45		1.51			
Sa	Ae	1½-30"	42	2	23	38	9.6	"		4.8		1		0.52	0.30	0.03	10	65	10		3.19			
Sb	Bi	30-42"	44	2	20	38	8.9	"		4.8		1		0.47	0.27	0.02	14	61	10		3.26			

Soil No.		C.E.C. Meq./100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K+Ca+Na+Mg.	Hydrogen	Percentage Saturation	Ratio
RS 299	T	12.77		0.11	0.21	0.16	0.21	0.69		5	
	Sa	6.47		0.03	0.16	0.21	0.10	0.41		6	
	Sb	6.00		0.03	0.10	0.16	0.16	0.45		7	

Profile No.6

PROFILE NO. 7 SOIL DESCRIPTION SHEET

FIELD NO. NJ 33	RAINFALL. 120 inches	LOCATION Map sheet 109e. Near Kg. Semanyir Darat School	VEGETATION Grass & straits Rhodedendram
LAB NO. RS 307	GRID REF. 850204		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Coastal Plain	below 50'	0 - 2 4	good 34"	Negligible	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDA
Ah	6"	0 - 15 cm	dark grey (10YR 4/1)	loamy sand	loose	fine crumb to single grain	abundant grass roots	-	fine quartz grains	-	-	dis.
A	10"	15- 40 cm	Light brownish gray (10YR 6/2)	fine sand	loose	single grain	many roots	-	fine quartz grain	-	-	dis.
Ae	18"	40- 85 cm	light gray (10YR 7/1)	fine sand	loose	single grain	few roots	-	fine quartz grain	-	-	dis.
Bt		85+ cm	black (10YR 4/1)	loamy sand	friable to firm	single grain	-	-	medium quartz grain	-	coffee rock concretion	dis.

SPECIAL FEATURES/NOTES:

Bt. horizon marks the present water-table.

SERIES ESTABLISHED/TENTATIVE: Rudua

PHASE | GROUP

SURVEYOR: H. Smallwood | DATE: 4/10/66

Profile No 7.

55

Revised Edition, December 1964.

PROFILE 7

Origin of sample | Near Kg. Semanyir Darat School. Map sheet 109e. Grid: 850204.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original Sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air-dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	Easily Sol. P N/10 NaOH	Cond. (Mhos x 10-6)	Sulphate meq/100g.	Calcium meq/100g.	Magnesium meq/100g.	Iron Fe_2O_3%
RS 307 T	Ah	0- 6	0	0	22	78	Nil	Nil		5.3		1	3	2.12	1.23	0.07	18	104					
Sa	A	6-16	0	0	21	78	"	"		5.2		1	0.3	0.10	0.06	0.02	3	80					
Sb	Ae	16-34	0	0	33	67	"	"		5.5		1	0.2	0.05	0.03	0	-	72					
Sc	Bt	34+	0	0	23	77	"	"		4.7		1	6	3.47	2.02	0.04	50	140					

	C.E.C. m.eq./100g.	Total Cations	Potassium	Sodium	Calcium	Magnesium	Total K+Ca+Na+Mg	Hydrogen	Percentage Saturation	Ratio
RS 307 T 0- 6	7.03		0.03	0.11	1.44	0.74	2.32		33	
Sa 6-16	0.69		Nil	0.07	0.16	0.12	0.35		50	
Sb 16-34	0.86		"	0.11	0.11	0.13	0.35		41	
34+	23.14		"	0.14	0.27	0.21	0.62		3	

Profile No 7.

PROFILE NO. 8

SOIL DESCRIPTION SHEET

FIELD NO. NJ 23	RAINFALL. 110"+	LOCATION Near forest dept. Access Road 8 approx. 90 ms. Mersing Endau road Map Sheet 118b.	VEGETATION Cut-over secondary jungle
LAB NO. RS 297	GRID REF. 033056		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
dissected peneplain	75' + A.S.L.	6 rolling C3	well drained water table below profile	Nil	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	4"	0 - 10 cm	brown to dark br. (10YR 4/3 - 3/3)	sandy loam	loose to friable	weakly developed crumb	abundant roots some casts and channels	2 P	quartz grains	-	-	dist.
Ae	4"	10- 20 cm	Grayish brown (2.5Y 5/2)	sandy loam to sandy clay loam	friable	weakly developed spherodal granular	many roots some channels	2 P	quartz grains	-	-	dif
AB	7"	20- 38 cm	light yellowish br. (2.5Y 6/4)	sandy clay loam	friable to firm	weakly developed subangular blocky	many roots , some casts and channels	2 P 1 C	quartz grains	-	-	dif
Bt	12"	38- 77 cm	pale yellow (2.5Y 7/4)	sandy clay loam	friable	subangular blocky	many to few roots	2 P 2 C	quartz grains	-	-	dif
BC	23"	77 -125 cm	Light brownish gray (2.5Y 6/2)	clay with grits	firm	subangular blocky	very few roots	1 C 1 P	quartz grains	distinct brownish yellow mottles	some laterised vien quartz	dif

SPECIAL FEATURES/NOTES:

SERIES ESTABLISHED/ TENTATIVE Marang

PHASE

GROUP

SURVEYOR: H. Smallwood

DATE: Aug.25, 1966

Revised Edition, December 1964.

Profile No 8

PROFILE NO. 8

Origin of sample: Near forest dept. Access Rd. 8 approx. 90½ mile stone Mersing Endau road. Map 118b. Grid. 033056.

CLASSIFICATION

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	on original sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	Easily Sol. p.p.m.: P. N/10 NaOH	K N/2 acetic acid	6N HCl Soluble: P. p.p.m.	% Fe_2O_3	K meq./100g.	Ca meq./100g.	Mg meq./100g.
RS 297 T	Ah	0- 4	22	8	44	30	Nil	Nil		4.2		1		3.05	1.77	0.10	18	65	28					
Sa	Ae	4- 8	22	8	46	28	"	"		4.4		1		1.71	0.99	0.05	20	59	20					
Sb	AB	8-15	26	6	50	22	"	"		4.8		1		0.88	0.51	0.03	17	48	10					
Sc	Bt	15-27	34	6	40	24	0.3	"		4.9		1		0.31	0.18	0.03	6	50	10					
Sd	BC	27-50	38	10	34	22	0.5	"		4.8		1		0.21	0.12	0.02	6	48	10					

Soil No.	C.E.C. Meq./100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K+Ca+Na+Mg	Hydrogen	Percentage Saturation	Ratio
RS 297 T	10.04		0.11	0.16	0.23	0.52	1.02		10	
Sa	5.62		0.09	0.16	0.21	0.26	0.72		13	
Sb	6.98		0.06	0.21	0.18	0.16	0.61		9	
Sc	4.77		0.03	0.10	0.30	0.26	0.69		14	
Sd	3.57		0.03	0.21	0.19	0.05	0.48		13	

Profile No 8

PROFILE NO. 9

SOIL DESCRIPTION SHEET

FIELD NO. NJ 18	RAINFALL. 110"+	LOCATION On coastal road at junction of road to P.W.D. quarry. Map sheet 109f Penyabong.	VEGETATION Secondary jungle and belukar
LAB. NO.	GRID REF. 904197		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Small hill dissected peneplain	50 A.S.L.	undulating C2	well drained water table below profile	-	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	6"	0 - 6"	grayish brown (10YR 5/2)	sandy clay loam	loose to v.friable	fine to medium crumb	many roots and channels & Casts	2 P 1 C	quartz grains	-	-	dist.
Ae	16"	6 - 22"	pale olive (5YR 6/3)	sandy clay loam	friable to firm	moderately developed sub-angular blocky	some roots channels & worm and ant casts	2 P 3 C	-	faint grayish	-	diff.
Bi	18"	22 - 40"	light gray to pale yellow (5YR7/2-7/4)	clay loam	firm	medium sub-angular blocky	few roots and some casts	2 P 3 C	some quartz grains	brownish yellow (10YR 6/6)	-	diff.
BC	10"	40 - 50"	light gray to pale yellow (2.5 7/2-7/4)	clay with grits	very firm	blocky	very few roots some casts	1 P 1 C	many angular quartz grains	reddish yellow (7.5YR 6/6)	-	diff.

SPECIAL FEATURES/NOTES:

SERIES ESTABLISHED/TENTATIVE Pohail ?

PHASE

GROUP

SURVEYOR: H. Smallwood

DATE: 23/8/66.

Profile No 9

59

Revised Edition, December 1964.

PROFILE NO. 9

Origin of sample	On coastal road at junction of road to PWD quarry. Map sheet 109F. Penyabong.	CLASSIFICATION

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original Sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	Easily Sol. p.p.m.: P N/10 NaOH	K N/2 Acetic Acid	6N HCl Soluble: P p.p.m.	% Fe_2O_3	K meq/100g.	Ca meq/100g.	Mg meq/100g.
RS 293 T	Ah	0- 6	33	14	44	14	Nil	Nil		4.4		2		3.41	1.98	0.13	15	76	45					
Sa	Ae	6-22	34	13	30	22	"	"		4.6		1		0.83	0.48	0.06	8	72	20					
Sb	Bi	22-40	41	12	32	20	0.9	"		4.7		2		0.47	0.27	0.05	5	64	10					
Sc	BC	40-50	39	12	34	19	0.7	"		4.7		1		0.31	0.18	0.04	5	61	10					

Soil No.	C.E.C. Meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
RS 293 T	13.11		0.16	0.36	0.30	0.68	1.50		11	
Sa	3.98		0.09	0.16	0.21	0.16	0.62		9	
Sb	5.96		0.06	0.16	0.18	0.31	0.71		12	
Sc	5.28		0.06	0.16	0.16	0.16	0.54		10	

Profile No 9

PROFILE NO. 10

SOIL DESCRIPTION SHEET

FIELD NO. NJ 35	RAINFALL. 120 inches	LOCATION Map sheet 118b. Near 92¼ milestone Mersing-Endau road side quarry pit.	VEGETATION Belukar
LAB NO. RS 309	GRID REF. 012077		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Dissected peneplain	about 100ft. A.S.L.	6 - 12 C 3	good 10'	Negligible	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	6"	0 - 15 cm	Yellowish brown (10YR 5/4)	sandy clay loam	friable	medium crumb	abundant grass roots	2 P 1 C	fine quartz grain	-	-	dist.
Ae	12"	15- 45 cm	Brownish yellow (10YR 6/6)	sandy clay loam	friable to firm	granular fine sub-angular blocky	few	2 P 3 C	fine quartz grain	-	-	undist.
Bt	26"	45-110 cm	Yellow (10YR 7/8)	sandy clay	firm	subangular blocky	-	2 P 3 C	fine quartz grain	-	-	dist.
Bcn	36"	110-200 cm	Yellow (10YR 7/8)	clay loam	firm	sub-angular blocky	-		few quartz grain & laterite	-	loose nodular laterite	dist.
C		200+cm	Variegated yellow (10YR 7/8)	clay loam	firm	sub-angular blocky	-	-	few quartz grain	profuse medium prominent red (10YR 4/8)		dist.

SPECIAL FEATURES/NOTES:

Ah - Surface slightly disturbed
Bcn - there occurs some massive laterite below the nodular laterite
C - beginning of parralled zone.

SERIES ESTABLISHED/ TENTATIVE: Bungor

PHASE | GROUP

SURVEYOR: H. Smallwood

DATE: 5/10/66.

Profile No 10

Revised Edition, December 1964.

PROFILE NO. 10

Origin of sample: Near 92½ mile stone Mersing-Endau road, side quarry pit. map sheet 118b. Grid: 012077.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	on original sample: Gravel	Stones	pH: Fresh	Air-dry	Moisture %: Fresh - ov. dry	Air dry ov. dry	Percentages: Loss on Ignition	Organic Matter	Carbon	Nitrogen	C/N Ratio	Easily Sol. p.p.m.: P N/10 NaOH	K N/2 Acetic Acid	6N HCl Soluble: P p.p.m.	% Fe_2O_3	K meq./100g.	Ca meq./100g.	Mg meq./100g.
RS 309 T	Ah	0-6	31	6	26	42	1.5	Nil		4.7		2		2.93	1.70	0.09	19	64	20					
Sa	Ae	6-18	45	4	24	30	2.4	"		4.5		2		0.53	0.31	0.02	16	48	10					
Sb	Bt	18-44	51	4	20	30	0.5	"		4.8		2		0.43	0.25	0.02	13	39	10					
Sc	Bcn	44-80	60	10	2	22	34.6	16.6		5.2		3		0.43	0.25	0.02	13	42	10					
Sd	C	80+	69	15	7	12	1.27	Nil		5.3		2		0.16	0.09	0.01	9	38	10					

Soil No.	C.E.C. Meq./100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K+Ca+Na+Mg.	Hydrogen	Percentage Saturation	Ratio
RS 309 T	10.72		0.06	0.36	0.18	0.41	1.01		9	
Sa	5.45		0.03	0.16	0.14	0.21	0.54		10	
Sb	4.77		Nil	0.10	0.11	0.21	0.42		9	
Sc	5.62		"	0.16	0.14	0.21	0.51		9	
Sd	5.62		"	0.05	0.14	0.31	0.50		9	

Profile No 10

62

SOIL DESCRIPTION SHEET

FIELD NO. NJ # 41	RAINFALL. 110" - 120"	LOCATION 57¼ ms. - Kota Tinggi Jamaluang Road. Map sheet 126c.	VEGETATION Primary Jungle
LAB NO. RU 381	GRID REF. 142560		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Eroded Surface	100'	8° - strongly sloping - C_3	Poor internal drainage	nil.	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ah	0 - 13 cm	A 707	10YR 6/2	sl	mfr	medium crumb	abundant roots	3 P			-	dist.
Ae	13- 32 cm	779	5Y 7/2 - 8/2	scl	mfr	lmsbk	many roots	2 P 1 C		7.8YR 6/8	-	dist.
Bt	32- 80 cm	A 81	5Y 7/2 - 8/2	cl	mfi	strong blocky	few roots, few casts and channels	3 P 1 P	large quartz grains	10YR 7/8	-	dist.
Cg	80+cm	E 97	5Y 8/1	sic	mfi to compact	massive	-	-	quartz grits (many)	10YR 7/8	-	-

SPECIAL FEATURES/NOTES:

This pit has been part of "Operation Bagful" (1964 - 1965).

Profile No 11

SERIES ESTABLISHED/ TENTATIVE	Apek
PHASE	GROUP Podzolic gley
SURVEYOR: H. Smallwood	DATE: 26/2/67.

3

Revised Edition, December 1964.

SOIL DESCRIPTION SHEET

FIELD NO.	RAINFALL 100"+	LOCATION Jalan Tiram Duku 5 ms. to Tiram	VEGETATION Lalang
LAB. NO. RU 32			

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL

HORIZONS SYMBOL	THICK-NESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSIST-ENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUND
	0 - 17	505	10YR 3/4	silty loam	very mfr	3-2 fsbk - fine granular	roots abundant (2cm - 1cm) cast & channel few	2 P clayskin along peds 1 C	nil	nil	nil	ds
	17- 52	506	7.5YR 5/6	sic	mfi - mfr	3.2 f to msbk	roots few (2mm) a lot of ant activity	2 P 2 C	nil	nil	nil	df
	52- 93	507	5YR 5/6	sic	mfr	co sbk breaking to 2-3 fmsbk and fine granular	roots few, casts nil channels few	2 P 2 C clayskin along peds	nil	nil	nil	df
	93-150	508	5YR 5/8	sic	mfr	co sbk breaking to msbk	roots nil a lot of ant activity	clayskin along ped faces	fine qtzs	nil	nil	df

SPECIAL FEATURES/NOTES:

rock specimen available

Profile No. 12

SERIES ESTABLISHED/TENTATIVE Seni

PHASE | GROUP

SURVEYOR: | DATE: 6/4/69

Revised Edition, December 1964.

PROFILE NO. 12

Origin of sample: Jalan Tiram Duku 5 mile stone to Tiram.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original Sample: Gravel	Stones	pH Air-dry: Distilled Water	1N. KCl	Organic Matter	Carbon	Percentages: Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. NaHCO3 Soluble	Loss on Ignition	Easily Sol.: 0.5N CH3 COOH Sol. Potassium p.p.m.	0.1N NaOH Sol. Phosphorus p.p.m.	6N HCl Soluble: Phosphorus p.p.m.	Iron Fe2 O3 %	Potassium meq/100g.	Calcium meq/100g.	Magnesium meq/100g.
RV 32 T		0- 7	60	12	12	18	Nil	Nil	5.0	4.5	4.78	2.78	0.20	14			17	16	74					
	Sa	7-21	74	8	10	13	"	"	4.9	4.4	1.15	0.67	0.07	10			12	4	19					
	Sb	21-37	79	4	8	13	"	"	4.9	4.5	0.41	0.24	0.03	8			11	4	11					
	Sc	37-60	81	4	8	12	"	"	5.1	4.6	0.31	0.18	0.02	9			11	4	8					

	C.E.C. meq./100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
RV 32 T		17.61	0.06	0.27	0.05	0.43	0.81		5	
Sa		10.70	0.01	0.16	0.03	0.30	0.50		5	
Sb		5.76	0.01	0.14	0.03	0.05	0.23		4	
Sc		5.93	0.01	0.11	Nil	0.05	0.17		3	

Profile No 12

PROFILE NO. 13

SOIL DESCRIPTION SHEET

FIELD NO. NJ/3	RAINFALL. 100"+	LOCATION Parit Hj. Salleh near 11 miles Ayer Hitam - Batu Pahat Road. Map sheet 223	VEGETATION Mature Rubber
LAB. NO.	GRID REF. 174856		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
River flood plain	50 ' A.S.L.	Depressional	slow-water table 21/2'	-	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
Ad	0 - 10 cm		brown				root mat on form vegetation, very fibrous					dist.
Ah	10-56 cm		very dark grayish brown 10YR 3/2	Clay	friable	Medium crumb to medium subangular blocky	many fibrous root, some casts, some carbonized roots.	2 P 1 C				diffus
C	56-133 cm		gray 5YR 6/1 to dark bl. gray 5B 4/1 (gley)	Clay	soft	structureless	many roots and stems					diffus

SPECIAL FEATURES/NOTES: Profile is subjected to brackish water conditions with a distinct sulphurous smell. Upper horizon contains a large percentage of highly decomposed organic matter while lower horizon (due to anaerobic conditions) contains considerable partly decomposed organic matter.

SERIES ESTABLISHED/ TENTATIVE: Linau.

PHASE | GROUP

SURVEYOR: | DATE:

Profile No 13

Revised Edition, December 1964.

PROFILE NO. 13. LOCATION: Parit Hj. Salleh milestone Ayer Hitam - Batu Pahat Road.

Depth (ins)	Percentages				pH	Percentages			C/N Ratio	Easily Sol. p.p.m.		C.E.C. m.e./100 g.	Exchangeable Cations m.e./100 g.				Saturation %	6N HCl Soluble				
	Clay	Silt	Fine Sand	Coarse Sand		Loss on Ignition	Carbon	Nitrogen		P N/10 NaOH	K N/2 CH_3COOH		K	Ca	Na	Mg		P (p.p.m.)	Fe_2O_3 %	K m.e./100g	Ca m.e./100g.	Mg m.e./100g.
4-22	56	23	12	1	3.1	14.7	5.01	0.21	23.85	114	33	30.95	0.11	0.10	0.13	0.36	2	400	2.50	4.99	3.36	10.22
22+	60	21	11	2	7.6	21.0	6.80	0.17	40.00	54	45	33.00	0.09	4.58	1.36	17.49	71	130	5.83	7.53	12.80	43.12

PROFILE NO. 14

SOIL DESCRIPTION SHEET

FIELD NO.	RAINFALL. 90 - 100'	LOCATION Parit Lundang	VEGETATION Smallholding
LAB. NO. RV 30	GRID REF.		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
				-	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDARY
	0 - 13	504	10YR 5/2	silty clay	mfr	3fsbk	roots abundant cast and channel few	2 C along 1 C peds	nil	nil	nil	di
	13- 40	502	10YR 6/1 to 6/2	silty clay	mfr	structureless	roots many (0.5mm fine) cast & channel nil	0 C 0 P	nil	fine distinct mottles (many) 2.5YR 4/3 - 10YR 6/8		df
	40-105	144	10YR 6/2	sic	mfi	columnar 11 mm.	few fine root (1mm) cast & channel nil	1 C 0 P		- do - as above	nil	di
	105+	501	Sic 5 BG 6/1	STRUCTURELESS			all nil.			nil		

SPECIAL FEATURES/NOTES:

Profile No 14

SERIES ESTABLISHED/ TENTATIVE Briah.

PHASE GROUP

SURVEYOR: P.S.T.A.H. Klg.

DATE: 6/4/69

68

Revised Edition, December 1964.

PROFILE NO. 14.

