CHARACTERISTICS OF SOME SOILS IN PENINSULAR MALAYSIA

Published as Part of the
Tour Guide for Pre-Conference Tour
8~12 AUGUST 1977

CLAMATROPS

Conference on Classification and Management of Tropical Soils

KUALA LUMPUR, MALAYSIA
15~20 AUGUST 1977

MALAYSIAN SOCIETY OF SOIL SCIENCE

CHARACTERISTICS OF SOME SOILS IN PENINSULAR MALAYSIA

Published as part of the Tour Guide

for Pre Conference Tour

August 1977.

Published by

The Malaysian Society of Soil Science

c/o P.O. Box 150, Kuala Lumpur

Malaysia

CONTENTS

		Page
PREFACE		v
I. PHYSICAL ENVIRONMENT		1
1.1	Location	1
1.2	Physiography	1
1.3	Climate	4
1.4	Vegetation	10
1.5	Geology	13
1.6	Present land use	14
II. PROFILE CHARACTERISTICS		16
Pedon 1	Lanchang series	17
Pedon 2	Segamat series	21
Pedon 3	Bungor series	24
Pedon 4	Rasau series	28
Pedon 5	Lunas series	31
Pedon 6	Kuantan series	34
Pedon 7	Rudua series	37
Pedon 8	Rengam series	40
Pedon 9	Kuala Brang series	45
Pedon 10	Organic clay	47
Pedon 11	Tai Tak series	48
Pedon 12	Ulu Tiram series	50
Pedon 13	Senai series	52
Pedon 14	Jerangau series	54
Pedon 15	Batu Anam series	56
Pedon 16	Durian series	59
Pedon 17	Parit Botak series	63
Pedon 18	Linau series	64
Pedon 19	Malacca series	67
Pedon 20	Briah series	70
Pedon 21	Sungei Mas series	72

Page

III. SOIL SUITABILITY FOR MAJOR PERENNIAL CROPS 77

Introduction 77

Soil Suitability for Rubber 79

Soil Suitability for Oil Palm 85

Soil Suitability for Cocoa 89

PREFACE

The objective of this publication is to highlight the characteristics of some of the common soils mapped in Peninsular Malaysia, Sabah and Sarawak so that it serves as a guide or forms the basis for discussion during the pre- and post-conference tour of the Conference on Classification and Management of Tropical Soils, organised by the Malaysian Society of Soil Science, in Kuala Lumpur on 15-20th August 1977. For convenience the publication is presented in two volumes for the respective tours.

The agricultural sector plays an important role in the Malaysian economy. In 1976, Agricultural output accounted for 30 percent of the Gross Domestic product, and this is expected to increase significantly in the coming years. The development in this sector will contribute significantly to the achievement of the objectives embodied in the new economic policy, particularly the eradication of poverty and the improvement of the productivity of the labour force through its transfer into high productivity agriculture. To accelerate the expansion and modernisation of the agriculture sector, large land development schemes are being launched. Optimum utilisation of land resources become imperative to sustain the high level of Agricultural productivity, and it is here that Soil Science plays a key role. A sound knowledge of the physical and chemical properties of the soil is necessary for us to be able to predict the behaviour and response of these soils to different levels of management.

In selecting the profiles, an attempt has been made to encompass a wide range of soils. From the landuse point of view, in this case primarily agricultural these include the good, marginal and problem soils.

The nature of these soils also focusses attention on some of the problems in field mapping and classification of these soils. It is

hoped that the examination of these profiles will highlight the need to reasses some of the criteria used in the classification of the tropical soils. For example, the permanent charge of 1.5 meq. is used in soil taxonomy to separate the highly weathered oxisols (Acrorthox) from other oxisols. The criteria is often very difficult to apply or determine. Another important criteria is the presence of ironstone nodules in the solum, a widely occurring feature in Peninsular Malaysia. Although these nodules form an important root restricting layer, this criteria is only considered at the family level in soil taxonomy. There may need to consider this criteria at a higher level.