Origin of sample	Parit Lundang. Johor. Correlation.																										
			Percentages				On Original Sample		pH Air-dry				Percentages						CLASSIFICATION								
																			Easily Sol.		6N HCl Soluble						
Sample No.	Horizon Symbol	Depth (ins)	Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	Distilled Water	1N K Cl	Organic Matter	Carbon	Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. $NaHCO_3$ Soluble	Loss on Ignition	0.5N CH_3COOH Sol. Potassium p.p.m.	0.1N NaOH Sol. Phosphorus p.p.m.	Phosphorus p.p.m.	Iron Fe_2O_3 %	Potassium meq/100g.	Calcium meq/100g.	Magnesium meq/100g.
RV 30 T		0- 5	62	29	6	Trace	Nil	Nil	4.0	3.5	4.47	2.60	0.25	10			11	100	115					
Sa		5-16	72	23	3	"	"	"	4.3	3.6	1.00	0.58	0.09	6			8	72	47					
Sb		16-42	72	23	4	"	"	"	4.5	3.7	0.74	0.43	0.07	6			7	86	47					
Sc		42+	65	20	8	"	"	"	4.3	4.0	1.36	0.79	0.06	13			7	166	79					

	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
RV 30 T	21.23		0.27	0.32	0.06	1.13	1.78		8	
Sa	18.93		0.19	0.76	0.14	1.22	2.31		12	
Sb	20.16		0.23	0.89	0.16	2.54	3.82		19	
Sc	19.92		0.48	2.30	0.59	8.91	12.28		62	

PROFILE NO. 15

SOIL DESCRIPTION SHEET

FIELD NO. 5	RAINFAL 100"+	LOCATION On the way to Gelang Patah 12 ms. to Johore Bahru.	VEGETATION Belukar
LAB. NO.	GRID REF.		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
	100 ft.	6°		Nil.	

HORIZONS SYMBOL	THICK-NESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSIST-ENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONE & CONCRETIONS	BOUNDAR
	0 - 7	423	7.5YR 4/4	sandy clay	mfr	3 to fine crumb - fsbk	roots abundant (resum) casts and channels many	2 P	-	-	-	dis.
	7 -42	50	7.5YR 5/6	silty clay	mfr	3 - 2 fine to msbk	roots abundants (0-5mm) casts and channels few	2 P 2 C	-	-	-	id.
	42-95	509	5YR 5/8	silty clay	mfr	3-2 fine crumb& fsbk	roots few, casts few, channels many	2 C 2 P	-	-	-	id.
	95-150	254	5YR 5/8	silty clay	mfr	3-2 cosbk to fine crumb	casts and channel few, roots many	2 C 2 P	-	variegated	-	

SPECIAL FEATURES/NOTES: The last horizon (38-60) stiffer than the third horizon (17-38) rock specimen available.

SERIES ESTABLISHED/TENTATIVE Yong Peng.

PHASE | GROUP

SURVEYOR: SSU/Ayer Hitam | DATE: 6/4/69

Revised Edition, December 1964.

Profile No 15

Origin of sample: On the way to Gelang Patah. 12 mile stone to Johore Baharu.

Sample No.	Horizon Symbol	Depth (ins)	Percentages: Clay	Silt	Fine Sand	Coarse Sand	On Original Sample: Gravel	Stones	pH Air-dry: Distilled Water	1N K Cl	Organic Matter	Carbon	Total Nitrogen	C/N Ratio	Ammonium Nitrogen p.p.m.	Nitrate Nitrogen p.p.m. NaHCO3 Soluble	Loss on Ignition	CLASSIFICATION Easily Sol.: 0.5N CH_3COOH Sol. Potassium p.p.m.	0.1N NaOH Sol. Phosphorus p.p.m.	6N HCl Soluble: Phosphorus p.p.m.	Iron Fe_2O_3 %	Potassium meq/100g.	Calcium meq/100g.	Magnesium meq/100g.
RV 31 T		0-3	84	9	5	7	Nil	Nil	4.3	3.8	3.78	2.20	0.16	14			18	28	94					
Sa		3-17	85	7	8	5	"	"	4.6	4.0	1.87	1.09	0.09	12			15	8	38					
Sb		17-38	90	6	5	4	"	"	4.8	4.2	0.89	0.52	0.04	13			14	4	26					
Sc		38-60	87	8	5	5	"	"	4.9	4.3	0.64	0.37	0.04	9			14	4	19					

	C.E.C. meq/100g.	Total Cations	Potassium	Calcium	Sodium	Magnesium	Total K + Ca + Na + Mg	Hydrogen	Percentage Saturation	Ratio
RV 31 T	13.99		0.08	0.24	0.14	0.29	0.73		5	
Sa	10.70		0.02	0.14	0.03	0.08	0.27		3	
Sb	9.05		0.01	0.11	0.03	0.05	0.20		2	
Sc	7.08		0.01	0.16	0.03	0.03	0.23		3	

Profile No 15

PROFILE NO. 16

SOIL DESCRIPTION SHEET

FIELD NO. NJ/39	RAINFALL: 100"+	LOCATION: Near Bukit Jintan, Ayer Hitam, Johore. Map sheet 123.	VEGETATION Secondary Jungle
MAP NO.	GRID REF: 268416		

LANDFORM	ELEVATION	SLOPE AND TERRAIN CLASS	DRAINAGE/WATER TABLE	EROSION	PARENT MATERIAL
Dissected Peneplain (eroded surface)	200 A.S.L.	8 - C_3 Strongly sloping	well drained-water table below profile depth	-	

HORIZONS SYMBOL	THICKNESS	SAMPLE DEPTH & NUMBER	COLOUR	TEXTURE	CONSISTENCE	STRUCTURE	ROOTS, CASTS, CHANNELS, ETC.,	PORES (P) AND CLAYSKINS (C)	IDENTIFIABLE MINERALS	MOTTLES	STONES & CONCRETIONS	BOUNDA
Ah	0 - 13 cm		2.5Y 5/4	sandy clay loam	friable	weak fine crumb	Abundants roots and casts	3 P 1 C				dist
Ae	13- 41 cm		2.5Y 7/6	clay loam	friable not firm	moderate to medium sub-angular blocky	many roots	1 P 1 C				indist.
Bt	41- 69 cm		2.5 7/8	clay	very firm	weak fine sbk		1 P				dist.
Btcn	69-101 cm		10YR 5/8	clay	firm	weak fine sbk	infested with termites	1 P 2 C	some laterite		laterite	indist.
Bc	101-142 cm		10YR 6/6	clay	firm	weak medium and fine sbk	few pores	2 C		many medium distinct red 2.5YR 5/8 mottles		

SPECIAL FEATURES/NOTES:

Profile No 16

SERIES ESTABLISHED/TENTATIVE Kulai.

PHASE | GROUP

SURVEYOR: H. Smallwood DATE:

REVISED EDITION, DECEMBER 1964.

by

LAW WEI MIN
Department of Agriculture
West Malaysia

1. INTRODUCTION

The systematic reconnaissance soil survey of West Malaysia initiated in the early nineteen-fifties was completed by the end of the year 1967. During the progress of the survey, attempts were made to produce soil maps of the country (1, 2, 3) but because of the incomplete coverage, inferences were made using the aid of topographical and geological maps in the areas not surveyed at that time. The 1968 Reconnaissance Soil Map of West Malaysia (4) represents the completed survey. During the same period attempts were also made to classify the soils (1, 5, 6, 7, 8, 9) with earlier attempts dating back to the early years of this century (10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21).

This is an attempt to group the vast array of soils that have been mapped to-date, at soil series level, into Great Soil Groups commonly in use in this part of the world (1, 6, 22, 23, 24, 25, 26). The Great Soil Groups are essentially those of Baldwin et al (27), revised by Thorp & Smith (28). No attempt has been made to follow the new names recommended in the World Soil Resources Report No. 33 (29) so that a general uniformity can be maintained.

This paper is based on the work carried out by the Department of Agriculture, and information has been drawn freely from published and unpublished reports and papers ([redacted]). This paper also represents the final phase of the ambitious project of completing the first ever stock-taking of the soil resources of the country. Information thus gathered has been put to very good use in accelerating the rate of development of agriculture in West Malaysia, with rapid expansion in the acreages of forest lands being cleared for agriculture by the Federal Land Development Authority, other State agencies and private developers.

2. GENERAL ENVIRONMENT

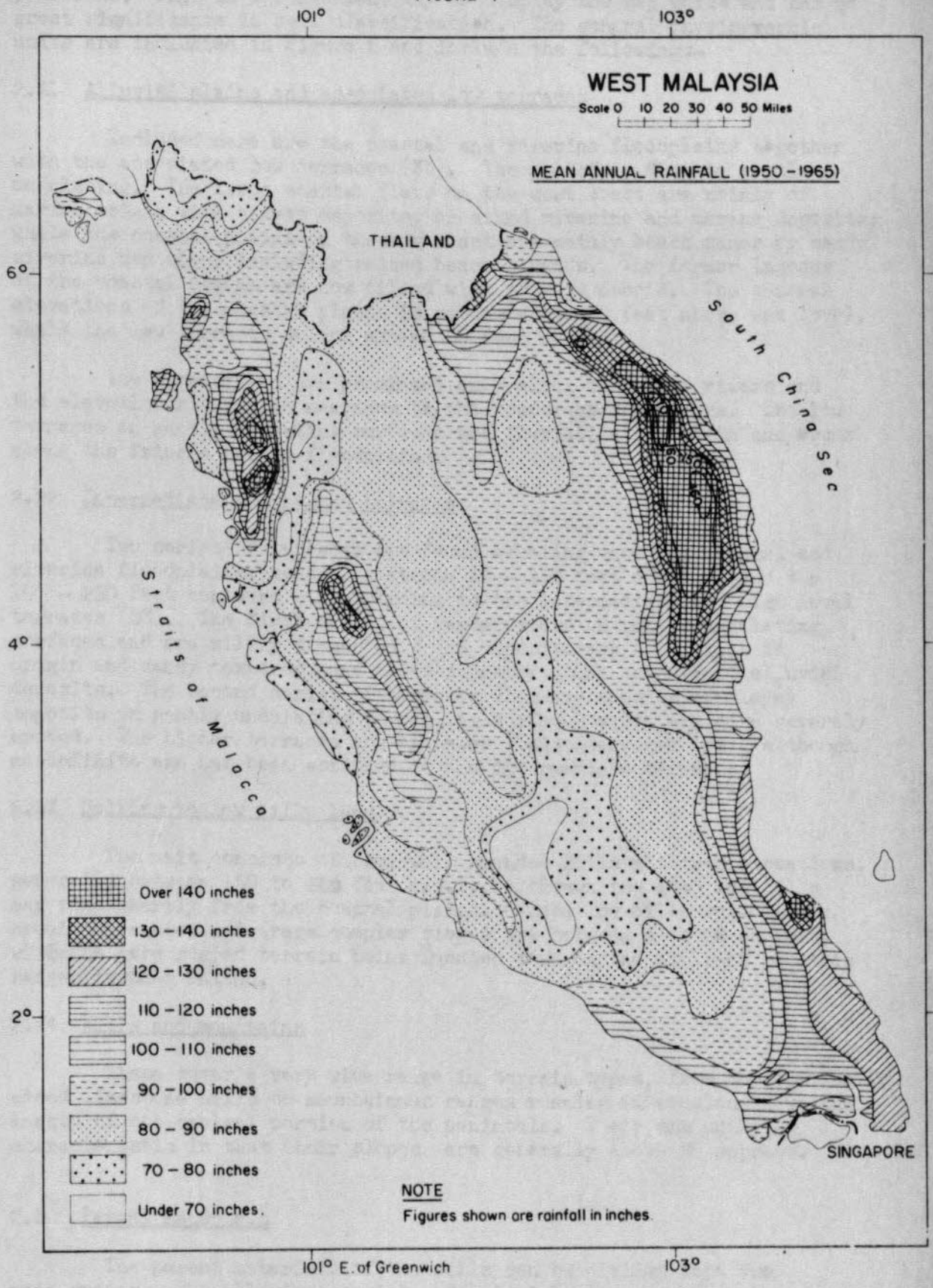
West Malaysia consists of the southern extension of the peninsula from Thailand and covers an area of approximately 50,840 square miles (131,676 square kilometers). The area lies between the latitudes 1° 15' and 6° 45' N. and longitudes 100° 5' and 104° 20' E.

2.1 Climate

The annual mean temperatures in the lowlands (below 500 feet above sea level) is ± 3° F of 80° F., with annual mean humidity at 85% and varying between 55% and 70% by day and rising above 95% by night (30). The mean annual rainfall ranges from below 70 inches to well over 160 inches (31, 32) (Figure 1). "Dry spells" are only experienced in the northeast and northwest, with the rest of the country having a fairly evenly distributed rainfall. The dominant influence of the climate on the soils formed in the country is the intense weathering and leaching, with the majority of soils having low cation exchange capacities, exchangeable cations and base saturation percentages.

.../2

FIGURE I


101°
103°
WEST MALAYSIA
Scale 0 10 20 30 40 50 Miles
MEAN ANNUAL RAINFALL (1950 – 1965)
THAILAND
6°
4°
2°
South China Sea
Straits of Malacca
Over 140 inches
130 – 140 inches
120 – 130 inches
110 – 120 inches
100 – 110 inches
90 – 100 inches
80 – 90 inches
70 – 80 inches
Under 70 inches.
SINGAPORE
NOTE
Figures shown are rainfall in inches.
101° E. of Greenwich
103°

2.2 Physiography

The map units are grouped according to their general physiographic positions. This is a convenient way to display the map units and has no great significance in soil classification. The general physiographic units are indicated in Figure 2 and include the following:-

2.21 Alluvial plains and associated low terraces

Included here are the coastal and riverine floodplains together with the associated low terraces (33). The relief is flat to gently undulating. The large coastal flats on the west coast are mainly of marine origin with clayey deposits, or mixed riverine and marine deposits; while the coastal plains on the east coast are mainly beach sands or sandy riverine deposits, including raised beach strands. The former lagoons of the coastal plains are now filled with organic debris. The general elevations of the coastal plains is seldom above 35 feet above sea level, while the low terraces seldom exceed 50 feet a.s.l.

The floodplains are prominent only along the large rivers and the elevation rises with nearness to the source of the rivers. The low terraces on gently undlating surfaces are fluviatile in origin and occur along the fringes of the floodplains.

2.22 Intermediate and higher terraces

Two series of terraces are found abutting onto the coastal and riverine floodplains, generally at the 20 - 150 feet contours and the 100 - 250 feet contours corresponding to the intermediate and high level terraces (33). The first series of terraces are on gently undulating surfaces and are mildly dissected. The deposits are fluviatile in origin and sandy textured, and older (subrecent) than the recent alluvial deposits. The second series of terraces (higher) consist of clayey deposits on gently undulating to rolling surfaces which are more severely eroded. The higher terraces are of Lower Pleistocene age (34), although no definite age has been assigned to the intermediate terraces.

2.23 Rolling to low hilly land

The unit consists of low, well rounded hills at lower elevations, generally between 150 to 500 feet a.s.l., although isolated low hills may rise sharply from the coastal plains. These low hills seldom form prominent ranges. Average complex slopes are between 6 to 20 degrees, with the more rugged terrain being located towards the hill and mountain ranges further inland.

2.24 Hills and mountains

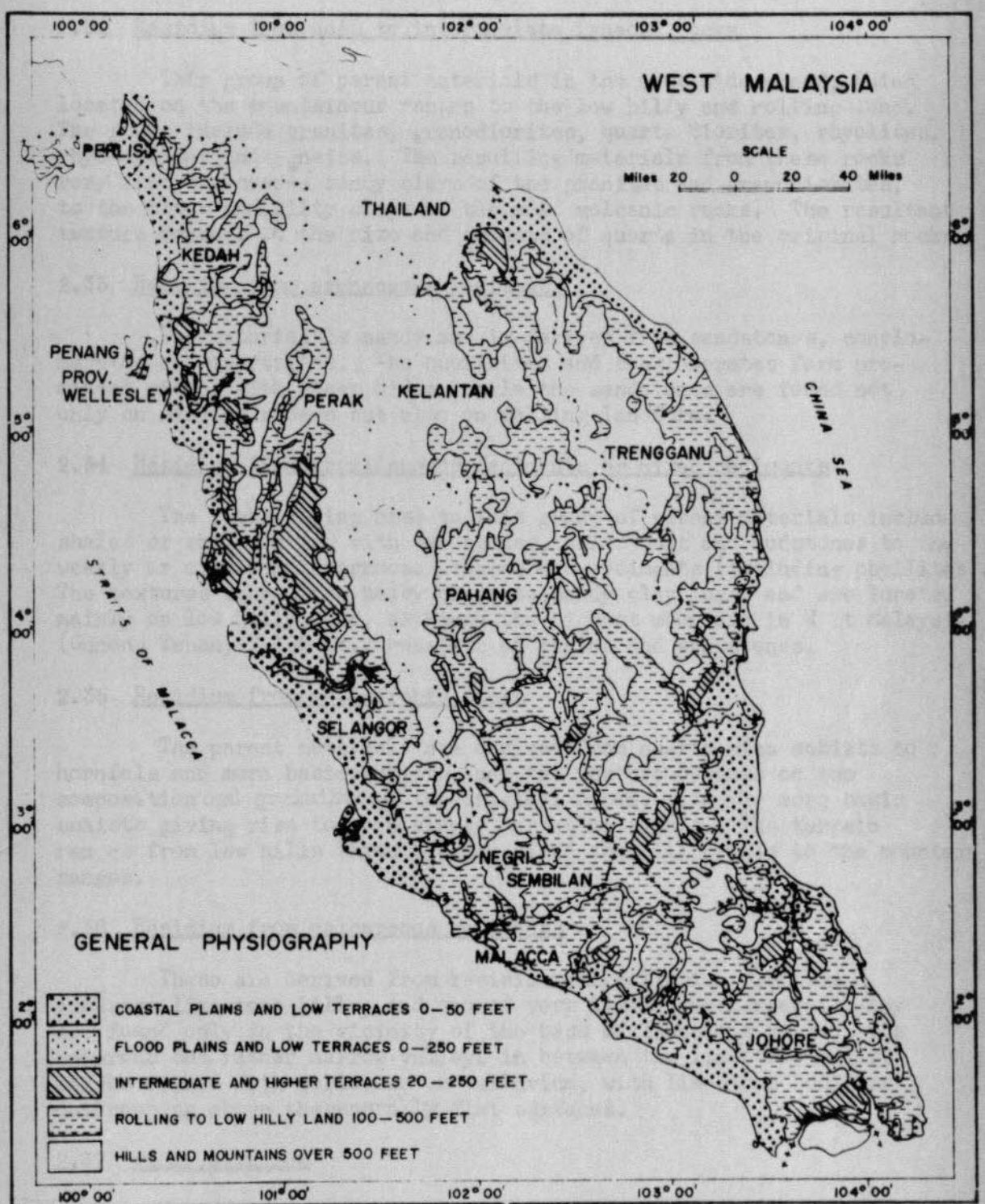
These cover a very wide range in terrain types, from the vertically sided limestone hills to mountainous ranges running in echelons down the length of the central portion of the peninsula. Their one unifying characteristic is that their slopes are generally above 20 degrees.

2.3 Parent materials

The parent materials of the soils can be divided into two main groups. The alluvium consists of materials that has been transported and deposited elsewhere, and the residium (together with colluvium) consists of the weathered mantle overlying the geological

.../3

FIGURE 2


WEST MALAYSIA
SCALE
Miles 20 0 20 40 Miles
100° 00'
101° 00'
102° 00'
103° 00'
104° 00'
6° 00'
5° 00'
4° 00'
3° 00'
2° 00'
PERLIS
KEDAH
THAILAND
PENANG
PROV.
WELLESLEY
PERAK
KELANTAN
TRENGGANU
CHINA SEA
STRAITS OF MALACCA
PAHANG
SELANGOR
NEGRI SEMBILAN
MALACCA
JOHORE
GENERAL PHYSIOGRAPHY
COASTAL PLAINS AND LOW TERRACES 0—50 FEET
FLOOD PLAINS AND LOW TERRACES 0—250 FEET
INTERMEDIATE AND HIGHER TERRACES 20—250 FEET
ROLLING TO LOW HILLY LAND 100—500 FEET
HILLS AND MOUNTAINS OVER 500 FEET

formations. Subdivisions are as follows:-

2.31 Residium from basic and intermediate igneous rocks

The parent materials from these rocks are limited to the rolling to low hilly land and isolated hills. The rocks include basalt, dolorite (and/or gabbro), andesite etc. The materials derived from these rocks are mainly clayey with very little silt and sand.

2.32 Residium from acid to intermediate igneous rocks

This group of parent materials is the most widespread, being located on the mountainous ranges to the low hilly and rolling land. The rocks include granites, granodiorites, quartz diorites, rhyolites, rhyo-dacites and gneiss. The resulting materials from these rocks vary from the coarse sandy clays of the granites and granodiorites, to the clays and silty clays of the acid volcanic rocks. The resultant texture depends on the size and amounts of quartz in the original rocks.

2.33 Residium from arenaceous sediments

The material is sandy and is derived from sandstones, conglomerates and quartzites. The quartzites and conglomerates form prominent ridges with steep sides, while the sandstones are found not only on similar ridges but also on rolling landform.

2.34 Residium from argillaceous sediments or mixed sediments

The rocks giving rise to this group of parent materials include shales or shales mixed with sandstones, siltstones and mudstones to the weakly or mildly metamorphosed shales and sediments (including phyllites). The textures range from heavy clays to sandy clay loams and are located mainly on low hilly land, although the highest mountain in West Malaysia (Gunong Tahan, 7,186 ft.) consists of shales and sandstones.

2.35 Residium from metamorphic rocks

The parent materials are derived from quartz-mica schists to hornfels and more basic schists, and the texture depends on the composition and graininess of the original rocks, with the more basic schists giving rise to more clayey parent materials. The terrain ranges from low hills through steep-sided foothill ranges to the mountain ranges.

2.36 Residium from calcareous sediments

These are derived from residium and colluvium from the numerous limestone hills, and are of very limited occurrence. They are found only in the vicinity of the base of limestone hills; the numerous but rather narrow valleys in between the limestone hills, may be filled with colluvium and alluvium, with limestone boulders outcropping above the generally flat surfaces.

2.37 Older alluvium

The older alluvium is limited to the areas immediately adjacent to the low hills near the coastal areas in the south of the peninsula ; the northeast and certain inland areas, but is generally between the 100 to 250 feet contours (34), although some are located at higher elevations

inland (35). The texture varies widely, ranging from sandy loam to coarse sandy (and/or gravelly and even bouldery) clay. The majority of the older alluvium are in the vicinity of granitic masses although sedimentary provenance cannot be ruled out.

2.38 Subrecent alluvium

The subrecent alluvium is limited in distribution to areas abutting onto the coastal and floodplains. The surfaces are gently undulating and only weakly dissected, and the materials are essentially sandy although the provenance is uncertain.

2.39 Recent alluvium

These sediments are limited to the coastal and fluvial floodplains, and the surfaces of these deposits vary from gently undulating to flat or even depressional. The riverine and marine alluvia dominate these surfaces with lacustrine deposits being of limited occurrence. The fresh water alluvium varies greatly in texture, being sandy on the levees of the rivers and more clayey in the backwater lagoons, especially if it occurs on the larger floodplains. It is even more mixed in smaller floodplains. The marine and brackish water clays are limited to the coastal strip, while the beach sands are generally more common in the east coast. The marine clays which are predominant on the west coast are dominated by montmorillonite (8).

2.4 Vegetation and land use

More than two-thirds of the country is still covered by one of the richest flora in the world. This vast acreage has been diminishing rapidly during the last decade because of rapid agricultural development. Wyatt-Smith (36) has divided the forest into 3 major groups namely:-

I - Lowland (dryland) vegetation
II - Hill and mountain vegetation
III - Swamp and low-lying vegetation.

The lowland vegetation is dominated by Dipterocarp and Shorea species but includes a multitude of species and is limited to elevations below 1000 feet. Above this elevation is the hill and mountain vegetation on the central forest ranges. The vegetation consists of hill, upper Dipterocarp and montane oak going up to 5000 feet, with mountane ericaceous forests above the level. The swamp and low-lying vegetation is dominated by:-

i) marine alluvial (mangrove) swamp forests on the muddy shores, lagoons and estuaries of tidal rivers

ii) fresh-water alluvial swamp forests on semi-permanent to temporarily submerged non-acid fresh water

iii) peat swamp forest evolved in permanently water-logged and anaerobic conditions, with limited species

iv) riparian forests as strips along the estuaries, rivers and streams throughout the country.

.../5

Only broad relationships have been drawn between soils and vegetation types. This is due mainly to the lack of correlation studies on soils and forest types.

Of the one-third of the country which is cultivated, the Present Land Use Survey of the country by interpretation of the complete set of aerial photographs taken in 1966, will bring out the location and acreages of different crops grown in West Malaysia (37, 38, 39, 40, 41). Emphasis has always been on padi cultivation in the lowlying areas, with rubber and oil palm dominating the dryland crops on the upland areas. This pattern is slowly changing with emphasis being shifted to diversification of crops to broaden the economic base of the country. This is possible through related studies on soils and crop performance.

3. SOILS

The soils in West Malaysia have been identified and mapped at the series level in reconnaissance surveys. The main mapping units in these surveys are associations of series, convenient landform units and other groupings. Phases and variants (colour) have also been established. The soils here are grouped at the level of the Great Soil Groups. Brief descriptions of the groups are given and the diagnostic characteristics outlined. Separation into groups is based mainly on physical features of the soils, while the chemical properties are so close that separation is not very effective (26). This emphasizes the intense weathering and leaching processes in the hot, humid environment of this country in which the dominant clay in the soils (apart from the young marine clays) is kaolinite (8).

3.1 Regosols

Regosols are formed on beach and dune sands, along or near the coastline, usually in elongated ridges. There is very little or no profile development apart from the humiferous surface layer resting immediately on the yellowish or brownish sands. The textures vary from fine sand to coarse sand. On the older beach ridges, a weakly developed eluvial horizon is evident beneath the humiferous surface layer. This forms the first stage in the development of the sand podzols which are so prominent on the older raised beaches along the east coast. Regosols may also be found on sandy subrecent deposits. These are loamy sand or sands with no horizon differentiation.

3.2 Alluvial soils

Alluvial soils are developed on recent alluvium deposited by rivers in flat to undulating floodplains and associated low terraces. These soils do not show prominent profile development apart from the humiferous surface layer. Only well drained and imperfectly drained soils on the alluvial deposits are included here.

These soils on recent riverine sediments vary in texture in relation to distance from the river bank, being sandy on levees of larger rivers and clayey in backwater basins. The soils on levees are well drained showing yellowish or brownish colours with mottling only at moderate depths. Those in the basins are generally imperfectly drained with prominent mottling, but no gley layer is found within 20 inches (50 cm) from the surface. Soils on the associated low terraces, especially in the east coast, show a similar sequence as above, the

.../6

better drained members being sited on slightly higher levels, the imperfectly drained members on the lower slopes and the gleyed members in depressions.

3.3 Gley soils

The gley soils are gleyed to varying degrees because of the presence of a high watertable or a perched watertable. Due to reduced conditions, peaty accumulations overlying the mineral layers may be as much as 10 inches thick.

Gley soils are developed in low-lying areas on recent alluvium of bottom lands and basins, marine sediments (mainly clays) and subrecent alluvium. The dominant feature is the presence of the gley horizon indicated by moist colours of low chromas, prominent mottling along root channels or structural faces; or bluish or greyish colours which may change on exposure to air. They gley soils are poorly to very poorly drained for most part of the year. Those on recent alluvium are weakly structured or massive in the subsoils.

Gley soils on the marine alluvium under tidal influence are saline, showing a humiferous surface layer resting on the gleyed clay. Intermixed with these "Saline Gley Soils" are areas of gley soils with high acidity (below pH 3.5) or containing sufficient sulphide compounds (or elemental sulphur) to cause acidification of the soils on oxidation to pH (H_2O) less than 4 within auger depth. These acid sulphate soils are also in large areas in depressions of the coastal plains, in locations which have allowed the accumulations of the required amounts of sulphides.

Drained soils on marine clays show a prominently mottled subsurface layer with well developed fine structures. The underlying B horizon is gleyed with mottles along structural faces. The B horizon is usually strongly developed coarse blocky, and overlies the completely reduced massive, sticky parent clay. The less acid members of the gley soils on marine clays are the most fertile soils in the country, with the clay fraction dominated by montmorillonite. Second generation rubber are still producing very well with minimal fertilizer applications. Oil palm is producing well over 12 tons of fresh fruit bunch a year. The acid members are the acid sulphate soils. These problem soils require special techniques in amelioration to bring them into agricultural production. The best use to which these soils can be put have been found to be wet padi with adequate lime and water control (fresh water).

Gley soils on the subrecent alluvium are poorly drained with weakly developed to massive (and compacted) subsoil horizons. Colours are grey or light yellowish brown, and textures vary from sandy loam to clay.

Separation into Humic Gley and Low Humic Gley soils is possible. Humic gley soils have a dark coloured top layer with organic content of more than 1.5%, and moderate base saturations. This would limit the Humic Gley soils to those on the marine clays along the west coast and in valley bottoms of limestone areas. The Low Humic Gley soils are on the recent alluvium (fresh water and marine) and subrecent alluvium. Texture varies but is generally sandy loam, loam, clay or silty clay. The colours are generally grey or light yellowish brown, with mottling limited to the root channels or ped surfaces. The majority of the soils cultivated with wet padi in flat to low-lying areas are low humic gley soils.

.../7

3.4 Podzols and Groundwater Podzols

These soils are characterized by a bleached Ae* horizon overlying a humus and/or iron B at depths varying from 20 inches to 50 inches from the surface. The best developed podzols are on the old raised beaches along the east coast. These are sandy, and the spodic B varies from a weakly, darkly stained layer to a compacted & well cemented layer.

Podzols are also found on granitic materials above 5000 feet a.s.l. i.e. in mountainous areas. These have a thick layer of mor overlying a distinct, bleached Ae and rests on a darkly stained spodic B. Beneath is the mottled layer.

3.5 Red Yellow Podzolic soils

This group is widely distributed, occurring on undulating to steep terrain. These soils are formed on a wide range of parent materials including acid igneous rocks, sandstones, shales and older alluvium. The Red Yellow Podzolic soils show distinct horizon differentiation. The eluvial A/illuvial B relationship is more distinct in the heavier textured members than in the lighter textured ones. Colours range from yellowish brown to reddish yellow to yellowish red, depending on the parent rocks. Structures in the B horizons vary from weak subangular blocky to strong subangular blocky, and the degree of development of the structure is directly related to the increase in clay content. Consistence is friable in the lighter textured members and firm in the heavier textured members. Laterized fragments of parent rock may occur as a distinct band in the B horizon or overlying the variegated C (plinthite).

3.6 Yellow Grey Podzolic soils

This group is formed mainly on shales, siltstones or interbedded shale and sandstones, although members have been found on rhyolites acid granites and subrecent alluvium. Colours are generally pale yellow to grey. Horizon differentiation is more distinct in the clayey members and less so in the sandier members. The Ae/Bt relationship is not very distinct. The heavy members may not have a very distint textural B and more often than not the B is indicated by darker, stronger or redder colours, with moderate to strong clayskins. Structures are moderate to strong blocky or even prismatic. Consistence is firm to very firm (and compacted) in the subsoils.

3.7 Reddish Brown Lateritic soils

These soils are formed on residial materials from intermediate igneous rocks, shales or schists. The profile is characterized by a weak Ae/Bt horizon sequence, with weak to moderate clayskins. The colours are strong brown to yellowish red or reddish brown. Textures are clay loam to clay; the consistence is friable in the upper portions of the profile and firm at depth.

The soils on intermediate igneous rocks have moderate to strong, medium to fine subangular blocky structures.

---

*Horizon designation as in 'Soil Survey Manual for Malayan Conditions' by M.L. Leamy & W.P. Panton 1966.

The aggregates are stable and in the darker coloured members resemble the stable aggregates of the Latosols. However, with the distinct Bt horizon (8) these soils are put into the group. The soils derived from shales have less well developed and coarser structures, and the aggregates are less stable. Some of the paler coloured soils derived from shales can be grouped with the Red Yellow Podzolic soils.

3.8 Reddish Brown Latosols

These soils are formed on the deeply weathered basalt over rolling to hilly terrain. The profile is deep and uniform, showing very little horizon differentiation. Colours are reddish brown to dark brown. The texture is generally heavy clay, but because of the strong granular and strong medium and fine subangular blocky structures, and friable to very friable consistence, the field texture tends to be loamy. The aggregates are very stable. Pores are abundant. The upper portions of the profile tend to dry out in the drier months. Laterite may be present but generally below 5 feet from the surface and are bouldery. The clay is dominated by kaolinite.

3.9 Red Yellow Latosols

Like the Reddish Brown Latosols, these soils are deep and friable, showing very little horizon differentiation. Colours are generally yellowish red to dark red, although some members may be only strong brown. Textures are clays or heavy clays, and although the top layers may contain less clay than the underlying horizons, no horizon can be designated as a textural B (Bt). Structures are moderate to strong granular, and medium and fine, subangular blocky. Laterite nodules may form a band at depths below 5 feet from the surface. These soils are formed on andesites and mafic schists, over rolling to hilly terrain. Included in this group are the yellowish brown, friable sandy loams to sandy clay loams with weak horizon differentiation developed on subrecent alluvium.

3.10 Laterites

These soils are dominated by the presence of iron-rich concretions and/or nodules and fragments within 20 inches from the surface. The laterite may be massive especially on the upper slopes. The concretions can occur as a distinct band or spread throughout the profile. As a band it is generally more than 20 inches thick. The laterite soils are formed on shales, phyllites and schists on undulating to hilly terrain.

The thin topsoil is friable, brown to greyish brown loam or clay loam, with strong fine structures. The laterite-free subsurface horizon is usually a strong brown to reddish brown clay loam to clay, with moderate medium subangular blocky structures and friable consistence. The laterite concretions constitute more than 50% in weight. It is generally noticed that concretions and nodules occurring in the upper parts of the profile are well rounded and smaller in size compared to those occurring lower down in the profile which are larger and more angular. The variegated clay is beneath the laterite horizon.

3.11 Lithosols

Very little detailed studies have been made of the soils in this group, because of the low agricultural potential. Lithosols are

.../9

generally found on steep to very steep slopes on a very wide range of parent materials. They are usually associated closely with more mature profiles on similar parent materials.

The thin humiferous top layer overlies a very weak or incipient B horizon, which is generally very stony. The C horizon and/or rock is reached within 10 inches from the surface.

The lithosols occur in close associations with the Red Yellow Podzolic soils, Yellow Grey Podzolic soils, Red Yellow Latosols. Lithosols formed on shales and sandstones generally rest on the parent rocks. Those formed on granites and associated rocks have very deeply weathered C horizons even on very steep slopes. Often 'core boulders' are found 'hanging' in the C horizons. Boulders are sometimes found on the surface of these soils.

The colour range is very wide, depending on the parent rock. On acid igneous rocks and sandstones, the colour ranges from yellow, yellowish brown to yellowish red. On shales the colour range is even wider; being pale yellow on iron-poor shales; yellow to strong brown on redder shales and yellowish red to dark red on ferruginous shales; and grey to dark grey on carbonaceous shales. Texture depends on the parent rocks and ranges from sandy loam to clay.

3.12 Organic soils

The organic soils include peats and mucks developed from the organic debris in the low-lying lagoons of the coastal regions. These are mainly woody or forest peats of the wet tropics. Most of the peat are more than 10 feet deep. The peat and mucks are generally very acid and pose special problems to management because of the paucity or non-availability of both major and minor plant nutrients. Once these shortages are corrected the peats and mucks are very good media for shallow rooting crops.

Highland peat has been located in the Cameron Highlands at elevations of above 5,000 feet. These are fibrous peats formed on the debris around the roots of the trees in the montane ericaceous forests.

3.13 Other soils

In addition to the Great Soil Groups outlined above, other soils have also been identified. These are, however, of very limited occurrence and cannot be represented in this map. Among the more important soil groups are:-

3.131 Brown Forest soils

These are juvenile soils formed on residual materials from basic and ultrabasic igneous rocks or calcareous sediments, over hilly to steep terrain. The humiferous top layer overlies the incipient B which has higher clay contents than the underlying C horizon. Colours are either brown or yellowish brown. The A horizon has strong granular structures, but the (B) horizon has weak subangular blocky structures. The pH is generally just above 5, and the base saturation is medium.

.../10

3.132 Red Brown Earths

These soils are formed on residual accumulations of materials formed as a result of weathering of limestones. Hence they are limited to the base of the limestone hills. The red to dark red, friable clay is deep and the moderate fine and medium subangular blocky structures in the textural B may sometimes contain black soft concretions which may be manganese. The terrain is generally undulating, but may also be steep.

4. DESCRIPTION OF THE MAP UNITS

The main mapping units in the reconnaissance soil survey are associations of series and convenient landform units. In these associations the member series may belong to different Great Soil Groups, and although progress was rapid the resultant maps have presented some difficulty in the selection of map units in the Generalized Soil Map. Of necessity, the map units are essentially associations of Great Soil Groups. The name of the unit is taken from the dominant soil group, and the associated soil groups are indicated in the text. In units with the name of two soil groups, the soil pattern is often complex and irregular. When joined by the conjunction 'and' the soil groups are of about equal importance in characterizing the units, otherwise the second name refers to the less dominant soil group. Where necessary additional soil groups associated with these compound units are again indicated in the text.

4.1 Soil of the alluvial plains and low terraces

Unit 1: Regosols and Podzols on beach and dune sands

This unit occurs as a narrow strip of varying width along the whole length of the east coast of the country, with smaller strips along the west coast. The topography is gently undulating. The Regosols are found on the fore beach (yellowish or brownish) or on raised beach ridges (grey to white with the spodic horizon well below 5 feet depth). Podzols are mainly on raised beaches occurring behind the fore beach. The micro-relief consists of low ridges and swales. The Podzols are best developed on the ridges while the depressions are occupied by Groundwater Podzols. Included here are the sands stained with organic matter occurring in depressions with high watertable.

Unit 2: Alluvial soils and Gley soils on recent riverine alluvium

This unit covers the riverine floodplains of the large rivers inland, the coastal plains of the east coast and the coastal plains with mixed or riverine alluvium on the west coast.

The general relief is flat to gently undulating, but micro-relief features has important influence on the soils formed.

In the river valleys, the higher levees are better drained while the lower basins away from the river banks are less well drained. In the upper reaches of the rivers, the basins generally have high watertable. Alluvial soils are found on the levees and better drained sites while Gley soils are located in depressions and smaller river valleys, especially when these valleys are intermittently or permanently waterlogged swamps.

.../11

In the riverine coastal plains, the present day rivers are still depositing materials during floods. The relief is generally gently undulating. Alluvial soils are again found on better drained sites, while the slight depressions are occupied by Gley soils (usually Low Humic Gley soils).

Unit 3: Gley soils with Alluvial soils on recent marine & riverine alluvium, and subrecent alluvium

This unit occurs extensively on the coastal plains on the west coast and to a lesser extent in the estuaries and brackish water regions of the larger rivers in the east coast. The relief is generally flat with only slight depressions.

In the better drained sites of the coastal plains, Alluvial soils are dominant, but the greater portions of these plains consist of Gley soils. Gley soils on the marine alluvium are heavy textured, grey brown or dark grey with mottling along root channels and structural faces; while the Gley soils on the riverine alluvium are yellowish or grey, lighter textured and less prominently mottled.

On the subrecent alluvium, the Gley soils are generally light yellow or light grey, with low organic matter, coarse structured or massive subsoils. These are essentially Low Humic Gley soils.

Unit 3a: Gley soils on marine clays (Saline Gley soils and Acid Sulphate soils)

Along the seaward edge of the coastal plains of the west coast, and the estuaries of the tidal rivers of both the east and west coasts where the vegetation is mangrove swamps, the Gley soils are saline. Intermixed with these 'Saline Gley soils' are Gley soils containing sufficient sulphides to cause acidification of these soils on oxidation to pH less than 4. These are potential acid sulphate soils to distinguish them from those Acid Sulphate soils in which the air-dried samples have pH (H_2O) or less than 3.5. These Acid Sulphate soils occur in depressions of the coastal plains, in large areas on the west coast and in smaller areas on the east coast.

Unit 4: Organic soils and Gley soils

This unit occurs as large areas on the coastal plains, generally occupying the basins on the landward edge. These are swampy depressions situated in most cases just above the sea level. The peats are usually thicker in the centre, becoming shallower towards the edges, with mucks and organic clays at the fringes. This unit can also be found in inland waterlogged river basins, in association with the Gley soils.

4.2 Soils of the intermediate and high terraces

Unit 5: Red Yellow Latosols and Regosols on subrecent alluvium

This unit consists of soils formed on the subrecent alluvial terraces with weakly dissected surfaces. The parent material range from loamy sand to sandy clay loam. Soils on the loamy sand parent material are essentially Regosols with yellow and light yellow brown subsoil colours. Soils on the sandy clay loam parent material has developed a B (oxic?) horizon. The colours in the B horizon are yellowish brown to brownish yellow, and structures are weak subangular

blocky. The low-lying depressions of this terrace are occupied by Gley soils. This unit is quite extensive, occurring just behind the coastal plains along both the east and west coast.