Various organisations contributed towards the compilation of these 2 volumes: these were the Department of Agriculture in Peninsular Malaysia, Sabah and Sarawak; MARDI: RRIM and UPM. Special mention must be made for the notable contributions made by Dr. H. Eswaran and all others in the Tours Sub-Committee without whose efforts, encouragement and advice this work would not have been possible. Additionally the contribution of Mr. Chew Poh Soon on the soil sutability evaluation for oil palm and cocoa is also acknowledge.

The composition of the committee responsible for the Tour and compilation of these two volumes are:

Chairman:	B. Gopinathan
Co-Chairman:	Dr. S. Paramanathan
Secretary:	Noordin Daud
Members:	C.P. Lim
	M.S. Kalsi
	Dr. H. Eswaran
	E. Pushparajah (Ex Officio, President MSSS)
	H.Y. Chan (Ex Officio, Secretary MSSS)

August, 1977.

B. Gopinathan

1. PHYSICAL ENVIRONMENT

1. PHYSICAL ENVIRONMENT

1.1 LOCATION

Peninsular Malaysia is situated near the equator between latitudes 1° 15'N and 6° 45'N and longitudes 99° E and 104° 20'E (Fig 1). To the east of the Peninsular lies the South China Sea while to the west is the Straits of Malacca. The country has an area of 13.2 million hectares. Its greatest length is about 736 kilometres and the maximum width is about 320 kilometres.

Peninsular Malaysia consists of eleven states: Perlis, Kedah, Pulau Pinang, Perak, Selangor, Negri Sembilan, Melaka, Johor, Kelantan, Trengganu and Pahang. It has a population of 10.3 million (1976 estimate) made up of 5.5 million Malays, 3.6 million Chinese and about 1 million Indians.

1.2 Physiography

The physical relief is dominated by the central mountain range which runs nearly through the middle of the Peninsular and up to a height of about 2,200 metres. Secondary ranges fan out from this, mainly in the northern half of the country. These ranges consist of steepland with slopes exceeding 25° and constitute some 40% of the total land surface. From these mountain systems, many rivers flow through hilly, rolling and undulating lowlands towards the floodplains, coastal flats and beach ridges. The intermediate lowlands lie mainly between 20-160 metres. The west coast is dominated by clay deposits of marine and riverine origin while the east coast exposes sandy beach ridges (Fig 2).

About 9 percent of the land area is swampland, mainly in the coastal depression. Peninsular Malaysia has about 1200 miles of coastline.