Unit 6: Red Yellow Podzolic soils on older alluvium

This unit is located on undulating to rolling surfaces of the high terraces in the southern end of the peninsular and in the northwest corner. Great difficulty has been experienced in separating these soils from the Red Yellow Podzolic soils on granites at the series level. In the narrow river basins of the high terraces are the Gley soils.

4.3 Soils of the rolling to low hilly land

Unit 7: Yellow-Grey Podzolic soils with Laterites and Red Yellow Podzolic soils on argillaceous & mixed sediments and acid igneous rocks

This unit occurs very extensively on undulating to hilly land, generally on the fringes of the granitic masses or in between these. The soil pattern is very complicated due to the sharp differences in lithology of the argillaceous and mixed sediments over short distances. It is often difficult to separate the dominant soil group out, let alone separating the different soil series in the soil group. The members of this unit occur in close association as sequences(42), each sequence usually containing only a few members closely related together. The Laterites are commonly associated with the dominant soil group especially when the Red Yellow Podzolic soils on argillaceous or mixed sediments are found amongst them. The pattern is further complicated by the occurrence, although in very limited extent, of Reddish Brown Lateritic soils on the argillaceous sediments.

Unit 8: Red Yellow Podzolic soils with Reddish Brown Lateritic soils on acid to intermediate igneous rocks, arenaceous argillaceous and mixed sediments

This unit is one of the most extensive one, stretching down the whole length of the country. The terrain is generally rolling to hilly, and the unit merges into the shallower soils of the steepland. The greater portion of this unit is formed on igneous rocks, in which the pattern is very simple consisting of the dominant soil group over vast acreages. On the sedimentary rocks, however, the pattern is more complicated, due again, to changes in lithology of the sediments over short distances. The dominant soil group on these sediments generally form the low foothills to the massive granite ranges. The Reddish Brown Lateritic soils are associated with the dominant soil group on both igneous and sedimentary rocks.

Unit 9: Reddish Brown Lateritic soils with Red Yellow Podzolic soils on argillaceous, arenaceous and mixed sediments

This unit occurs on the rolling to hilly land of the low foothill ranges to the granite mountains, or on isolated low hills. The dominant soil group is closely associated with the Red Yellow Podzolic soils on arenaceous and mixed sediments. The unit is more widespread on the western side of the main ranges, and to lesser elsewhere.

Unit 10: Reddish Brown Latosols on residual materials from basic igneous rocks (mainly basalts)

This unit is limited to a small area near Kuantan, on basaltic flows over low hills. The area is covered by the deep, friable reddish brown clays, but in the valleys, waterlogged conditions has resulted in greyish colour instead of the reddish brown colour of the well drained members on higher sites.

Unit 11: Red Yellow Latosols on residual materials from intermediate igneous rocks and mafic metamorphic rocks

This unit does not occur in very large acreages in continuous blocks, but as areas spread throughout the central portion of the country in which volcanic activity had been widespread. The soils are well developed on the andesitic flows or tuffs, with smaller areas on the mafic schists. Associated with the soil group are the Reddish Brown Lateritic soils on the ferruginous shales or tuffaceous shales. The terrain is rolling to hilly, and occasionally steep.

Unit 12: Laterites on residual materials from argillaceous sediments and metamorphic rocks

The unit is very widespread in the northwest corner, but elsewhere occurs in close association with other soils, especially the Red Yellow Podzolic and Yellow Grey Podzolic soils and often in a complex pattern. The terrain is generally undulating to hilly.

4.4 Soils of the hills and mountains (steepland)

The steepland complex of the reconnaissance soil survey maps was not examined in detail because of the low potential for normal agricultural development due to steep slopes and severe soil erosion. Information to date, however, indicates that there are more than one soil group in the steepland complex. The terrain ranges slopes with more than 20 degrees to the almost vertical limestone crags. The following map units are inferences based on our present knowledge of these soils and on information from geological and topographical maps.

Unit 13: Red Yellow Podzolic soils with Lithosols on acid to intermediate igneous rocks

This unit is the largest of the steepland complex, occupying all the prominent granite hills and ranges running the length of the country. Weathering is deep seated on most of these granites, expect on very steep slopes and sharp ridges. The Red Yellow Podzolic soils are dominant and these merge into the Lithosols, the surface of which are littered with boulders.

Unit 14: Lithosols and shallow Red Yellow Podzolic soils arenaceous sediments

The arenaceous sediments in the steepland complex occur as prominent parallel ridges or isolated hills with very steep slopes. The soils are generally sandy and colours are yellow, yellowish brown or redder. The dominant soil group is the Lithosols with the shallow Red Yellow Podzolic soils on less steep slopes.

Unit 15: Shallow Red Yellow Podzolic soils and shallow Yellow Grey Podzolic soils with Lithosols on argillaceous and mixed sediments

The argillaceous and mixed sediments in the steepland complex generally occur as foothills to the main granite ranges or as isolated ranges. The foothill ranges consist of hills with short steep slopes and V-shaped gullies, the tops of which are generally concordant or rise gradually into the higher granite ranges. Gunong Tahan consists of a series of ridges risin from a broad base. Very little is known of the soils on Gunong Tahan. The lower slopes of the foothill ranges consist of shallow Red Yellow Pozolic and Yellow Grey Pozolic soils. Lithosols are generally found to occupy the tops of these hills.

Unit 16: Pozols and Lithosols on acid igneous rocks at elevations of above 5,000 feet

This unit occurs on the main range and the granite range on the east, where the highland peat is abundant. The Podzols are formed as a result of the leachate from the acid peat flowing through the siliceous parent material. The peat has accumulated because of the lower temperatures. Where the slopes are too steep for the peat to accumulate, Lithosols are found on the siliceous parent material.

Unit 17: Lithosols on limestone crags

Where the limestone is not pure, the resultant landform due to subaerial erosion tend to approach the roundness characteristic of the topography of non-calcareous rocks. Pure limestone hills however are usually vertically sided. The relatively rounded limestone hills are covered with denser vegetation on lithosols, while the vertically ided hills have very sparse vegetation on very little soil.

ACKNOWLEDGEMENTS

The permission of the Director of Agriculture, West Malaysia, to prepare this paper and the accompanying map for presentation is gratefully acknowledged. Grateful thanks are due to my colleagues Messrs. Ignatius Wong Fen Thau and K. Selvadurai for valuable discussions and comments, and to the staff of the Soil Science Division for the help rendered.

REFERENCES

1. Panten, W.P., "The 1962 Soil Map of Malaya", Jour. Trop. Geog. Vol. 18, 1964. pp. 118-124.

2. Ng Siew Kee, "Soils in The Oil Palm in Malaya". 2nd Ed. Min. of Agri. & Co-opt. Malaysia. 1966. pp. 164.

3. Ng Siew Kee, "Soil Resources in West Malaysia" Second Sym. on Sci. & Tech. Res. in Malaysia and Singapore, Uni. of Malaya, K.L. 1967.

4. Law Wei Min & Selvadurai, K, "The 1968 Reconnaissance Soil Map of Malaya" Proc. 3rd. Malaysian Soil Conf., Kuching, 1968. pp. 229-237.

5. Owen, G, "A Provisional Classification of Malayan Soils" Jour. of Soil Sci., Vol. 2, 1951. pp. 20-42.

6. Leamy, M.L., "Soil Classification in Malaya" Proc. 2nd. Malaysian Soil Conf., K.L. 1966. pp. 79-84.

7. Leamy, M.L., "Proposals for a Technical Classification of Malayan Soils" Malayan Soil Survey Report No. 3/1966, Division of Agric., K.L. pp. 62.

8. Ng Siew Kee, "Laboratory Data and Classification of Malayan Soils" Proc. 2nd Malaysian Soil Conf., K.L. 1966. pp. 93-97.

9. Joseph, K.T., "A Scheme for the Classification of Malayan Soils" Proc. 2nd. Malaysian Soil Conf., K.L. 1966, pp. 86-92.

10. Akhurst, G.G. and Haines, W.B. "Descriptions of Soils at the Rubber Research Institute Experimental Station" Jour. of the R.R.I.M., Vol. 3, 1931. pp. 174-181.

11. Barrowcliff, M., "Malayan Rubber and Coconut Soils" M.A.J., Vol. 2, 1931. pp. 328-337.

12. Belgrave, W.N.C., "General considerations on a Soil Survey of Malaya" M.A.J. Vol. 17, 1929. pp. 175-178.

13. Dennett, J.H., "Preliminary results of a soil survey in Selangor" M.A.J. Vol. 17, 1929. pp. 179-187.

14. Dennett, J.H., "The Soils of Cameron Highlands" M.A.J., Vol. 18, 1930. pp. 20-29.

15. Dennett, J.H., "The western coastal alluvial Soils" M.A.J., Vol. 20, 1932. pp. 347-361.

16. Grantham, J., "Some Johore Soils" M.A.J., Vol. 4, 1915. pp. 114-121.

17. " " "Some soils from the Kuala Pilah and Jelubu Districts", M.A.J., Vol. 4, 1915, pp. 243-247.

18. " " "Soils of the Sabak District on the Bernam River", M.A.J., Vol. 4, 1915. pp. 298-300.

19. Greenstreet, V.R., "Report on the Soils of Lubok Temang and Cameron Highlands" M.A.J., Vol.10, 1922. pp. 281-283.

20. Hamilton, R.A., "Notes on tropical soils with special reference to Malayan soils for rubber cultivation" Jour. R.R.I.M., Vol. 7, 1936. pp. 27-45.

21. Savage, H.E. and Wilshaw, R.G.H., "An examination of the geology and soils of an area in the State of Perak" Dept. of Agric. Sci. Series, No. 10, 1932.

22. Dudal, R. and Moorman, F.R., "Major Soils of South-east Asia" Jour. Trop. Geog., Vol. 18, 1964. pp. 54-80.

23. Soil Survey Staff, "A Classification of Sarawak Soils" Dept. of Agri. Sarawak, 1966. pp. 45.

24. Thomas, P., and Allen, A.W., "A Provisional Soil Map of Sabah" Dept. of Agric, Sabah, 1966. pp. 30.

25 Moorman, F.R. and Rojanasoonthon, S., "Soils of Thailand "Soil Survey Report No. 72, Min. of National Development. Bangkok, 1968. pp. 43.

26. Ng Siew Kee and Law Wei Min "Pedogenisis and Soil Fertility in West Malaysia" Paper presented at the Bandung Conf. on Tropical Weathring, 1969.

27. Baldwin, M., Kellog, C.E. & Thorp, J., "Soil Classification" in Soils and Man. Year Book of Agriculture, U.S.D.A. 1938. pp. 979-1001.

28. Thorp, J. & Smith, G.D., "Higher Categories of Soil Classification: Order, Suborder and Great Soil Group" Soil Sci., Vol. 67, 1949. pp. 117-126.

29. FAO/UNESO World Soil Resources Report No: 33, "Definitions of Soil Units for the Soil Map of the World" 1968. pp. 72.

30. Dale, W.L., "Surface Temperatures in Malaya" Jour. Trop. Geog., Vol.17, 1962. pp. 57-71.

31. Dale, W.L., "The Rainfall of Malaya, Part I" Jour. Trop. Geog., Vol. 13, 1959. pp. 23-37.

32. Drainage and Irrigation Department, "Rainfall Data 1950-1965" Min. of Agric. & Co-opt. K.L. pp.

33. Gopinathan, B., "Terrace and Alluvial Soils in West Malaysia" Proc. 3rd Malaysian Soil Conf., Kuching, 1968. pp. 45-49.

34. Burton, C.K., "The older Alluvium of Johore and Singapore" Jour. Trop. Geog., Vol. 18, 1964. pp. 30-42.

35. Law Wei Min, "Reconnaissance Soil Survey of the Raub-Temerloh : Jerantat . Region" Malayan Soil Survey Report 2 /1967. Dept. of Agric. K.L.

36. Wyatt-Smith, J., "A Preliminary Vegetation Map of Malaya with Descriptions of Vegetation Types" Jour. Trop. Geog. Vol. 18, 1964. pp. 200-213.

37. Donaldson, R.D., "The Present Land Use of Malacca" Present Land Use Report No:1, Dept. of Agric., K.L. 1968. pp. 1-11.

38. Donaldson, R.D. & Siew Kam Yew, "The Present Land Use of Negeri Sembilan", PLUR No:2, Dept. of Agric., K.L. 1968. pp. 1-15.

39. Siew Kam Yew, "The Present Land Use of Penang/Province Wellesley" PLUR No:3, Dept. of Agric. K.L. 1969. pp. 1-14.

40. Wong, I.F.T., "The Present Land Use of Selangor" PLUR No: 4, Dept. of Agric., 1969. pp. 1-13.

41. Wong, I.F.T., "The Present Land Use of Johore" PLUR No:5, Dept. of Agric. 1969. pp. 1-18.

42. Law Wei Min & Leamy, M.L., "Factors involved in the Genesis of some shale derived Soils in Malaya" Proc. 2nd Malaysian Soil Conf. K.L. pp. 104-111.

N.B.

M.A.J. - Malayan (Malaysian) Agricultural Journal
PLUR - Present Land Use Report

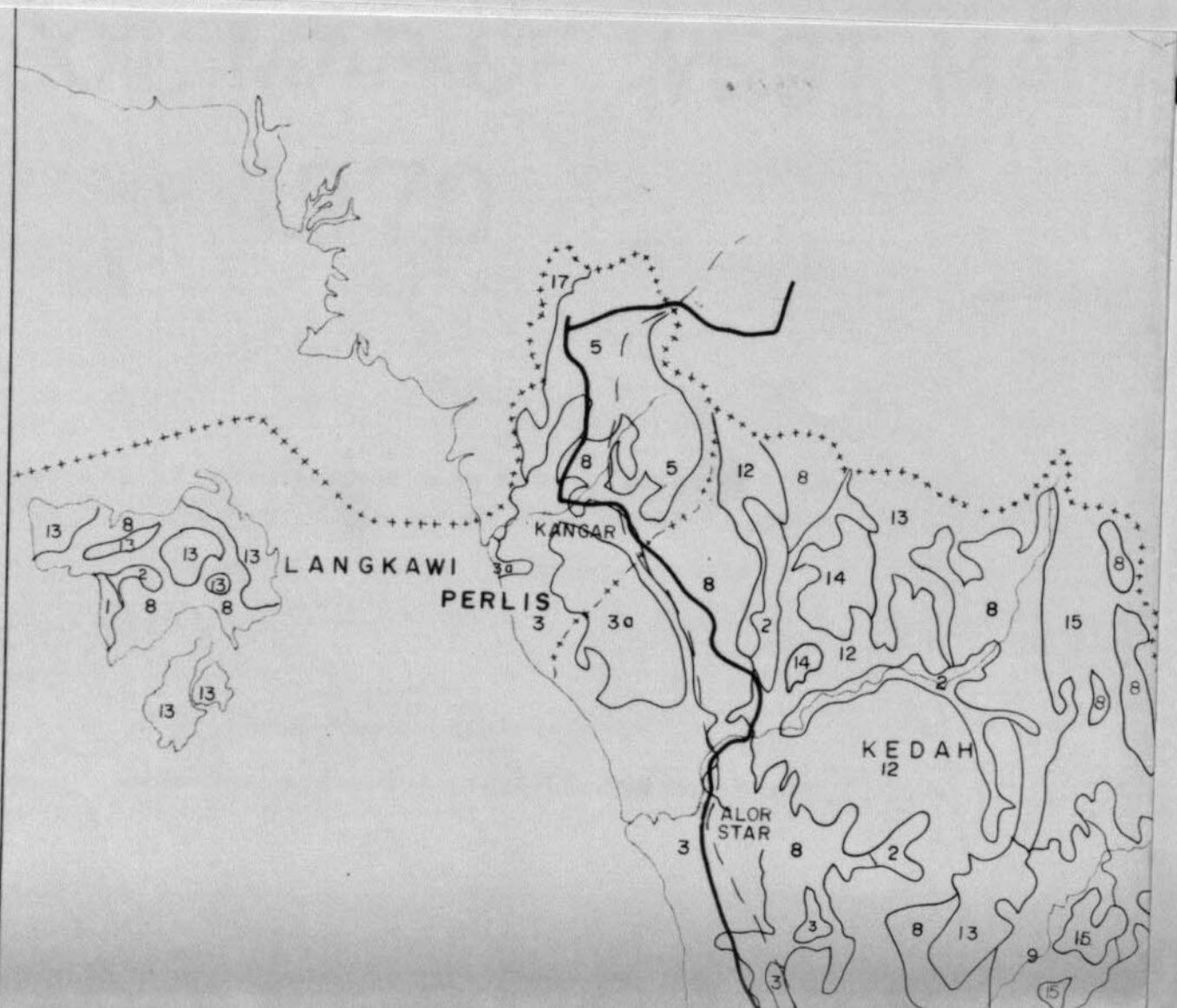
103° 00'

104° 00'

7° 00'

6° 00'

YSIA



(b)	Tapioca, whole plants	208
	Tapioca (tubers)	42
(c)	Sorghum leaves	94
(d)	Sugar cane (whole plant)	28
(e)	Tobacco (whole plant)	4
(f)	Ginger (whole plant)	2
(g)	Tapioca leaves	28
(h)	Sugar cane leaves	30
(i)	Egg plant (fruit)	46
	Egg plant (whole plant)	48
(j)	Coffee leaves	12
(k)	Coconut leaves	13
(l)	Chilli (whole plants)	33
(m)	Maize (whole plants)	28
(n)	Groundnut leaves	2
13.	Sweet corn.	4
14.	Palm oil	3
	Total:	2045

(3) Research on Analytical methods

(a) Extractable per cent of tapioca starch

The estimation of extractable starch per cent from wet tapioca tubers was made. It was noted that the results of chemical determination of starch bears little relationship to the factory extractable amount of starch from the wet tubers. Thus in this determination, the tubers after being weighed as fresh weight, are washed, peeled and macerated to form a paste. The starch grains are dispersed in water, and then squeezed out with muslin cloth. The hampas is recovered and washed once more to extract the remaining starch. Starch grains settle on standing and this is then recovered. The first preliminary results of a few varieties were as follows:-

Varieties	Unnamed	Berat	Kekabu	B. Twig
% dry starch	13.6	17.1	18.0	13.8
% dry hampass	9.4	11.2	9.5	9.6

It is generally seen that extractable starch is in the vicinity of 15%, with 10% hampas. Moisture constitutes 75% of the fresh weight.

A second set of analysis gave the following results:-

	Varieties and age	% moisture	% ODB starch chemical	% as fresh starch chemical	% extractable dry starch on fresh tubers
1.	Green twig 11 months	60.1	82.2	32.8	10.3
2.	Black twig 11 months	61.3	80.3	31.1	15.6
3.	Black twig 18 months	56.1	87.3	38.3	19.4
4.	Jurai 11 months	58.3	82.3	34.3	14.5
5.	Medan 11 months	57.3	85.3	36.4	16.7
6.	Medan 18 months	57.0	87.6	37.3	16.1

Figures on the last column indicate how much dry starch can be obtained from a pikul of harvested fresh tubers. It is noted that for some varieties extractable starch content increases with age of tubers. Generally speaking when young the tubers have higher content of moisture. The dry hampass is in the order of 11-15% on fresh tubers. The peelings and soluble materials are about 12% on the fresh weight.

In determinations of the % of extractable starch about 2 to 3 kilograms of fresh tubers were used and this would mean spending a lot of time for one particular determination. Work was carried out to determine whether it is possible to use smaller weights of the fresh tubers for the determination. The results are tabulated below:-

	Weight of fresh tubers (in grams)	% of extractable starch on fresh tubers (Values are mean of 3 determinations)
(i)	100	9.0
(ii)	200	9.3
(iii)	500	8.9
(iv)	1000	9.1
(v)	1500	8.3

The small variations of the % of extractable starch when 100, 200, 500 and 1000 gms. of fresh tubers are used are within experimental errors but however it is suprising that the % when 1500 gm. of fresh tubers are used is lower than the rest. When too small a weight of fresh tubers is used sampling is very important and also small experimental errors will cause large differences in the final % of extractable starch. Since the usual procedure is to do a single determination for a particular sample a reasonable weight of fresh tubers for the determination would be 500 or 1000 gms. Further work is being carried out to determine whether drying of the tubers prior to extraction of starch will affect the % of extractable starch.

(b) Essential Oil

A sample of sandal-wood was received and the essential oil was extracted by steam distillation. Much difficulty was encountered in its recovery. It was found that the wood contained 1.5% of steam-distillable essential oil. This is rather low but since the amount of sample was small, the figure was not reliable.

Two more samples of sandalwood were submitted for determination of their oil content. The results were as follows:-

	A	B
Moisture%	7.4	9.4
Oil content as received%	1.3	2.7
Oil content on dry basis %	1.4	3.0

(c) Oil of Lemmon Grass

Lemmon grass oil was extracted by steam distillation from fresh lemmongrass grown in the glass house. The grass was first cut into lengths of about 4 inches. The oil thus obtained was analysed and some results are given below:-

	% Moisture in grass	% Oil extracted O.D.B.
1.	77	0.69
2.	78	0.31
3.	79.6	0.68

Physical properties of the oil:

Density	0.904 g/ml
Solubility	1.5 vols 70% alcohol
Rotation (α)	-1°
Colour	Yellowish orange

The % of oil extracted was low as expected. The density, angle of rotation and colour agree well with published values. The solubility of the oil in 1.5 volumes of 70% alcohol indicates that the oil is of the East Indian (Cymbopogon flexuosus) type. The most important uses of the oil are for the production of citral and ionones for flavours and perfume. A little is used in soaps and detergents, although the demand is increasing, it faces increasing competition from synthetic citral.

(d) Total sugar of sweet corn.

The % of sugar in sweet corn varies around 3% and this is too low to be determined using the Lane & Eynon Method. To overcome this difficulty a known amount of sucrose solution was added to the 'prepared sweet corn solution' before the whole solution was hydrolysed with acid. The total inverted sugar minus the inverted sugar from sucrose gives the inverted sugar from the sweet corn. Results of 3 different samples of sweet corn from Tanjong Karang are as follows:-

	Sweet corn variety	% moisture	% reducing sugar as received	% reducing sugar O.D.B.
(i)	American Cream	11.3	2.3	2.5
(ii)	from Tanjong Karang	10.2	3.3	3.7
(iii)	Stawaian Sugar	11.2	3.5	4.0

(e) Aflatoxin Assay

The method of aflatoxin assay has been re-examined and a quicker, simpler procedure has been worked out using TLC (thin layer chromatography) instead of paper chromatography. This will enable the detection of much smaller quantities of the toxin with more reliable accuracy. Level below 0.1 p.p.m. can be assayed.

(f) Arsenic determination

The Gutzeit's method of arsenic determination was reviewed. This method may be regarded as an estimation rather than a determination since it depends on the evaluation of the intensity of a stain on the test paper. The Molybdenum Blue method was investigated using a sample of mining sand. Its reliability and reproducibility is under study.

(4) (a) Peat fertiliser preparation

Further attempt was made to mix peat with CIRP and Nitrophoska. 10 kg. air dry peat was mixed with 500 g CIRP, 1 kg. 12:12:17:2:T nitrophoska, and 400 ml ammonia 5% solution. After treatment and mixing, the mixture was poured out and exposed. Almost immediately the difficulty in proper mixing was observed. The fertiliser remained in fairly large granules; the dispersal of ammonia solution was difficult. Before treatment pH was 3.55 and conductivity 168 mhos x 10^{-6}, moisture content was 40% and yet the peat felt dry.

After keeping the mixture for almost 3 weeks, 6 samples were made and these were analysed.

Number	1	2	3	4	5	6
Moisture %	18.9	20.2	19,8	20.3	19.1	20.4
Air dry pH Air dry	4.05	4.0	4.1	4.0	4.0	4.15
Conductivity 10^{-6} mhos	13860	13440	13060	13720	13300	13580
C % ODB	36.0	36.8	38.6	37.8	36.3	37.8
N % ODB	2.90	2.91	3.01	2.87	3.02	2.95
C/N ratio	12.4	12.6	12.8	13.2	12.0	12.8
Available P % ODB	0.73	0.81	0.46	0.49	0.26	0.74
Total P % ODB	1.11	1.06	1.09	1.09	1.26	1.19
Available K % ODB	1.29	1.44	1.34	1.26	1.45	1.34
Total K % ODB	1.62	1.53	1.53	1.65	1.63	1.68

A close look at the NPK figures and C/N ratio shows that though mixing is difficult, the final mixture did show improvement. N-content can yet be increased to the comparable level of prawn-dust which has 6-7%N. More work is being done on this.

(b) Liming of Peat

Application of limestone powder on prepared peat was made to determine the dosage required in bringing up pH to a suitable level before it is used for fertiliser mixture. Originally the pH was 3.55 and moisture content was 35%. The following readings were observed:-

Dosage	pH
0.25 g	3.80
0.50	4.00
0.75	4.10
1.00	4.25
1.25	4.45

Dosage was applied to 50 g peat and readings were made 1 day after treatment. It was seen 1% limestone powder has brought the pH to 4.0. This dosage is expected to vary for different types of peat with different moisture content.

(5) Peat (Pot Tests)

(a) Sulphur deficiency

The test whether sulphur containing fertilisers were required on peat with maize as a test plant was continued in pots. The results of the harvest of maize grain was as follows:-

Treatment	Pot Nos.	Yield in gms.	Total
With sulphate	1, 2, 3.	331	615
	4, 5, 6.	284	
Without sulphate	7, 8, 9,	276	522
	10, 11, 12.	246	

(b) Boron deficiency

The test with okra as a boron deficiency indicator plant was continued. Symptoms of boron deficiency were produced. In the same test plants to which no copper were added grew to about 6 to 7 inches and then died. The average yields of fresh pods of okra for the various treatments and the amount of boron in the vegetative tissues are as follows:-

Treatment	Yield of pods gms.	p.p.m. B in leaves
Control	165	35
-B	18	8
-Mo	135	25
-Zn	127	32
-Cu	0	-
15:15:15	252	30
12:12:17:2+T	328	61

It does appear from the analysis that the amount of boron applied could be increased.

(c) Tapioca deficiency symptoms

The test to study tapioca deficiency symptoms in pots is being continued and at present the following symptoms are being shown:-

-N	Very poor, older leaves yellow turning light red and premature death.
-P	Older leaves dying, yellowing near the midribs.
-K	Symptoms very similar to those of -P
-L*	No leaf symptoms but plants generally smaller in size.
-Copper	Plants are very stunted, stalk thin, leaves yellow and dying especially younger leaves.

L* = Lime

(d) Sugarcane deficiency symptoms

The test to study sugarcane deficiency symptoms is being continued with the ratoon. In the first crop some of the deficiency symptoms were not clear but in the ratoon most of the symptoms have shown up and are as follows:-

-N	All leaves have light yellow colour and have very few tillers.
-P	Leaves are dark green, very narrow and stalks are very thin, tillering is almost normal.
-K	Tillers are normal but very thin, premature death of leaves.
-L	Some plants had yellow leaves in the younger stage. Plants are smaller than control but no marked symptoms.
-Copper	Leaves are broad but soft with yellow stripes. The stalks do not develop properly as a result plants look very short and are covered with droeping leaves.

The analysis of the 1st. crop in this test has been completed and the results are as follows:-

Treat-ment	Yield of cane gms.	Yield of leaves gms.	% nutrient in leaves				
			N	P	K	Ca	Mg
Control	331	334	1.17	0.23	0.96	0.20	0.30
-N	130	144	0.53	0.31	1.24	0.21	0.18
-P	203	242	0.86	0.07	1.30	0.16	0.20
-K	158	261	1.32	0.27	0.48	0.32	0.38
-L	138	304	1.24	0.21	0.98	0.16	0.23
-Cu	105	225	1.19	0.23	1.06	0.21	0.28

It can be seen from the results that the lack of copper on peat reduces the yield of cane more than the lack of any other nutrients.

(e) Tobacco

Tobacco was grown on used peat with the addition of nitrophoska blue special, 5 gms per plant at planting and once every month and 0.5 gms of urea every 2 weeks. Twice, thrice and four times the quantity of fertiliser was also tried with all treatments receiving 20 ml of 1 percent copper sulphate solution and 5 gms of C.I.R.P. at planting. The pH was 4.6. Initial growth was better with the lower fertiliser addition but later the higher fertiliser plants caught up and surpassed. The leaves were analysed and the results are as follows:-

Treat-ment	Fresh wt. in gms./plant		% Nutrients in tobacco leaf				
	Stem	Leaf	N	P	K	Ca	MG
F1	362	383	2.28	0.65	2.50	1.04	0.61
F2	427	497	2.97	0.80	3.18	1.08	0.60
F3	493	750	3.02	0.82	3.62	1.05	0.60
F4	548	955	3.52	0.87	3.59	1.09	0.66

(f) Analysis of peat

Sample of peat from pots in which sorghum was grown for the production of deficiency symptoms was analysed after the harvesting of the crop. The results were as follows:-

Treat-ment		p.p.m. on dry peat		
		N	P	K
Control	Available	-	232	567
	Total	1.33	491	642
-N	Available	-	133	686
	Total	1.36	660	781
-P	Available	-	48	923
	Total	1.35	347	1092
-K	Available	-	136	109
	Total	1.37	596	186

It appears from the results that analysis of available P, available or total K could be used as a means of determining fertiliser requirement on peat. Total N is the same in all cases and may be due to the fact that there is no residual N after harvest.

(g) pH and crops on peat

Jalan Kebun peat was limed with various amounts of limestone powder and maize, sorghum, okra, cowpeas, groundnuts and soya bean were planted after the addition of Nitrophoska Blue special fertiliser. The result of this test are as follows:-

	pH				
	4.1-4.5	4.6-5.0	5.1-5.5	5.6-6.0	6.1
Maize	Dead	Dead	2 lb. 5 oz.	3 lb. 5 oz.	3 lb. 0 oz.
Sorghum	"	"	1 lb. 10 oz.	1 lb. 13 oz.	1 lb. 14 oz.
Okra	"	6 oz.	2 lb. 2 oz.	3 lb. 13 oz.	3 lb. 11 oz.
Cowpeas	"	3 oz.	3 oz.	3 oz.	4 oz.
Groundnuts	13 oz.	13 oz.	1 lb. 0 oz.	1 lb. 8 oz.	1 lb. 5 oz.
Soya bean	6 oz.	6 oz.	10 oz.	13 oz.	15 oz.

Maize and sorghum for fresh weight per whole plant.
Okra - Fresh pod weight.
Cowpeas - Sundried pod weight per plant.
Soya bean - Sundried weight per whole plant.

The test is being continued with other crops like chillies, egg plant, spinach, broccoli, ginger and chinese white cabbage as well as tapioca.

(6) Peat (Field tests)

(A) Maize

(a) Varietal

A varietal trial with three different varieties of maize that is UPCA(1), UPCA(11) from the Philippines and Metro was conducted at the Tanjong Karang peat station. Yields were poor and this could have been due to the unfavourable weather and water table at that time. The yield of grain was as follows:-

	Yield in lbs/ac.		
Block	UPCA(1) Yellow	UPCA(11) White	Metro
I	3177	2471	2537
II	2764	4206	2818
III	2551	2604	2143
IV	3191	2471	3779
Average	2921	2938	2819

This test confirmed previous results in that there is not much difference between the UPCA varieties and Metro.

(b) Time of planting trial.

Monthly planting of maize variety metro during 1969 gave the following results:-

Planting date	Harvesting date	Yield of dry grain lbs/ac. /1	/2	Average
10.10.68	10. 1.69	1914	2875	2394
10.11.68	13. 2.69	4176	4471	4323
10.12.68	27. 3.69	2784	2924	2854
10. 1.69	21. 4.69	2778	2795	2786
10. 2.69	12. 5.69	3080	3366	3223
10. 3.69	18. 6.69	2591	2638	2614
10. 4.69	21. 7.69	2344	1984	2154
10. 5.69	16. 8.69	3257	2414	2836
10. 6.69	22. 9.69	2738	2939	2834
10. 7.69	16.10.69	2437	2924	2680
10. 8.69	20.11.69	3577	3628	3602
10. 9.69	20.12.69	3193	2783	2988
	Average:	2906	2978	2942

There did not appear to be any relationship between yield and rainfall. Some crop was poor due to severe attack of Helminthosporium leaf spot. High water table due to the planting of padi in adjacent areas had probably some influence on the yield. The difference of yield due to liming at the rate 1.5 tons and 4.5 tons of ground magnesium limestone per acre appears to be negligible.

Samples of plants were taken to study the uptake of nutrients by maize. It was found that for every 1000 lbs of dry maize grain 1290 lbs of stem, leaves, cob sheath etc. were involved. The amount of nutrients taken out for every 1000 lbs of dry grain produced is as follows:-

	Nutrients in lbs. for 1000 lbs dry grain				
	N	P_2O_5	K_2O	CaO	MgO
Grain	15.9	7.34	4.42	0.20	2.1
Stem etc.	7.7	6.32	19.17	3.11	4.6
Total	23.6	13.66	23.59	3.31	6.7

It would be noticed that there is high amount of nitrogen in the grain which is removed while the potash is largely in the stem and leaves and remains behind in the residues.

(c) 3x3x3 factorial fertiliser trial

Harvesting of maize crops on two sets of fertiliser factorial trial on Field 5 and Field 15 was done twice during the year. Crops were poor at both times partly due to leaf spotting, heavy rains and high water table. In the crop that was harvested in April the summarised results for field 5 and 15 (high water table) are as follows:-

Yield of dry grain in lbs./ac.

	Fld.5	Fld.15		Fld.5	Fld.15		Fld.5	Fld.15
No	1940	1446	Po	2725	2160	Ko	2219	1996
N1	2449	2164	P1	2087	2010	K1	2554	2024
N2	2759	2487	P2	2335	1939	K2	2375	2093

The fertiliser addition was as follows:-

N - 90, 150 and 210 lbs./ac. as urea.

P_2O_5 - 0, 30+30 and 90+90 lbs./ac as L. Super and C.I.R.P. respectively

K O - 0, 60 and 180 lbs./ac as muriate of potash.

The second crop in the same area was harvested fresh due to heavy lodging as a result of unprecedented rainstorms. Growth was poor but the trends were the same, that is clear response only to nitrogen. Addition of phosphate and potash showing no clear trends.

Leaf analysis of the crops is being done as the main objective is to find out the relationship of leaf analysis to yield.

(d) Maize copper test

The 6th, 7th and 8th crops to find out the amount of copper required and its residual effect was harvested during the year. The summarised yields of the three crops is as follows:-

Yield of maize, dry grain in lbs./ac. (3 crops)

Copper sulphate in lbs./ac.	Block I	Block II	Block III	Block IV	Mean
0	4560	0	5940	115	2654
15	10106	10122	7364	10457	9512
30	13827	11557	12352	8724	11615
60	10367	11497	11444	11647	11239

The yields of the 0 plot and that of the 15 lbs per acre copper sulphate have fallen considerably when compared to the results of the previous three crops harvested in 1968. The yield of about 8000 lbs/ac. dry grain per crop for the 30 and 60 lbs. of copper sulphate per acre under continous cropping conditions must be considered as good.

Maize leaf samples taken from the 3rd to the 7th crop were analysed for copper and the summarised results of the analysis are as follows:-

Copper in p.p.m. in maize leaf.

Copper sulphate in lbs./ac.	Block I	Block II	Block III	Block IV	Mean
0	3.73	2.14	4.03	3.26	3.29
15	5.24	4.98	5.77	3.66	4.91
30	5.35	5.60	6.36	4.67	5.50
60	6.41	6.86	5.32	5.93	5.13

It appears from these results that about 5.0 p.p.m. of copper in the cob leaf of metro maize is sufficient for good yields.

(B) Sorghum

3x3x3 Fertiliser factorial trial

Three sets of crops were grown and harvested during the year at the Tanjong Karang peat station. The first crop was grown in two replicates in field 16 which had a high water table. Damage due to flooding was so severe that one replicate had to be abandoned. The other replicate which was poor gave the following summarised results:-

Yield of dry grain in lbs./ac.

No	1312	Po	2241	Ko	1995
N1	2151	P1	1869	K1	2025
N2	2735	P2	2089	K2	2180

The variety used was 56-7, white large grained variety and the fertiliser was as follows:-

N - 45, 90, 180 lbs./ac. as urea.

P_2O_5 - 0, 20+20, 60+60 lbs./ac. as D. Super and C.I.R.P. respectively.

K_2O - 0, 60, 180 lbs./ac. as muriate of potash.

In view of the high water table in Field 16 the trial was also conducted in field 19 where the water table was much lower. The yield of the crop was good inspite of loss due to bird damage. The summarised yields were as follows:-

Yield of dry grain in lbs./ac.

	Rep.I	Rep.II		Rep.I	Rep.II		Rep.I	Rep.II
No	3405	3712	Po	3877	3697	Ko	3860	3655
N1	3969	3757	P1	4080	3611	K1	3887	4027
N2	4391	3916	P2	3806	3878	K2	4018	3705

As in the previous crops yield responses were good for nitrogen and trials were laid out with slightly increased nitrogen on both field 16 and field 19. The summarised yields obtained were as follows:-

Yield of dry grain in lbs./ac.

	Fld.16	Fld.19		Fld.16	Fld.19		Fld.16	Fld.19
No	1328	2596	Po	2044	3028	Ko	1928	2704
N1	1933	2903	P1	1912	2885	K1	1948	2904
N2	2754	3108	P2	2058	2695	K2	2138	2999

It is quite clear that high water table in field 16 has a detrimental effect on yields. Response to nitrogen is good and there appears to be some indication of a response to potash but hardly any response to phosphate.

Leaf analysis of a crop harvested in 1968 was completed. The variety used was 655N, a red variety. The flag leaf soon after emergence was sampled. The relationship between yield and nutrients in the flag was as follows:-

Treat	% N in leaf	Yield lbs/ac	Treat	% P in leaf	Yield lbs/ac	Treat	% K in leaf	Yield lbs/ac
No	2.16	1736	Po	0.32	2146	Ko	1.48	2046
N1	2.29	2131	P1	0.32	2116	K1	1.47	2042
N2	2.36	2504	P2	0.32	2165	K2	1.49	2279

It does appear from the results that %N in flag leaf increases with increasing yield. There is however no increase in %P or K and no marked increase in yield. It is possible that 0.32% P and 1.48% K in flag leaf are sufficient for good yields of sorghum variety 655N.

(C) Tapioca

(a) Variety x Time of harvesting

A variety x time of harvesting trial with tapioca was planted in the middle of July, 1968. It had 6 of the best varieties and was intended for harvesting at 8, 10 and 12 months from planting. However, many of the plants suffered from copper deficiency inspite of the application of 30 lbs copper sulphate per acre. Apart from this the pH of the particular plot at the Tanjong Karang peat station was low 3.5 to 3.8 and as a result of these two factors many plants were poor.

All the plants were harvested about the middle of February, 1969 that is about 7 months from planting. The yield of the various varieties was as follows:-

Variety	Yield of Fresh Tubers in tons/acre
Green twig	10.80
Black twig	10.66
Berat	12.01
Puteh	9.71
Jurai	4.48
Kekabu	7.73

Magnesium limestone powder and copper were applied and the test was continued. The first harvest at 8 months was completed and samples obtained were analysed. Some of the results are as follows:-

Variety	Tuber tons/ac.	% Moisture	Hydrogen cyenide p.p.m.		Starch %(chem)	Starch %(ext)	Hampas %
			Tuber	leaf			
1. Green Twig	12.4	65.3	43.7	108	28.5	11.7	8.67
2. Black Twig	13.1	63.2	46.3	103	31.1	12.8	8.67
3. Ubi Puteh	12.9	64.7	46.0	135	29.7	12.1	9.06
4. Jurai	12.1	58.9	43.0	44	34.8	15.4	10.30
5. Kekabu	11.9	59.2	20.0	83	34.2	14.7	11.50
6. Berat	10.9	63.4	37.7	118	31.8	11.9	11.70

The experiment was replicated three times and samples analysed for hydrogen cyanide from the same variety showed much variation. The method of determination of hydrogen cyanide and the sampling for its determination are being looked into. Starch was determined by the usual chemical method as well as extraction as done in simple starch factories.

Leaf samples, 6th and 21st leaf were taken at 4 months from planting to see whether there was any marked difference between the various varieties. The results of analysis are as follows:-

% nutrient in dry matter - 6th leaf.

Variety	N	P	K	Ca	Mg	Fe p.p.m.	Mn p.p.m.
1. Green Twig	3.75	0.33	1.44	0.93	0.46	72	125
2. Black Twig	4.09	0.34	1.60	0.93	0.48	70	115
3. Ubi Puteh	4.13	0.36	1.58	0.80	0.49	65	123
4. Jurai	4.02	0.34	1.66	0.75	0.37	70	109
5. Kekabu	3.88	0.34	1.54	0.97	0.38	76	151
6. Berat	4.07	0.37	1.73	0.88	0.42	74	149

% nutrient in dry matter - 21st leaf.

Variety	N	P	K	Ca	Mg	Fe p.p.m.	Mn p.p.m.
1. Green Twig	3.31	0.33	1.47	1.47	0.61	64	217
2. Black Twig	3.32	0.31	1.29	1.39	0.58	71	192
3. Ubi Puteh	3.27	0.32	1.38	1.14	0.59	110	179
4. Jurai	3.23	0.34	1.50	1.17	0.46	69	155
5. Kekabu	3.23	0.38	1.44	1.31	0.49	64	207
6. Berat	3.36	0.35	1.54	1.20	0.52	74	219

There does not appear to be marked differences between the different varieties in the leaf nutrient content at the 4th month from planting.