FIG. I LOCATION OF SOIL PITS

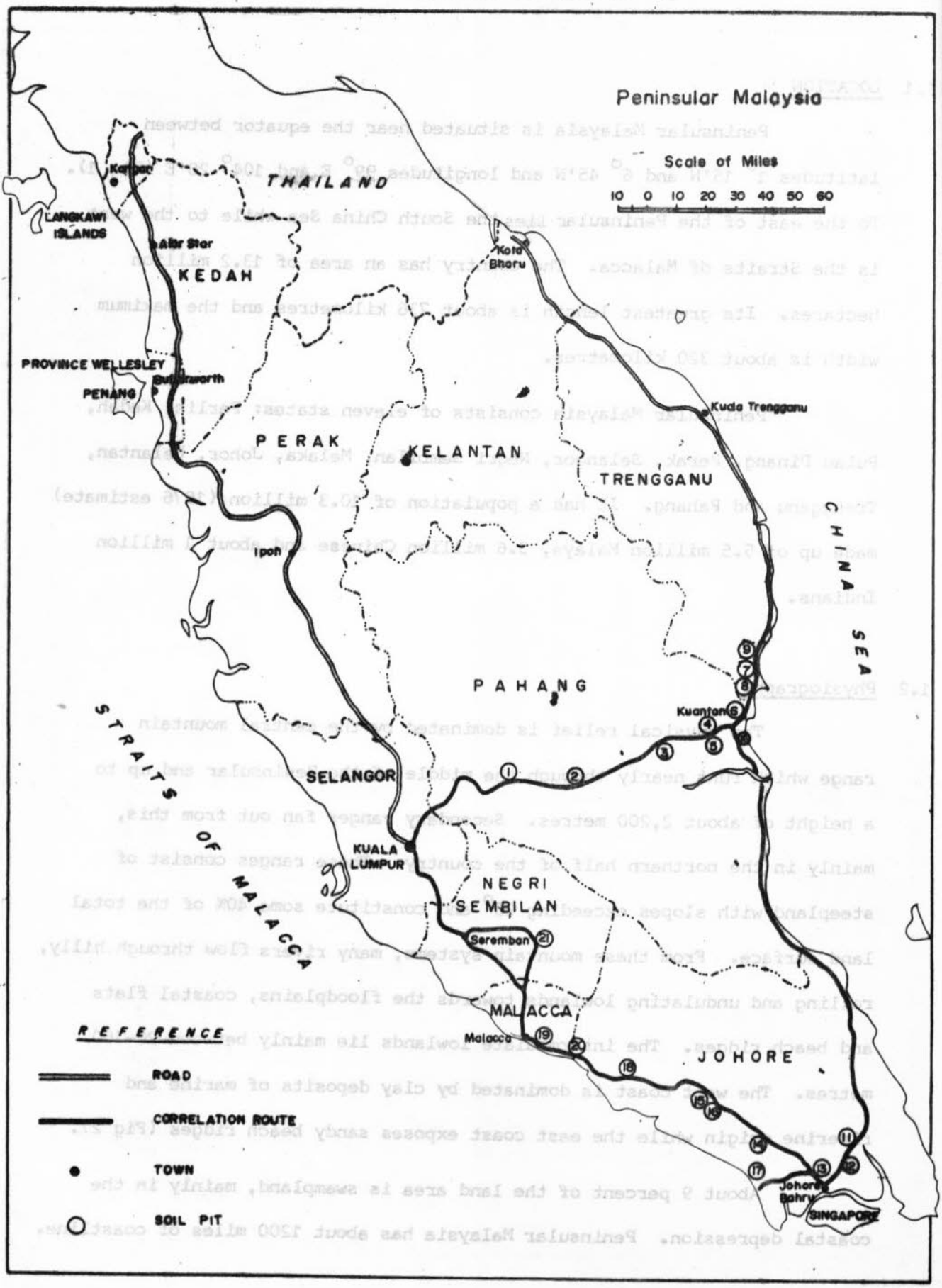
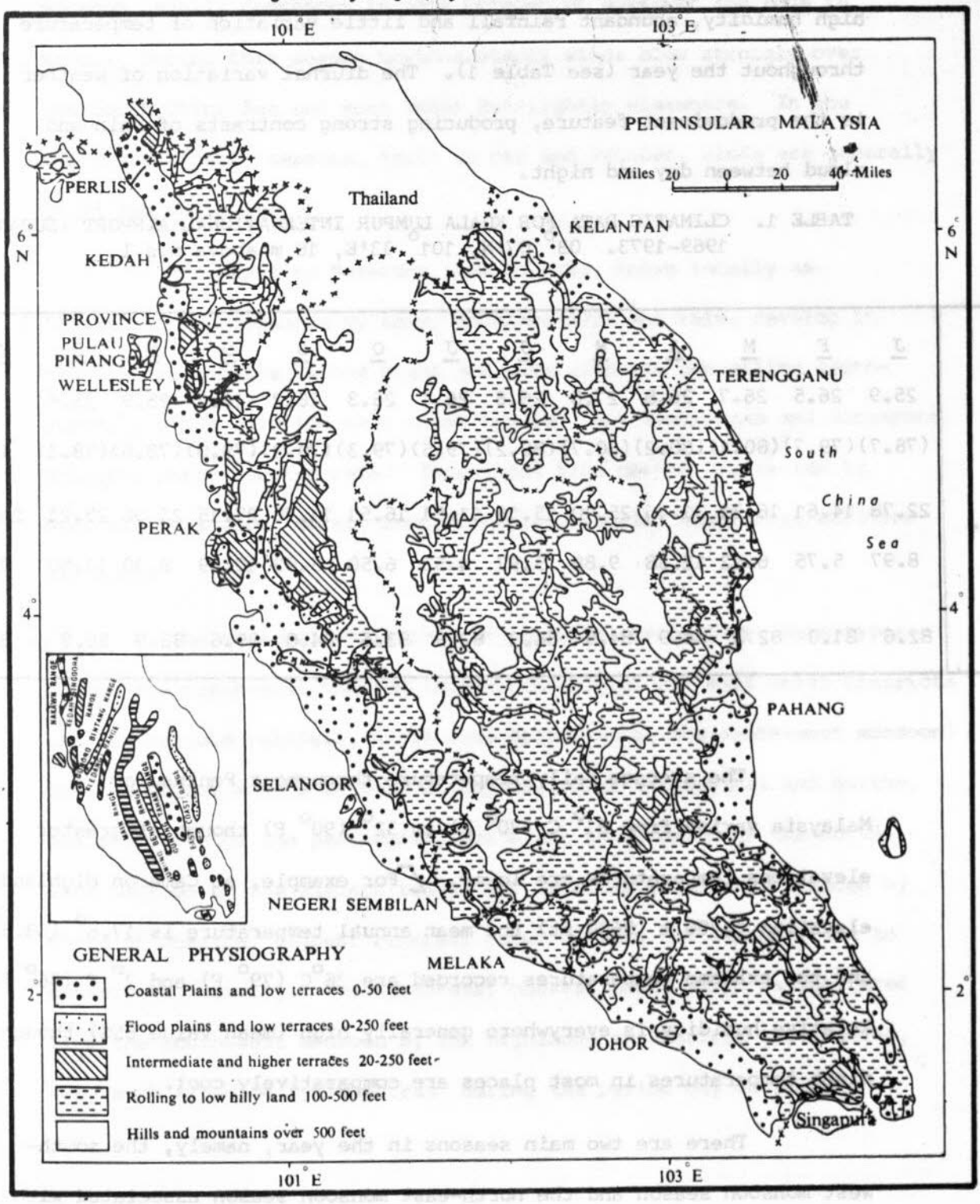