(b) Time of harvesting trial

The time of harvesting trial with the unnamed variety of tapioca at Jalan Kebun was concluded after the last harvest at 10.5 months. Samples consisted of 160 plants for each harvesting and the results were as follows:-

Yield of fresh material in tons/acre

Months	Leaves	Stem	Tubers
6.25	1.65	7.08	9.10
9.00	1.57	10.93	11.40
10.50	1.00	11.96	12.46

Two rows of a patch of tapioca at Tanjong Karang variety Green Twig was harvested at 9¼ months from planting. The yield of tubers was as follows:-

Row No.	2	6	Av.
No. of Plants	10	9	
Yield/plant	11 lb.1oz.	8lbs.9oz.	9 lbs.13oz.
Yield/acre	17.9 tons.	13.9 tons.	15.9 tons.

Row 6 was particularly bad with many fallen plants.

Part of the same patch of tapioca consisting of 36 plants was harvested in just over 11 months. The average yield of tuber per plant was 13.86 lbs. giving an yield of 22.45 tons of fresh tubers per acre.

(c) Exhaustive Cropping

Tests were laid down with tapioca in order to determine the soil potential for nutrients N, P and K both at Jalan Kebun and at Tanjong Karang. It is expected to extend this to other soil types if it is found convenient. In the first test done at Tanjong Karang peat station the following results were obtained:-

Yield of Tapioca Tubers in tons/acre

Control	-N	-P	-K	NPK
7.50	7.34	12.18	10.74	12.62

The stem, leaf and tubers were analysed in order to calculate the nutrients removed. A second crop has been planted in the same area.

Leaf analysis of the 6th and 21st leaf sampled at 3½ months from planting were analysed and the results seem to indicate a relationship between percentage nitrogen in the 21st leaf and yield. The results which are the average of six replicates are as follows:-

Yield and % nutrient in 6th and 21st leaf.

Treat	Tubers tons/ac.	6th Leaf			21st Leaf		
		%N	%P	%K	%N	%P	%K
NPK	12.62	3.58	0.29	3.43	2.49	0.28	1.35
PK	7.34	3.20	0.36	1.62	2.27	0.47	1.51
NK	12.18	3.29	0.28	1.30	2.43	0.26	1.18
NP	10.74	3.54	0.31	1.00	2.41	0.32	0.80
C	7.50	3.25	0.35	1.31	2.29	0.45	1.12

There are indications that the nutrient contents of the 21st leaf beginning from the youngest fully developed leaf could be used to find nutrient deficiencies.

The amount of nutrient removed by the crop for the various treatment is as follows:-

Total Nutrients removed in lbs/ac.

Treat	N	P	K	Ca	Mg	Fe	Mn	Yield tons/ ac. tubers
NPK	100.3	30.3	167	49.8	31.6	0.49	0.74	12.62
PK	69.5	30.6	122	37.8	23.3	0.33	0.59	7.34
NK	109.6	35.9	169	59.6	36.6	0.52	0.84	12.18
NP	96.6	35.3	104	50.6	43.0	0.45	0.66	10.74
C	61.7	25.5	96	32.4	22.5	0.34	0.50	7.50

From the results it appears that the shallow peat has supplied nearly 70 lbs of N, 36 lbs of P and 104 lbs of K without the application of these nutrients in the space of about 6 months.

A similar test on the Jalan Kebun peat with tapioca was harvested in 9 months from planting. The results were as follows:-

Yield per plant in lbs

Treatment	Tubers	Stem	Leaves
-N	7.70	4.70	0.80
-P	7.25	5.65	0.50
-K	6.70	4.03	0.40
NPK	9.60	6.45	0.55

The yield of tubers was quite high as the area suffered from burning just before planting.

A subsequent test was harvested at 7 months at FES Jalan Kebun. Two of the plots in the -K treatment had very low yields and the plants showed symptoms of potash deficiency. The deficiency symptoms were: leaves small in size. There was tendency to form many small branches. The stem was thin and with upper portion having folds and wrinkles. There were many tubers but mostly small about 6 to 12 inches long and diameter between 0.25 to 1 inch with most of them about 0.5 to 0.75 inches. The yield of tubers was as follows:-

Fresh tubers in tons/acre

-N	-P	-K	NPK
7.54	10.97	6.24	11.24

(d) Trace elements, water table and liming

A test to find out whether boron or sulphur are required for tapioca was carried out for one season at F.E.S. Jalan Kebun. The test was conducted in two areas, one in which the peat was deep 6-8 ft. and the water table low and in another area where the peat was shallow 3-4 ft. and water table was higher. In each area there were two blocks, one of which had been limed with 4.8 tons per acre magnesium limestone powder and the other unlimed before tapioca planting. Both limed and unlimed areas had previously received uniform dressing of lime and had been cultivated with maize. The summarised results of this tests are as follows:-

Yield in tons/acre tubers
(Harvested at 8 months)

Treat	Tons/ac.	Treat	Tons/ac.
Boron	11.83	Lime - pH 6.6	11.28
No Boron	11.92	Unlimed pH 5.0	12.61
Sulphur	12.10	Deep peat - low water table	10.77
No Sulphur	11.78	Shallow peat - higher water table	13.11

It does appear that boron and sulphur in the form of ammonium sulphate have had hardly any influence on the yields. It is possible that later crops may suffer from these deficiencies. The shallow peat in the slightly higher water table area has given better yields than the deep peat. The unlimed at pH 5.0 appears to be better than limed at pH 6.6. It is unfortunate that the test could not be continued so that the results could be confirmed with more crops.

(e) Tapioca and Cowpeas

Tapioca was interplanted with dwarf cowpeas as a catch crop and to reduce weed growth. A few plots with and without cowpea were tried at Jalan Kebun peat station. The yield without cowpea was 8.49 tons/acre and with cowpea 7.24 tons/acre when harvested at 7 months. The cowpeas gave a yield of 500 lbs/acre dried peas.

(f) Fertiliser 3x3x3 factorial trial

A 3^3 factorial trial with tapioca replicated twice was planted on May 20th, 1968 after a crop of maize which had been uniformly fertilised at the Tanjong Karang peat station. One of the replicates was harvested on November 28th. Tubers were not well developed and the harvesting of the other replicate was done on the 21st of January, that is, 8 months after planting. The summarised yield for the various treatments and time of harvesting is as follows:-

Yield of fresh tubers in tons/acre

Treat-ment	28/11	21/1	Treat-ment	28/11	21/1	Treat-ment	28/11	21/1
No	9.4	12.2	Po	10.4	14.5	KO	10.5	14.1
N1	11.1	14.2	P1	10.2	13.5	K1	10.4	13.9
N2	10.8	15.5	P2	10.6	14.0	K2	10.3	14.0

The fertiliser addition for the test was as follows:-

N - 60, 120 and 240 lbs/acre

P_2O_5 - 0, 60+30, 180+90 lbs/acre as C.I.R.P. and D.Super

K_2O - 0, 90 and 270 lbs/acre.

It is fairly obvious that the additon of phosphate and potash fertilisers had no effect on the yield. It does suggest that tapioca grown after maize to which adequate fertiliser has been added does not require phosphate or potash.

Two fertiliser factorial trials had to be harvested in 7.5 months and 6.5 months although it was felt that they should be harvested only at 9 months. Both the trials were subjected to very strong winds as a result a good number of plants were uprooted. There was little variation between treatments and the summarised yields are as follows:-

Yield of fresh tubers in tons/acre

	Rep.I	Rep.II		Rep.I	Rep.II		Rep.I	Rep.II
No	10.1	8.3	Po	9.1	7.8	Ko	9.9	9.4
N1	10.0	8.6	P1	9.8	7.8	K1	9.2	8.0
N2	8.4	8.0	P2	9.5	9.3	K2	9.3	7.4

The various trials with tapioca both at Jalan Kebun and Tanjong Karang peat station seem to indicate that tapioca is well suited to grow on peat.

(D) Sugarcane

(a) 3x3x3 fertiliser factorial trial

The sugarcane fertiliser trial was planted at the end of July 1968 and harvested in July 1969. The variety used was NCo 310. Some of the canes were attacked by stalk borers. Lodging was heavy, and many canes dried out as a result of snapping. Fallen canes were attacked by rodents. The trial was conducted in an area which had been uniformly fertilised and cropped with maize. There was no marked difference in the growth or yield of cane and the summarised results are as follows:-

Yield of cane in tons/acre

	Rep.I	Rep.II		Rep.I	Rep.II		Rep.I	Rep.II
No	29.5	29.7	Po	29.9	28.0	Ko	30.5	28.6
N1	31.2	29.7	P1	30.5	31.7	K1	29.8	30.0
N2	28.6	28.0	P2	29.0	27.7	K2	29.0	29.1

Analysis was done for juice, reducing sugar and sucrose. The yield of cane compares favourably with that grown on ordinary mineral soils.

The sugar-cane fertiliser factorial trial replicated twice planted with the variety F134 in October and November, 1968 was harvested in October and November, 1969. Canes lodged and there was considerable damage by rodents and borers. The summarised yield results are as follows:-

Yield of fresh cane in tons/ac.

No	28.0	Po	30.7	Ko	32.6
N1	33.1	P1	31.7	K1	32.4
N2	32.6	P2	31.4	K2	28.8

The rather poor response due to fertiliser may be partly due to the fact that the area had been previously fertilised uniformly and a crop of corn had been grown. The experiment is being continued in order to relate leaf analysis to yield of cane.

Soil And Foliar Analysis Section

Trace Element Analysis

	No. of samples
Oil palm	782
Cocoa	20
Coconut	79
Total:	881
Check Analysis	48
Sorghum plant analysis from pot expt.	116
Spectrographic analysis of soils for total trace element contents	93

Foliar Analysis Unit

Number of Samples Analysed	-	3,853
Number of analysis carried out	-	20,035
Oil Palm Leaf Samples from F.L.D.A. Schemes (1 acre plots)	-	1,102
Oil Palm Leaf Samples from F.L.D.A. Schemes. (Nitrogen Trial)	-	580
Oil Palm Leaf Samples from F.E.S. Serdang (Placement Trial)	-	350
Oil Palm Leaf Samples from Jendarata Estate (Manurial Expt.)	-	168
Oil Palm Leaf Samples from Sungei Mahang Estate. (Manurial Expt.)	-	81
Oil Palm Leaf Samples from Sussex, Kamachie and Bonapodane Estates	-	23
Oil Palm Leaf Samples from F.E.S. Serdang and Jerangau (Progeny Trials)	-	88
Oil Palm Leaf Samples from F.E.S. Serdang (Expts. I, II, III)	-	64
Tapioca Leaf Samples from F.E.S. Serdang (Manurial Trial)	-	675
Check Analysis Samples from Holland	-	36
Check Analaysis Samples from H. and C.	-	18
Sugar Cane Leaf Samples from Agronomy Branch	-	12
C.T.S. Samples from Jalan Kebun, Serdang and Kong Kong	-	24
Oil Palm Leaf Samples from Ulu Tiram Estate	-	40
Oil Palm Leaf Samples from F.E.S. Jalan Kebun Fertiliser Trial)	-	64
Coconut Leaf Samples from Torkington Estate. (Fertilizer Expt. on Dwarfs)	-	32
Sorghum Samples from Glasshouse	-	444
Miscelenous Oil Palm coconut and Cocoa Leaf Samples	-	52
TOTAL :		3,853

Soil Analysis

Number of soil samples received during the year	2945

Soil analysis done

pH values	3909
Moisture %	1408
Loss on Igintion%	1318
Organic carbon %	1595
Total nitrogen %	1717
N/10 NaOH soluble phosphorus	1612
Acid flouride soluble Phosphorus	764
Organic Phosphorus	582
N/2 Acetic Acid soluble Potasium	1355
Conductivity	596
Sulphate % as SO_4	200
Chloride % as Cl	200
Cation exchange capacity	1504
Exchangeable cations, Potasium	1504
" " Sodium	1504
" " Calcium	1504
" " Magnesium	1504
6N HCl soluble, Iron as Fe_2O_3	175
" " Potasium	342
" " Calcium	348
" " Magnesium	348
" " Phosphorus	361
Free Iron by sodium Dithionite	270
Mechanical Analysis	918
Water holding capacity	89
Reductant soluble Iron Phosphate	159
Occluded Aluminium Phosphate	159
Lime requirement	2
Relationship of pH to C.E.C.	6
Quantity of potassium in soil	4
Intensity of potassium in soil	4
Potential buffering capacity of K in soil	4
Loosely bound phosphorus	195
Aluminium phosphate	279
Iron phosphate	251
Calcium phosphate	213
TOTAL :	26903

Soil - Pot Tests

The first crop of sorghum grown in pots with 11 different types of soils has been harvested and is now being analysed. The dry weight of plants has been determined and from these the following conclusions can be drawn:-

Phosphorus - On all soils examined sorghum showed relatively poor growth due to lack of phosphorus. Some soils were better than others and they can be divided into the following categories:-

Medium	Poor	Very poor
Telemong	Bungor Jerangau	Kg. Kolam
	Kuantan Katong	Jempol
	Lunas Bg. Merbau.	Marang
	Akob	

Potassium - In all the eleven soils examined sorghum showed no marked potash deficiency.

Magnesium - Same as potassium

Calcium - Differences in growth and dry weight were shown in the various soil types.

Good	Medium	Poor
Kuantan Akob	Katong	Kg. Kolam
Jerangau Telemong	Jempol	Bg. Merbau
Lunas Bungor		

Trace elements - No trace element deficiency was observed in sorghum on any of the soils.

Phosphorus Fractionation Studies

6 soil phosphorus fractions were obtained by the modified method of Chang and Jackson i.e. Loosely-bound (or Saloid) P, Aluminium-bound P, Iron-bound P, calcium-bound P, Reductant-soluble P and Occluded-P. Total P and organic P components were done on separate samples.

Table below gives an idea of the range of soil P values of the soils completed to date:-

Soil Series	(0 - 6") Inorganic soil P Fractions (ppm)						
	Saloid-P	Al-P	Fe-P	Ca-P	Red-P	Occl-P	Tot P*
Rengam	1.5	3.0	17.8	2.2	60	3.3	87.8
Kuantan	1.0	1.5	53.3	4.0	146	9.7	215.5
Kg. Kolam	1.5	2.5	95.8	6.7	487	28.6	622.1
Jerangau	0.5	6.3	36.0	2.2	95	7.4	147.4
Bungor	-	11.7	10.2	-	72	1.0	94.9
Langkawi	-	17.7	708.3	36.2	308	21.7	1092.9
Telok	0.3	43.1	69.5	4.0	6.7	1.3	124.9
Akob	3.8	10.2	60.0	6.2	203	6.3	289.5

* "Total P" - sum of inorganic P fractions.

From the results it can be seen that Fe-P and Reductant-soluble P form the major part of the soil inorganic P. Al-P varied from 0.40-34.50% Fe-P from 10.74 - 64.86%; Red-P from 5.4 - 78.2%; and Occl-P from 1.04 - 5.02% of the total inorganic soil phosphorus.

(E) Oil Palm

(a) Type of nitrogen experiment

Sampling and analysis of leaves taken from the type of nitrogen experiment laid down in various F.L.D.A. areas in April, June and August was completed. The summarised results are as follows:-

% N in dry matter - Frond 9

Treatment	Sg. Dusun	Kulai	Ulu Jempol	Jerangau	Av.
1. 100% urea - raked in	2.74	2.78	2.90	2.88	2.825
2. 100% urea - surface	2.76	2.79	2.90	2.88	2.833
3. 50% urea + 50% N -26	2.72	2.74	2.86	2.88	2.800
4. 100% N - 26	2.79	2.75	2.92	2.84	2.825
5. 100% sulphate of ammonia	2.78	2.79	2.92	2.86	2.838
6. 50% urea + 50% S. of A.	2.73	2.78	2.90	2.83	2.810

Results obtained from frond 17 are very similar to those of frond 9 except being about 0.2 units lower throughout. Yield of F.F.B. also shows no variation with treatment, however it is too early to have any effect. Since fertiliser is recommended on the basis of leaf analysis and the leaf analytical results do not show difference the cheapest and simplest method of application that is treatment 2 with urea on the surface could be used until there is evidence to the contrary.

(b) 3^4 Fertiliser factorial experiment, Sungei Mahang

Analysis of the leaf samples taken from the Sungei Mahang fertiliser factorial experiment was completed. The yield data supplied by the estate was statistically analysed by the Colombo Plan Biometrician Mr. E. Walters and the summarised yields and his conclusion were as follows:-

F.F.B. mean yields in tons/ac.

Levels	N	P	K	Mg
0	6.68	6.26	6.07	6.52
1	6.51	6.68	6.69	6.42
2	6.28	6.52	6.70	6.53

Standard error of mean = 0.101

(a) Significant negative linear response to N

$N_2 = -0.40 \pm 0.25$ tons/ac.

(b) Significant quadratic response to P.

$PQ = -0.58 \pm 0.25$ tons/ac.

(c) Significant linear and quadratic response to K.

$$K_2 = +0.63 \pm 0.14 \text{ tons/ac.}$$

$$KQ = -0.61 \pm 0.25 \text{ tons/ac.}$$

(d) Significant NK interaction.

Leaf analysis results show the following:-

Mean % nutrient in leaf-frond 17

Levels	N	P	K	Mg
0	2.68	.157	1.253	.275
1	2.62	.160	1.263	.266
2	2.67	.158	1.237	.284

As can be seen the highest N is in the leaves of the palms to which no N has been added. Similarly for the other nutrients the results are not in keeping with the addition of fertiliser although small.

(c) 3^4 Fertiliser factorial experiment Field 49, Jenderatta.

Leaf analysis of samples taken in October, 1968 and April, 1969 were completed and sent to the estate. The yield results after statistical treatment by the estate for the period of 1967-68 is as follows:-

F.F.B. in Kgs. per palm (1967-68)

Levels	N	P	K	Mg
0	229	225	224	234
1	226	226	230	220
2	224	228	224	225

Significant Difference = 9.6

The experiment was started early in 1965 and yet so far the only indication seems to be that the addition of kieserite tended to lower yields. The results seems to be completely contrary to the idea that the quantity of nutrient taken up should be replaced. An important factor to be noted is the high yields of these Dura palms planted in 1956. The yield of about 220 kg per palm works out to about 11 tons F.F.B./ac. Another important factor is the acidity of the soil which is quite acid. Soil profiles examined in the experimental area for pH gave the following results:-

pH of soil profiles 3^4 experiment (air dried)

Depth in inches	0 - 6	6-12	12-24	24-36	36-48	48-60
Plot 1	3.4	3.5	3.2	3.0	2.6	2.2
Plot 41	3.9	3.6	3.1	2.7	2.4	2.1
Plot 81	4.4	3.6	3.4	2.9	2.6	2.3

(d) Trace element experiment

The trace element experiment at Ayer Puteh Division, Nam Heng Estate on the Ulu Thiram Series was continued. Leaf samples taken in February, 1969 have been analysed for all the major and trace elements. Yield results have been provided by the estate up to July 1969. Results are being put together to see whether any of the trace elements has had a marked effect on the yield of oil palm fruit on this very poor soil.

(e) Oil palm on peat

The 2^4 factorial fertiliser trial replicated twice and planted in September, 1967 at F.E.S. Jalan Kebun is progressing satisfactorily. Castration of fruit bunches was stopped in September 1969. Analysis of leaf samples taken in June has been completed. In all cases the higher level addition of nutrients N, P, K and Mg has been reflected in the leaf.

Mean % nutrient in leaf Frond 9

Levels	N	P	K	Mg
1	2.66	.175	1.21	.459
2.	2.95	.187	1.28	.481

The pH of the peat near the palms was determined and found to be 3.46 where only small quantity of magnesium limestone was applied and 3.53 where the larger quantity was applied. This again shows the tolerance of oil palm to acidity since the growth is good.

(f) Foliar Analysis Service to F.L.D.A. and Fertiliser Recommendation

Foliar samples collected from over 3 year old palms for March and September, 1968 were analysed and the results were tabulated for the various FLDA schemes. A visit to the various schemes were made in December, 1968 and January, 1969 by Senior Chemist and the Assistant Research Officer to study the condition of growth of the palms in the various FLDA schemes. It was observed that the palms in almost all the schemes visited showed white strip and hooked leaf symptoms. Taking all these conditions of palms and nutrient levels of the leaves, fertiliser recommendations were made for the various schemes for palms 3 years and above. In this 1969 recommendations Nitrogen was slightly lowered, but P and K was increased compared to the 1968 recommendation.