Fig. 2. Physiography of Peninsular Malaysia



1.3 CLIMATE

The climate of Peninsular Malaysia is characterized by high humidity, abundant rainfall and little variation of temperature throughout the year (see Table 1). The diurnal variation of weather is the predominant feature, producing strong contrasts of rain and cloud between day and night.

TABLE 1. CLIMATIC DATA FOR KUALA LUMPUR INTERNATIONAL AIRPORT (SUBANG), 1969-1973. 03° 07'N, 101° 33'E, 16 m above m.s.l.

	J	F	M	A	M	J	J	O	S	O	N	D	Year
Temp.	25.9	26.5	26.7	26.8	27.0	26.8	26.4	26.3	26.2	26.1	25.9	25.6	26.
	(78.7)	(79.7)	(80.1)	(80.2)	(80.7)	(80.2)	(79.5)	(79.3)	(79.2)	(79.0)	(78.6)	(78.1)	(79.
Precip.	22.78	14.61	16.31	31.45	25.10	15.16	11.51	16.51	14.78	27.15	21.08	29.21	245.6
	8.97	5.75	6.42	12.38	9.88	5.97	4.53	6.50	5.82	10.69	8.30	11.50	96.7
R.H.	82.6	81.0	82.3	84.9	84.9	84.3	82.9	83.6	84.8	85.6	86.9	86.9	84.2

The average daily temperature throughout Peninsular Malaysia varies from 21° C (70° F) to 32° (90° F) though at greater elevations temperatures are lower. [For example, at Cameron Highlands, elevation 1,700 m (5600 ft) the mean annual temperature is 17.6° (63.8° F and the extreme temperatures recorded are 26°C (79° F) and 2° C (36° F)] Relative humidity is everywhere generally high (mean value 85%) though night temperatures in most places are comparatively cool.

There are two main seasons in the year, namely, the south-west monsoon season and the north-east monsoon season associated with the periodic changes in the prevailing winds. There are two transitional periods separating the two monsoons. The south-west monsoon is usually

established in the latter half of May or early June and ends in September. The winds are light south-westerly. The north-east monsoon usually commences in late October or November and ends in March. During this season north-easterly winds blow strongly over the South China Sea and east coast but lightly elsewhere. In the two transitional seasons, April to May and October, winds are generally light and variable.

For April to November line squalls, known locally as 'Sumatras', accompanied by heavy thunderstorms and rain, develop in the Malacca Straits in the night and move with the prevailing south-westerly winds onto the west coast between Port Swettenham and Singapore bringing early morning rain. Throughout this period the region is overlain by a warm, moist, conditionally unstable, equatorial maritime air mass.

The seasonal variations of rainfall are of three main types. During the north-east monsoon (November-January) the east coast districts get the maximum rainfall, while June-July (during the south-west monsoon) are the driest months in most districts. Over the central and north-eastern parts of the peninsular, which are sheltered from the north-east monsoon by the eastern ranges and from the south-west monsoon by those of Sumatra, highest rainfall occur between the seasons, due to convective activity. The south-west coastal area, which is sheltered from the south-west monsoon by the highlands of Sumatra, is, however, very much affected by 'Sumatras' during the period May to August.

The annual rainfall is high over the whole of the peninsular and varies from place to place, generally lying between 2,000 m (78 in.) and 3,000 mm (120 in), no one place being extremely dry or wet. The driest is Jelebu with 1,670 (65 ins) and the wettest is near Taiping with 5,900 mm (232 ins) (See Fig. 3) Heavy falls are common but they are of short duration, except on the east coast during the north-east monsoon, particularly in November and December. Very heavy rain storms often causing severe flooding are not infrequent and more than 380 mm (15 ins) in 24 hr have been recorded on occasions on the east coast. Dry spells, sometimes lasting for three or four weeks, may occur at times.

According to Koppen's classification, Peninsular Malaysia has Afi climate (Tropical Rainforest), with temperature and precipitation both remaining high throughout the year and the range of temperature between warmest and coldest months less than 5° (9° F). In the extreme north-west of the peninsular, the climate tends to be Am (Tropical Monsoon) with a distinct dry season in January and February. In the 1948 Thornthwaite classification, Peninsular Malaysia has Humid Tropical Rainforest climate, ArA'a', which is per humid, megathermal with no season of water deficiency, and a temperature- efficiency regime normal to a megathermal climate.

As distinct from the atmospheric climate, the soil climate, or pedoclimate, is characterized by the soil temperature and soil moisture regimes (Soil Taxonomy, Soil Survey Staff, 1975).