Foliar sampling of all the FLDA schemes were carried out in February and March and during October this year. The following schemes were foliar sampled:-

1.	FLDA Kulai	Phase	I, II & III
2.	" Pasir Rajah	"	I, II & III
3.	" Bt. Besar	"	I, II & III
4.	" Sg. Sayong	"	I & II
5.	" Ulu Tebrau	"	I, II, III & IV
6.	" Ulu Jempol	"	I, II & III
7.	" Jerangau	"	Nucleus I, II & III
8.	" Bt. Bading	"	I, II & III
9.	" Sg. Dusun	"	I, II & III

During this sampling exercise it was noticed that the fronds of the palms in all areas were still dark green, indicative of high nitrogen status of the palms.

Oil Palm experiments F.E.S. Serdang

(a) Fertiliser Placement Trial

3 different methods of fertilizer application to mature oil palms were tested here. It was observed in 1967 that the oil palm showed rapid uptake of N, P and K nutrients (detected in Frond 17) 2 weeks after fertiliser application. This was in contrary to some observations in oil palm research where the uptake of nutrients by the oil palm was slow and would not be detected until at least 2 months from fertilization. The 1967 results showed that N, P and K levels in Frond 17 increased with time uptill the 9th or 10th month and decreased slightly towards the end of the year. Early results of 1968 also showed increases of leaf nutrient levels with time as in 1967. No significant differences between the 3 placement methods were detected from the 1967 and early 1968 results. However, after the first quarter of 1968, there appeared to be a tendency that one of the placement methods showed slightly higher leaf nutrient levels over the other two which were similar. The analysis of data has not been completed and more definite deductions will be made after the results have been compiled and processed.

3^3 Factorial Trial on Taipoca, F.E.S. Serdang

The first phase of this trial has been completed and a second crop is to be planted at the same site.

From the leaf analytical data obtained up to this time, it was observed that the first young leaf can show rapid uptake of nutrients though their generally higher values could also be due to lesser dilution. Examination of the results also showed that nitrogen decreased with leaf age i.e. from young leaf 1, 6, 11, 16, 21, 26, down to leaf 31. Phosphorus also displayed this trend. In the case of potassium, the K levels decreased from Leaf 1 through to 11 or 16 and then increased with leaf age from 16 to 31. Calcium was observed to increase definitely with leaf age whereas Magnesium remained almost constant though the trend was not clearly shown.

Total nutrient uptake by the tapioca plant are being compiled and yield data processed.

Chemical Characterization Project of Soils in Test Stations

9 out the 11 states have submitted lists of agricultural stations the exceptions are Kelantan and Pahang. A reminder has been sent to each of the 2 states. The breakdown of agricultural stations in the 9 states are as follows:-

State	No. of Stations	No. of Stations Completed
Perlis	4	1
Kedah	7	-
Penang & P.W.	7	-
Perak	20	-
Selangor	13	-
Negri Sembilan	10	-
Malacca	3	-
Johore	8	-
Trengganu	13	13
Pahang	-	1

Some details on these 23 stations and the soils mapped are given below:-

Station	Total Area (acres)	Area Approx. Planted (acres)	Soils mapped	Dominant Soil Series
1. FES Tanah Rata, Cameron	100	88	Bukit Temiang (N), Bk. Temiang (Red Var), Alluvium & Colluvium	Bukit Temiang, & Alluvium
2. Bukit Temiang Station, Perlis	21.0	14.0	Chuping, & unnamed series	Chuping
3. FES Jerangau, Trengganu	1020.0	300.0	Jerangau, Rengam, Kg. Kolam Bukit Temiang & Kg. Kubor	Jerangau, Rengam & Kg. Kubor.
4. Padang Ipoh, K. Brang, Trengganu	49.9	17.0	Padang Ipoh (N), Padang Ipoh (shallow phase), Akob	Padang Ipoh
5. Ajil, Kg. Ajil, Trengganu	43.8	40.0	Jerangau (N), & Jerangau (Lateritic phase)	Jerangau
6. Gelugor Station, Trengganu	10.0	10.0	Riverine Alluvium	Riverine Alluvium
7. Kg. Raja Station, Besut, Trengganu	10.4	7.0	Rudua, & Rusila	Rudua
8. Gerai, Besut, Trengganu	12.8	12.2	Holyrood	Holyrood
9. Jabi, Besut, Trengganu	7.0	5.8	Telemong, & Riverine Alluvium	Telemong
10. Sg. Tong, Trengganu	20.0	20.0	Jerangau, Telemong, Riverine Alluvium & Local Alluvium	Jerangau
11. Padang Kemunting, Trengganu	29.0	5.8	Peat (deep)	Peat
12. Rantau Abang, /Dungun, Trengganu	10.8	9.7	Rudua	Rudua
13. Merchang (Bris Station) Trengganu	50.0	(Apparently abandoned)	Baging, & Rusila	Baging & Rusila
14. Cherating, Petak Jambu, Colok, Trengganu	310	?	Rudua	Rudua
15. Pasir Semut, Kemaman, Trengganu	19.7	15.5	Bungor, Bungor (Lateritic phase), & Riverine Alluvium	Bungor & Riverine Alluvium
16. Ayer Hitam	Batu Anam, Durian, Malacca, Tavy and Local Alluvium. (Station being revised due to some discrepancies in present map by Enche Smallwood)			Batu Anam, Durian and Malacca.
17. Padi Station. Endau/Mersing	Local Alluvium and Colluvium.			Local Alluvium Colluvium.
18. C.T.S., Kongkong.	Harimau			Harimau
19. Padi Station, Sg. Balang	Marine (clay) alluvium			Marine, Alluvium
20. Coconut Station Sg. Sudah	Selangor (Acid Phase)			Selangor (Acid phase)
21. Jementah Station	Riverine Alluvium			Riverine Alluvium
22. Tangkak Station	Malacca (Normal), Malacca (Strong Brown), Bungor, Local Alluvium.			Malacca (N), Malacca (Strong brown), Bungor.
23. Parit Botak Station	Selangor (Acid Phase)			Selangor (Acid Phase).

Crop testing stations.

Analysis of leaf samples of oil palm, coconut and cocoa from a number of crop testing stations has been completed. The results are of interest and with the help of yield results it might be possible to obtained a better idea of the soils and work towards more appropriate fertiliser requirements.

Coconut leaf samples from C.T.S. sampled Ja nuary / March 1969

Frond 4 — On Oven Dry Basis

DESCRIPTION OF SAMPLES	% N	% P	% K	% Ca	% Mg	ppm Mn	ppm Fe	ppm Zn	ppm B	Dry Wt. of Pinnae /Palm (Gms.)
Jalan Kebun (Planted 4/1963										
Manured (Tall Frond 14)	1.68	.127	1.044	.390	.312	174	60	10.7	11.1	67.9
Manured (Dwarf Frond 14)	1.99	.168	1.173	.321	.340	135	69	12.2	12.6	32.3
Kong Kong (Planted 21/10/64)										
Manured (Tall) Frond 4	1.87	.130	1.178	.344	.332	27	63	13.0	10.2	23.7
Manured (Dwarf) Frond 4	2.10	.156	1.253	.297	.352	29	53	13.0	11.7	32.1
Control (Tall) Frond 4	1.58	.092	.834	.334	.331	23	55		13.1	24.0
Control (Dwarf) Frond 4	1.64	.104	.880	.298	.295	21	50	13.9	14.5	24.2
Bukit Goh (Planted 1/2/63)										
Manured (Tall) Frond 4	1.90	.133	1.390	.300	.260	63	51	13.4	11.6	70.3
Manured (Dwarf) Frond 4	2.07	.143	1.488	.232	.243	53	48	12.1	11.9	41.2
Control (Tall) Frond 4	1.85	.120	1.393	.222	.214	61	49	12.3	12.1	68.3
Control (Dwarf) Frond 4	1.97	.133	1.594	.154	.187	60	47	11.5	12.6	41.7
Jerangau (Planted 9/4/63)										
Manured (Tall) Frond 4	2.04	.144	1.546	.251	.236	61	39	17.8	9.5	71.5
Manured (Dwarf) Frond 4	2.22	.157	1.515	.217	.211	67	43	15.7	9.3	40.0
Control (Tall) Frond 4	2.07	.124	1.679	.273	.242	70	43	17.9	12.3	69.7
Control (Dwarf) Frond 4	2.10	.131	1.487	.191	.196	71	35	14.6	9.6	32.9
Kampong Awah (Planted 19/11/64)										
Manured (Tall) Frond 4	1.76	.111	1.570	.320	.214	111	41	14.0	9.2	47.8
Control (Tall) Frond 4	1.76	.102	1.602	.278	.107	85	48	14.6	11.1	34.4
Jambu Rias (Planted 29/11/66)										
Manured (Tall) Frond 4	1.90	.130	1.290	.516	.249	107	50	14.8	9.7	17.4
Control (Tall) Frond 4	1.88	.114	1.356	.356	.208	95	54	15.9	11.8	14.4

Oil Palm leaf sampled from C.T.S. sampled January / March 1969
Frond 17

On Oven Dry Basis

DESCRIPTION OF SAMPLES	% N	% P	% K	% Ca	% Mg	ppm Mn	ppm Fe	ppm Zn	ppm B	Dry Wt. of Pinnae/Palm (Gms)
Jalan Kebun (Planted 4/1963)										
Control	2.43	.141	.341	.546	.685	378	154	13.8	16.5	24.9
Control (Palm better than 1st C)	2.75	.149	.584	.564	.601	417	89	15.2	14.4	29.5
Manured	2.88	.178	.859	.514	.450	337	75	12.2	16.4	33.3
Manured	2.74	.176	.825	.649	.465	340	75	11.7	17.0	35.1
Serdang (Planted 20/1/63)										
Control	2.62	.142	1.206	.412	.185	310	85	19.6	16.4	31.6
Manured	2.66	.159	1.102	.575	.151	278	87	19.7	17.0	34.2
Kong Kong (Planted 21/10/64)										
Control	2.51	.125	.926	.727	.394	44	63	18.0	13.8	18.4
Manured	2.78	.166	.999	.789	.377	61	68	16.6	14.4	26.7
Bukit Goh (Planted 21/2/61)										
Control (clean weeded)	2.65	.164	1.031	.559	.234	131	85	19.1	16.4	42.1
Control (Stylo)	2.58	.166	.985	.517	.229	188	78	17.8	16.1	39.4
Manured (clean weeded)	2.82	.167	1.131	.618	.264	209	82	15.8	15.9	44.4
Manured (stylo)	2.72	.164	1.108	.551	.288	224	84	15.5	14.7	40.8
Jerangau (Planted 9/4/63)										
Control	2.74	.162	.938	.630	.270	393	66		13.2	35.0
Manured	2.82	.168	1.137	.615	.240	312	67	20.4	12.9	35.8
Kampong Awah (Planted 19/11/64)										
Control	2.60	.147	1.252	.575	.212	392	55	17.9	12.2	34.6
Manured	2.60	.156	1.164	.640	.212	412	66	18.7	10.7	40.0
Jambu Rias (Planted 13/11/65)										
Control	2.52	.145	1.367	.593	.255	322	71	15.4	15.1	21.7
Manured	2.78	.158	1.218	.571	.266	321	64	13.7	13.1	30.4
Optimum values	2.70	.170	1.20	.60	.25	200				

Oil Palm leaf samples from C.T.S. Gajah Malhi
Sampled: 26/3/69

On Oven Dry Basis

DESCRIPTION OF SAMPLES	% N	% P	% K	% Ca	% Mg	ppm Mn	ppm Fe
Manured Frond 9	2.65	.158	1.478	.404	.430	254	57
	2.92	.155	1.430	.367	.363	276	67
Control Frond 9	2.45	.127	1.424	.375	.384	247	55
	2.16	.133	1.332	.456	.447	328	56
Manured Frond 17	2.56	.149	1.234	.631	.416	397	58
	2.99	.155	1.240	.584	.370	381	66
Control Frond 17	2.27	.125	1.264	.541	.390	361	66
	2.84	.130	1.244	.585	.363	423	60

Cocoa leaf samples from C.T.S.
Sampled: March 1969

On Oven Dry Basis

DESCRIPTION OF SAMPLES	% N	% P	% K	% Ca	% Mg	ppm Mn	ppm Fe	ppm Cu	ppm Zn
C.T.S. Bukit Goh									
Control 4th leaf 1st whorl.	2.46	.175	1.939	.402	.455	167	36	11.4	23.5
Manured "	2.57	.213	2.150	.260	.350	88	35	12.9	22.8
Control 2nd leaf 2nd whorl	2.41	.110	1.116	.960	.758	489	35	9.2	15.9
Manured "	2.40	.126	1.527	.793	.568	281	45	8.9	19.2
C.T.S. Kampong Awah									
Control 4th leaf 1st whorl	2.48	.142	2.503	.363	.379	189	36	11.2	29.6
Manured "	2.40	.160	2.488	.408	.413	363	38	10.3	30.3
Control 2nd leaf 2nd whorl	2.46	.093	1.895	.988	.544	136	42	9.5	23.9
Manured "	2.37	.104	1.863	1.033	.548	133	47	9.6	20.8
C.T.S. Jambu Rias									
Control 4th leaf 1st whorl	2.39	.151	2.234	.371	.400	168	42	9.5	41.8
Manured "	2.38	.158	2.161	.392	.448	189	42	8.9	33.9
Control 2nd leaf 2nd whorl	2.10	.101	1.608	.779	.469	305	48	7.4	37.8
Manured "	2.05	.108	1.567	.878	.500	423	48	8.2	27.6

It can be seen from the results obtained that some fertilised palms in areas like Kong Kong are worse than the unfertilised palms in areas like Bukit Goh. In some station dwarf coconuts failed completely due to their high nutrient requirement. The effect of soil on crop growth and requirements is a crucial factor and unless the deficient factors in the soils are known it would not be possible to fertilise a crop to obtain maximum yields.

Reclamation of acid soils

A highly significant finding in the reclaimation of acid soils was made during the year. These soils have been studied since the days of Dennett J.H. in 1933. Draining and liming was considered but it was found that draining invariably led to greater acidity and injury to crops while liming proved ineffective. Inspite of such discouraging results a test in draining and liming was started at Ulu Bernam Estate in 1964. Oil palm fronds were scorched due to excess acidity in the area. Drains were kept at about 3 feet deep and limestone powder was broadcast on the surface of the soil. No cultivation was done. pH of the are was taken before liming, nearly two years later in 1966 and more recently in February 1969. The results of these determinations and yield of oil palm are as follows:-

Treatment. limestone powder/acre	1964 before liming	pH 1966	1969 Feb,	Av. Yield of FFB in tons/ac/year 1965 - 68
Control 0 - 6"	3.50	3.75	3.05	
16 -12"	3.40	3.52	3.63	7.08
12 -18"	2.90	-	-	
2 tons "	3.90	4.35	4.33	
"	3.55	4.02	4.10	6.72
"	2.90	-	-	
4 tons "	3.60	4.53	4.70	
"	3.45	4.27	4.58	7.41
"	2.85	-	--	
6 tons "	3.75	4.73	4.80	
"	3.45	4.24	4.63	7.41
"	2.85	-	-	
Bunch waste 0 - 6"	3.65	3.34	3.82	
6 -12"	3.35	3.73	3.72	8.45
12 -18"	2.95	-	-	
Bunch ash "	3.70	3.87	4.13	
"	3.40	3.70	4.00	7.49
"	3.00	-	-	

The palms are now about 20 years old and a yield 7 to 8 tons F.F.B. per acre per annum must be considered as good.

In view of the fact that sampling of the soil was done only to a depth of 12" and it was found that the pH had changed quite considerably a further sampling was done in August to a depth of 24" and the results are as follows:-

pH of soil samples (air dried)

Depth in inches	Cont.	2 tons/ac	4 tons/ac	6 tons/ac	B/waste	B/ash
0 - 12	3.59	3.82	4.32	4.54	3.70	3.60
12 - 18	3.30	3.61	3.76	4.18	3.48	3.52
18 - 24	3.20	3.55	3.70	3.75	3.32	3.36

It can be seen from the results that liming has increased the pH of the soil to a depth of 18-24 inches. Addition of bunch waste and small amount of bunch ash has had little influence on pH. Yield differences are not of much significance as this preliminary test was done only in duplicate.

The important conclusions that can be drawn from this test are as follows.-

(i) Drainage should not be too deep when a crop has already been planted. Drains about 3 feet deep are quite satisfactory.

So why lime ? (ii) Oil palm is tolerant to acidity on coastal alluvial soils and good yields can be obtained with the pH levels even below 4.

it reduced yield ! (iii) Liming raises the pH of the soil considerably and even two tons per acre of limestone powder would be beneficial at or near the critical pH.

(iv) Limestone powder should be broadcast and no effort should be made to cultivate. Cultivation was probably the main cause of failure in liming tests. It destroyed the weeds, brought up more acid sub-soil and possibly compressed the soil as a consequence the movement of lime was hampered.

(v) The effect of liming lasts for a very longtime and must therefore be considered economical.

(vi) Fertilisers containing sulphate should be avoided and preference should be given to basic materials like ash. In the test no sulphate containing fertiliser was used.

With the highly encouraging results obtained from the Ulu Berna tests it can be definitely said that acid coastal soils which can be drained could be reclaimed quite economically and used for growing oil palms.

Pulau Gadong - Acid test station

Samples of soils were taken from some of the areas that had been limed in September 1964 for pH determinations and some of the results are as follows:-

	Average for plots 11A, 11B & 13A			
	July 1965		Jan. 1969	
	pH		pH	
	0 - 4"	4" - 12"	0 - 4"	4" - 12"
Limestone powder				
0 tons/acre	3.50	3.37	3.47	3.23
1 tons/acre	3.67	3.30	3.57	3.33
2 tons/acre	4.05	3.70	3.83	3.50

It does appear that the effect of limestone powder continues to persist even after 4 years. The station appears to have been virtually abandoned since the end of 1965 and no attempts have been made to keep the drains flowing although the D.I.D. had a large drain dug close to the station. The water table in plot 14 was only 9 inches from the surface. Steps are being taken to clear the drains, the undergrowth and eventually to plant oil palm, coconuts, coffee and other crops.

Leaching of acid sulphate soil

One of the methods to reclaim acid soils is by drainage or in other words leaching. About 450 gms of acid sulphate soils were put into containers and leached with distilled water. The soil was allowed to dry in between periods of leaching. Some of the results obtained were as follows:-

pH of soils - subject to leaching

	pH at start	5 litres	10 litres	115 litres
1.	3.5	4.1	-	-
2.	3.6	4.2	4.25	-
3.	3.2	3.8	3.85	3.9
4.	3.0	3.4	3.55	3.5
5.	3.0	3.5	-	-

The soils tend to become impermeable and difficult to leach, however it can be seen that the first leaching with 5 litres of water has increased the pH quite considerably. Sulphate was determined in the leachate of a soil sample which had an initial pH of 2.9 and the results were as follows:-

	p.p.m. Sulphate in leachate		
	(1)	(2)	Limed
1st. 2 litres	630	639	727
2nd. 2 litres	340	341	62
3rd. 2 litres	196	120	85
4th. 2 litres	102	N.D.	N.D.

It appears from the results that liming encourages leaching of sulphate however this needs to be confirmed by further work.

Neutralisation of acid sulphate soils

The neutralisation of acid sulphate soils was studied with aid of buffer curves. It was apparent that the relatively acid sub-soils showed very slow rise in the pH when neutralised.

Soil Survey Section

Staff changes

Four Cadet Agricultural Assistants were appointed in July, after having worked as Leading Hands since March. Enche Chung Chee Yoke was posted to the Kuantan Unit on 1.8.69; Enche G.A. McGuire and Lau Chen Chee to the Ayer Hitam Unit on 16.9.69 and 16.11.69 respectively; Encue Keh Chai Heng who was posted to Ayer Hitam resigned on 13.9.69 to join ESSO.

Enche F. Nicholson was appointed Cadet A.A. on 1.10.69 and remained in K.L.

Enche S. Makeswaran, Cadet A.A. was transferred from Ayer Hitam to take charge of the Kuantan Unit from 15.5.69 when Enche Gopinathan left for post graduate studies in Canada.

Enche Lim Cheng Eng, Propationary Technician resigned to join the University of Malaya as a Laboratory Assistant on 15.6.69.

Post Graduate Training

Four Soil Scientists left for overseas institutions for post graduate studies in Soil Science:-

(a) Enche S. Paramananthan on 24.1.69 for the University of Queensland, Brisbane for a course in clay mineralogy and pedology.

(b) Enche B. Gopinathan on 24.5.69 for the University of Alberta, Edmonton, for a course in pedology & soil classification.

(c) Enche Chow Weng Tai on ..... for the University of Newcastle, U.K. for a course in soil chemistry.

(d) Enche Chin Fatt on 27.12.69 for the University of Saskachewan, Saskatoon, for a course in soil physics and pedology.