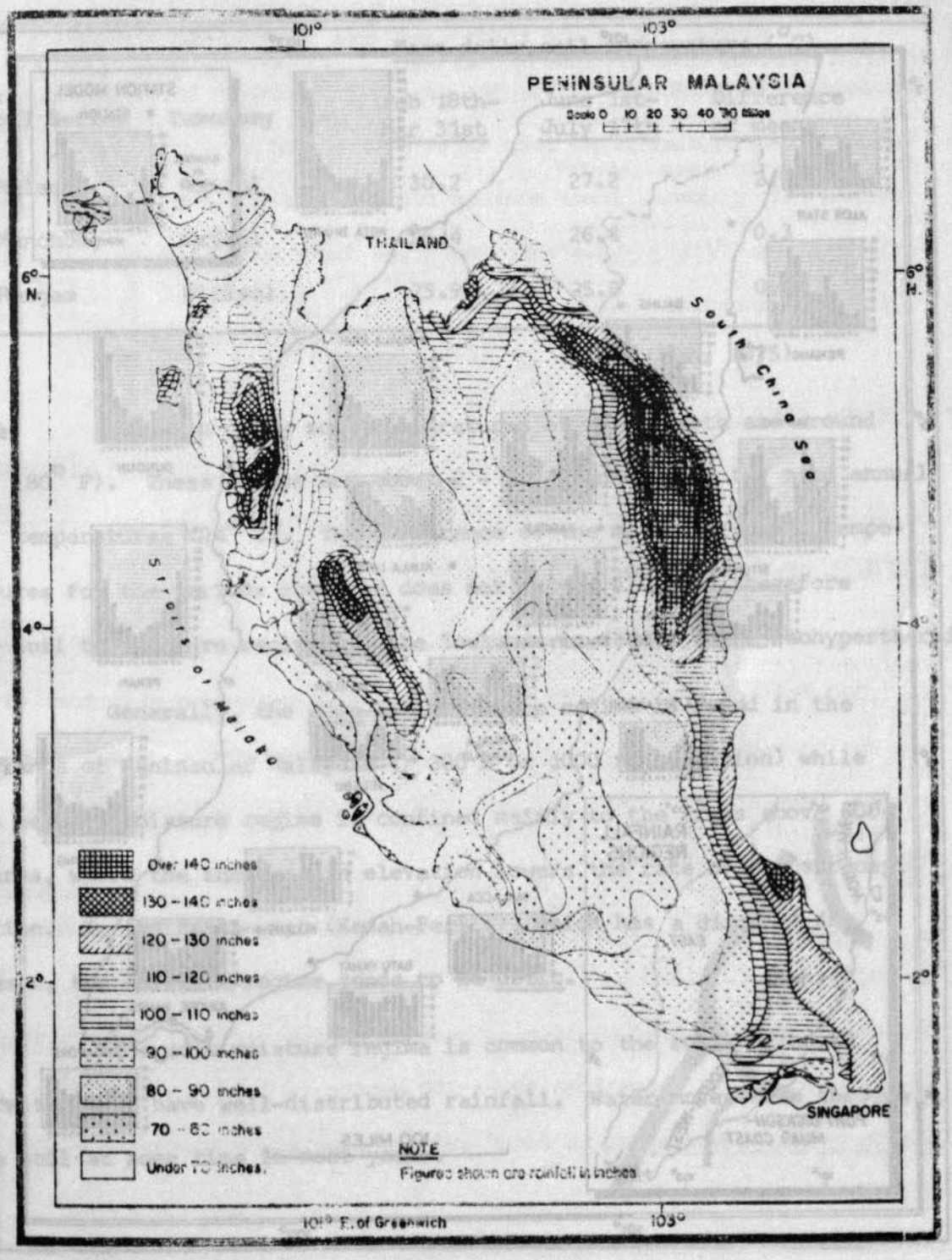
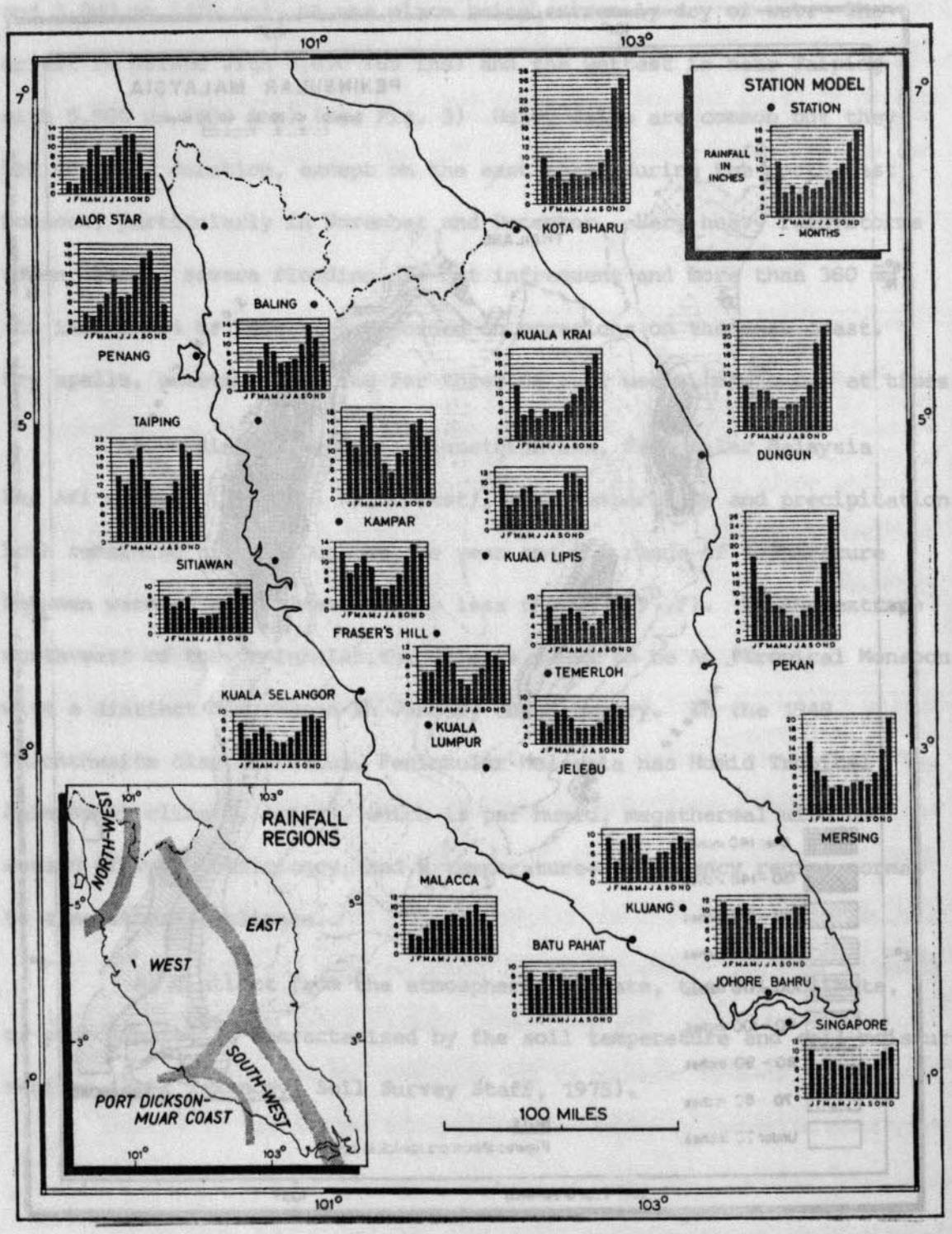