SOIL SURVEY

(A) Reconnaissance Survey

Perak

The original draft soil map of the state was revised and brought up to date with new topography maps being printed. The area thus revised covered the new sheets nos. 52, 53, 54, 63, 65, 66, 74, 75 & 76. This final map was then readied for colour separation for printing in full colour.

(B) Semi-detailed Survey

1. Perlis Sugar Cane Plantations

The remaining 10% of Phase I (app. 10,000 acres) was completed in the first quarter. The final map was prepared and the report completed. The area consisted mainly of subrecent alluvial soils, well drained and

also well leached of nutrients. Physically these are ideal for sugar cane. A small area however, consisted of soils with high but variable base saturation percentages. This was due to the high contents of exchangeable magnesium and calcium and indicated that the basement rocks were calcareous, especially as the pH were commonly above 5 and increasing with depth.

Phase II of approximately 10,000 acres was examined briefly to draw up the rentis plan. However, with the unhealthy situation in the border area with Thailand, field work was postponed till the situation returned to normal.

2. Kemubu Irrigation Scheme (App. 60,000 acres)

The field work was completed in the early sixties, but no proper map was produced. The draft map was prepared and was then checked in the field for accuracy in September, Except for a few minor amendments, the map would be readied for colour separation together with the report which was being prepared.

3. Johor Tengah (App. 240,000 acres)

Phase I (App. 120,000 ac.) was completed in the first quarter when the traverse of the last two lines were done. Slope measurements and field checking were carried out. The soils were mainly Rengam Series and variants and phases of this series, the majority of which were on easy terrain. The other soils occurring in minor proportions included some older Alluvial soils in the north and soils from sandstone and rhyolites, together with some mixed soils which were not identified. The soil map, terrain classification map, and soil suitability map were handed over to the Hunting Technical Services soil survey team by the third quarter. The report was being edited and would be ready in early 1970.

Phase II (App. 110,000 ac.)

Work was started in the first quarter and completed by the end of the year. The draft soil map was prepared together with the terrain classification map. The soil suitability map is being prepared and would be ready in early 1970, together with the report. The soil pattern was more complicated than the Phase I area. Soils Rengam Series and variants and phases of this series, Bungor series on the metasediments in the Pantai Forest Reserves, and older alluvial soils mainly Harimau Series. Analyses however, indicated that these Harimau and even some of the Rengam Series are higher in exchangeable magnesium and calcium given a higher base saturation percentages. The Rengam with these high figures could be developed on the more basic granites, while the Harimau with the higher figures could be formed from these materials as well. The other soils included riverine alluvium and Telemong Series.

4. Rompin-Endau Area, Panang (App. 100,000 ac.)

Work in this area was started in May 1968 and completed in 1969. Soil samples were collected from the rentis2 cut by the I.I.D., Panang for spot level checks, and also along some 20 miles of rentis cut by the soil survey team. Soils included Peat, Akob and Briah Series, together with organic clays and mucks and Bris soils. Only about 40% of the area surveyed was considered suitable for padi cultivation.

5. Pusat Perchubaan Sayor2an, Titi Gangtong, Perak

The rentis cut under the supervision of the JAA stationed at Parit were traversed and the soils examined. The 500 acres consisted mainly of organic clay and muck soils with some patches of peat. This area would be ideal for vegetable experimental trials, but the soil are not typical of other areas.

6. Proposed Padi areas, Pahang

The following areas were examined for the SAO in more detail than usual:-

Ganchong - Pulau Rusa Scheme (10,400 ac.)

Briah series occupies about 50% of the area which is suitable for padi; while the remaining areas are on organic clay and muck which are marginal for padi.

Sg. Pandan Scheme (13,500 ac.)

Only 50% of the area is suitable for padi. Soils mapped included Organic Clay and Muck, Telemong-Telega, Holyrood and some sedentary soils.

Sg. Soi Scheme (26,000 ac.)

Only about 20% of the area is suitable for padi. Soils include deep peat, Holyrood-Local Alluvial Association, Organic Clay and Muck - Akob Association and Rudua and Rusila Series.

Kuala Pahang Scheme (16,000 ac.)

Only about 20% of the area is suitable as the soils are mainly peat, Rudua and Rusila Series.

Pekan Padi Scheme (161,000 ac.)

The survey was started in the third quarter and will be carried om in 1970. So far the soils include Akob, Briah, Peat and Telemong Series.

7. Ulu Jabor, Trengganu (5,000 ac.)

The area was examined for suitability for tapioca. Soils are mainly Rengam Series, but the terrain is rolling and hilly. Tapioca was not recommended for the hilly area.

8. Kesang Drainage Scheme, Malacca (6000 ac.)

The low lying areas were examined in greater detail, as the area identified from the reconnaissance soil survey was one of the areas with potential for agriculture. The river valleys are occupied by peats of varying depths from shallow peat at the edges of the basins to more than 10 feet deep at the centre. The soils along the Kesang River are mainly Briah Series. Those away from the river are thought to be acid sulphate soils as faint smell was detected. However, the samples collected had pH over 5 and very low conductivity figures. The peat had pH of about 4 and up to about 40% mineral matter. The Briah has good potential when drained, and the peat are among the better type.

(C) Detailed Survey

a. F.L.D.A. Oil Palm Schemes

Jerangau Scheme, Trengganu.

Some doubts were raised by the foliar sampling team regarding the soil boundaries when locating the sampling blocks. Corrections were made on the area as some of the boundaries had to be realigned.

Ulu Jempol Phase IV, Pahang

The survey revealed that the soils are mainly Segamat, Munchong, Durian, and Batu Anam Series, with some narrow patches of colluvial and local alluvial soils.

Sungei Dusun Phase II, Selangor

Further field checking was carried out and the map produced.

Bukit Bading Scheme, 3 & 4 Trengganu.

Soils mapped were mainly Rengam Series together with shallow phases and variants of the series. Pockets of Jerangau Series was also mapped.

Sg. Tekam Research Station

About 200 acres of this station was surveyed and maps produced.

b. Other Schemes

MARA Tapioca Plot, Paya Besar, Pahang

The 450 acres of the Mara tapioca plot was surveyed in detail. The area consists of Akob together with Organic clays and mucks. At depths jarosite was noted in the deep drains. The Abok and Organic clays are poorly drained. Improved drainage would help in the cultivation of tapioca

Sungei Tong Oil Palm Scheme, Trengganu

An area totalling some 1,900 acres was cleared for oil palm. The terrain was mainly steep, and because of this the Menteri Besar requested through the SAO, Trengganu for a detailed survey to be carried out. The survey showed that the major portion of the cleared land was unsuitable for oil palm either because of shallow soils or very steep slope. This area was marked as unsuitable for oil palm for the State Economic Development Corporation in our original examination of the Sungei Tong Scheme. Subsequent to this the Dutch Technical Aid Team also marked this area as unsuitable for oil palm.

Sungei Tong Oil Palm Scheme Phase I

At the request of the State Government this area was surveyed in detail for foliar sampling and fertilizer recommendation. The soils are mainly granite divived belonging to the Rengam-Jerangau group with phases of this scheme will be surveyed at the later part of 1970 when the palms will be ready for sampling.

Acid Sulphate Soils - Kedah Plain

The areas of acid sulphate soils were sampled very closely and analyses for pH determined. These points were plotted on the maps so that a pH map of the top 6 inches of soils could be produced. The map for Guar Chempedak area was prepared, while further work is necessary in the Kedah-Perlis area.

c. Experimental Stations - characterization of soils programme

In the revised programme for the characterization of the soils in all experimental stations in West Malaysia, the combined efforts of the soil surveyors and soil chemists were called upon to carry out detailed surveys and samplings according to soil types for full analyses.

The following stations were surveyed and samples collected for analyses:-

Perlis - Bukit Temiang Station

Soils mapped were mainly the Chuping Series with minor variations in colour and texture. A reddish soil, not unlike the Serdang Series was also mapped. Odd patches with limestone concretions are also present. These soils with the concretions are paler in colour and heavier in texture than the Chuping Series.

Pahang - Cameron Highlands Station

Soils mapped consists mainly of the Bukit Temiang Series from granites in steep terrain, together with steetches of alluvium in the valleys and colluvium at the foot of the hills.

Trengganu

Eleven State and one Federal Station were surveyed. The Padang Ipoh stationwhich was indicated in the area as suitable for maize was having so some difficulty as the maize trials laid down were not doing well. As far as the physical and chemical properties of the soils (Padang Ipoh Series - tentative - on the higher levels of the low terraces associated with the coastal plains of Trengganu) were concerned, there did not seem to be any limitations to maize growth. The availability of moisture could be the cause of the failure.

Johore

Parit Botak Station

The many samples collected in a grid system for pH determinations and sulphate content has proved very useful. pH were all below 4 and the sulphate contents were medium to high. A pH map and a soil map were produced. These soils were acid sulphate soils, although they were mapped as Selangor shallow phase in the previous survey. This was due to a lack of correlation by the supervising officer, as the drains now show signs of jarosite being formed. This will mean that most of the shallow Selangor Series in this part of Johore will have to be viewed with caution.

Perak - Telok Baharu Station

Soils are mainly of the Kangkong Series, with only minor variations in depth. This soil, with drainage would be excellent for coconut.

(D) Ad hoc surveys

(a) State Schemes

These were mainly requests received from the State Agricultural Officers for the soils in proposed areas for development to be examined and the suitability rated.

1. Kelantan

Six areas for clearance regarding the suitability of these areas for agriculture were received from the SAO. These were requests for mining prospecting. They were reported on, based on information of topography and the field records of the reconnaissance survey of the State.

2. Trengganu

Two proposed schemes totalling 36,000 ac. were examined during the first quarter. During the third quarter, four areas in the Marang District were examined for suitability for tapioca.

(a) Mukim Jerong

65% in steepland with shallow Kuala Brang Series unsuitable. Remaining 35% on Marang Apek Association which are marginal for tapioca.

(b) Buloh Nipis & Bt. Kuang

25% on steepland would be unsuitable. 25% is swampy land which is waterlogged for the greater part of the year which with drainage could be used for tapioca. The ramaining 50% is on Marang Apek Association which is marginal.

(c) Sg. Karak

The eastern portion is suitable as the soils were Serdang-Holyrood association. The western area consists of nearly half on steepland and the ramaining area on the Marang-Apek Association (marginal).

(d) Merang Scheme

The area consists of organic clay and gley clays with high water table. When drained the area could be developed.

In addition, an area of 200 ac. in the Parit Memarit Kijal was examined for padi. Soils are organic clay and shallow peat in permanent swampy land. The area is marginal.

(e) Parit Memarit Kijal

An area of 200 acres was examined for an irrigation scheme for padi. This consists of a permanent swamp with organic clay and shallow peat soils of marginal suitability for padi even if the area can first of all be drained.

3. Pahang

In addition to the proposed padi schemes which were examined in greater detail than usual, the Cameron Highlands area was also examined for suitability for tea. Five areas were examined. Slopes of up to 35 degrees are considered suitable for tea cultivation if other factors are favourable. One area of 5,000 acres is considered unsuitable. Two of the areas are within the catchment area for the hydroelectric scheme. The dam is already being silted much quicker than anticipated because of severe erosion and the intensive type of cultivation, and opening of forested areas for agriculture within the catchment will further aggravate the situation.

4. Johore

(a) Ban Foo II (app. 900 ac.)

Soils are mainly Harimau Series with some Ulu Tiram and Local Alluvium. Suitable for agriculture.

(b) Sungei Pengaleh (app. 1100 ac.)

Soils are mainly Harimau Series on undulating to rolling terrain, with the river valleys occupied by Local Alluvium.

(c) Batu 52½ miles Simpang Rengam Road, Ayer Hitam (app.500 ac.)

The area consists of peat more than 6 feet deep, and only marginal for agriculture.

(d) Machap Dalam VII (app. 600 ac.)

Soils are mainly Durian Series on the upland areas with peat and riverine alluvium in the lowlying areas.

(e) Sungei Inas (app. 3 square miles)

More than 60% of the area are on terrace alluvium consisting mainly of Holyrood and Harimau Series, while the remaining area is of riverine alluvium.

(f) Sungei Seluyut (app. 640 ac.)

Soils are mainly Rengam Series with the river valleys of riverine alluvium.

(g) Mambai Forest Reserve (3,000 ac.)

The area consists mainly of Rengam Series, Serdang-Munchong Association and a small area of steepland. Except for the the steepland, the rest of the area is suitable for oil palm.

(h) Triang Kechil Drainage Scheme

The soil map was extracted from the Reconnaissance survey for the SAO. Indications are however, that the area has very low potential for padi, as the soils are mainly Rudua, Rusila and sedentary soils. Only a small area is of alluvial soils.

(i) Sg. Belitong II

Soils are mainly Harimau Series on rolling terrain, with small patches of riverine alluvium.

(j) Chaah Padi Scheme (13,000 ac.)

The area is covered mainly by alluvial soils of which the organic clay and muck are prominent. Peat of 2 to 6 feet deep are also found in the south. The potential for padi is marginal.

(k) Proposed tapioca area (2,500 ac.)

Approximately 70% of the area are of soils of the Serdang and Durian Series, with small areas of Malacca aseries and some tuff derived soils. Organic clays are found along the river valleys. The Serdang & tuff derived soils are suitable, while the Durian series are marginal. Malacca Series is not suitable for tapioca, while the organic clays need to be drained.

(l) Ulu Sg. Johor (320 ac.)

Soils are mainly Rengam Series with alluvium bordering the river. Suitable for development, but the alluvium is seasonally flooded.

(m) Ulu Jementah, Segamat (500 ac.)

Soils are mainly Serdang Series with small pockets of riverine soils.

(n) Kg. Sayong & Kg. Gambot, Sedeli Besar

This low lying area proposed for padi consists of peat with some riverine soils and surrounded by sedentary soils, and has very low potential for padi.

(o) Replanting Scheme, Jabi (2,000 ac.)

The soils are Tavy and Bungor Series from shales, and suitable for rubber.

5. Perak

(a) Batang Padang (1,500 ac.)

Soils are mainly Holyrood-Manik and Serdang-Munchong associations, and has been recommended for rubber, oil palm and mixed annual crops.

(b) Hutan Simpanan Bintang Hijau & Piah (1,075 + 1100 ac.)

The Bintang Hijau Reserve is not suitable for agriculture as the slopes are vey steep. In the Piah Reserve, the soils of the Kala Series occupy about 500 ac. while the ramaining 600 ac. are on steep land.

(c) Ayer Panas (1000 ac.)

70% are on the Chenian Series while the ramaining 30% are on steepland, and the area has been recommended for rubber.

(d) Perloh Extension (1,250 ac.)

About 1000 ac. are on steepland and unsuitable for oil palm. The remaining 250 acres are on Chenian Series with some Apek and con... considered marginal for oil palm.

(e) Trans-Perak Stage II Changkat Chermin Area (11,300 ac.)

Shallow peat, organic clay and mucks occupy about 5000 ac. and should be suitable for shallow rooting crops with the correct fertiliser applications. Sogomana-Sitiawan-Holyrood Association occupy about another 5,000 ac. while the rest of the area consists of Telemong-Akob Association, and the Serdang-Munchong Association. All these soils have good potential for rubber, tapioca and other cash crops.

6. Selangor

(a) Ranchangan Tanah Duabelas, Kuala Langat (3,000 ac.)

The soils are mainly Briah-Akob Association and has been recommended for padi.

(b) Chier Game Reserve

This area was examined but the greater portions of which are only of marginal suitability for oil palm. The required 200 acres for a Youth Scheme will have to be augmented by land across the river.

7. Negri Sembilan

(a) Jelai Forest Reserve

The area was proposed for a banana scheme, but the soils are lateritic or shallow and not suitable for banana.

(b) Hutan Simpanan Kenaboi (1,000 ac.)

The area is unsuitable for agriculture because of steep slopes.

(c) Ayer Hitam Area for sugarcane

The area north of the Ladang Gedes had been surveyed for FLDA and reported on. A copy of the report was extended to the S.O

8. Perlis

A total of 2,000 acres in the state were examined for smallholders for cash crop cultivation. These are mainly on terrace alluvium and have been recommended for vegetables and other shallow rotting crops.

(a) FLDA proposed schemes

The proposed schemes for development were inspected and reported on:-

State	No. of Schemes	Acreages
Selangor	1	10,000 ac.
Trengganu	1	2,000 ac.
Pahang	1	4,000 ac.
Perak	1	2,000 ac.
Johore	3	2,300 ac.
Perlis	1	

(b) Estates for soil suitability certificates for oil palm

Pahang. Ulu Keratong (6,000 ac.) were found to be suitable for oil palm.

Trengganu:

Jabor Valley Estate (2700 ac.) on Hengam & Kuantan Series were certified as suitable.

Johore. Bukit Katil Estate on Brian-Selangor Associations were certified suitable for oil palm with drainage.

Selangor.

Permatang Estate (29.5 ac.) on Permatang Series were certified as marginal for oil palm.

Seng Ho Estate, Klang (90 ac.) on Serdang-Munchong Association were certified as suitable for oil palm.

Correlation

The following correlation trips were made during the year, to correlate the soils or checking the soil units before the preparation of the soil maps:

1. Parit Botak Station & Kulai Young Estate.

2. Johore Tengah Area, Phase I & II.

3. Kemubu Scheme, Kelantan.

4. Kuantan Area for tapioca.

5. Two trips were made with the Huntings Consultant soil survey team. The first was a familarization tour of the South Johore Area, during which representative soils mapped in the area were shown. The second trip was to correlate the soils in the vicinity of Kota Tinggi area which has been selected by the team as a preliminary study area.

6. A correlation to the Bukit Cheraka Estate to check on the mapping units of the estate so that the surveyor can use these as guides for the survey of other estate in the Barlow group of estates, was carried out late in the year.

Miscellaneous

Visitors included Mr. Robinson, Huntings Technical Services Ltd. who came for discussion and consultation regarding the soil survey of the Johore Tengah & Tg. Pengarang Area.

The senior officials of the Engineering Resources of Canada came in to find out more about the South East Pahang area to enable them to put up a final proposal for the feasibility study.

Present Land Use Section

1:25,000 PRESENT LAND USE MAPPING:

The 1: 25,000 Land Use Mapping programme has been completed.

The total national coverage at this scale is 728 sheets. 46 sheets with no agricultural land use (containing 7F, 7S 6 and 8 only) are not compiled. The total number of sheets fairdrawn is therefore 682.

	TOTAL NATIONAL COVERAGE	COMPLETED IN 1969	TOTAL COMPLETED	SHEETS REMAINING
INTERPRETATION AND COMPILATION SHEETS COMPLETED. (including sheets with no agricultural land use)	728	195 (27%)	728 (100%)	NIL
AREA MEASUREMENT COMPLETED (Including sheets with no agricultural land use)	728	263 (36%)	728 (100%)	NIL
FAIRDRAWN SHEETS COMPLETED	682	317 (46%)	682 (100%)	NIL

2 MILES TO 1 INCH PRESENT LAND USE STATE MAPPING

STATE	NO: OF SHEETS COVERING EACH STATE	LAND USE COMPILED	SHEETS FAIRDRAWN	PUBLISHED IN BLACK & WHITE	COLOUR PREPARATION	PUBLISHED IN COLOUR
Malacca	1	1	1	1	1	1
Negri Sembilan	1	1	1	1	IN PRODUCTION	-
Penang/Province Wellesley	1	1	1	1	1	-
Selangor	2	2	2	2	-	-
Johor	4	4	4	4	-	-
Perlis	1	1	1	1	IN PRODUCTION	-
Kelantan	3	3	2	-	-	-
Pahang	5	5	3	-	-	-
Kedah	2	2	-	-	-	-
Trengganu	2	-	-	-	-	-
Perak	3	IN PRODUCTION	-	-	-	-

REPORTS: The following reports were published:-

1) Land Use Report of Penang/Province Wellesley
2) Land Use Report of Selangor
3) Land Use Report of Johore
4) Capability Classification for Outdoor Recreationof Penang Island
5) Aerial Photo Index of West Malaysian Land Use.

The draft for the Land Use Report of Perlis was completed. Reproduction is now in progress.

MAP SHEET DELIVERIES:

Of the 6,888 copies of map sheets delivered to date, 5,091 were delivered in 1969.

STAFF:

Canadian Colombo Plan Specialist	2
Malaysian Counterparts	3
Compilation Section	15
Area Measurement	2
Hand Colouring & Report Binding	7
Draughting	5
Colour Separation	4
Typist	2
	40

The interpretation section, having completed the interpratation of al' moved out of the premises in the Survey Headquarters, Jalan Gurney, in June 1[illegible] Interpreter has since returned on completion of his contract. The two techr the Survey Department have also returned back.

Of the 40 persons connected with the project, 2 are Canadian temporary staff.

(K. KANA[illegible]Y),
Senior Che[illegible]ist.

/lml.