Fig. 3.1. Mean Annual Rainfall
(1950—1965. Supplied by the Drainage and Irrigation Department, Peninsular Malaysia)

Fig. 3·2. Average Monthly Variation of Rainfall, and Rainfall Regions.



Mean daily soil temperatures of 3 soils under nature rubber (measured at 50 cm depth in 1970)

Soil Series	Taxonomy	Mean daily soil temperature (°C) Feb 18th–Mar 31st	June 1st–July 17th	Difference of means
Malacca	Oxisol	30.2	27.2	2.9
Munchong	Oxisol	26.4	26.1	0.3
Rengam	Ultisol	25.9	25.8	0.1

(After Chan, 1975)

The mean daily soil temperatures at 50 cm depth are around 26° (80° F). These values are about 2 - 3 °C higher than the mean annual air temperatures (24° C). The difference of the mean daily soil temperatures for the periods compared does not exceed 5°C, and therefore the soil temperature regime for the lowlands is deemed to be isohyperthermic.

Generally, the udic soil moisture regime is found in the lowlands of Peninsular Malaysia (/ 300 m or 1000 ft elevation) while the perudic moisture regime is confined mainly to the areas above 300 metres, where the increase in elevation lowers the rate of evapotranspiration. In the north-west (Kedah-Perlis), which has a distinct dry season, the moisture regime tends to be ustic.

The udic moisture regime is common to the soils of humid climates that have well-distributed rainfall. Water moves down through the soil at some time in most years.

1.4 VEGETATION

1.4.1 General

Almost 60% of the total land area of Peninsular Malaysia is under forest (Wong, 1971). The dryland vegetation of Peninsular Malaysia can be classified into three main formation types, namely lowland rain forests, lower montane rain forests and the upper montane rain forests. Fig 1 shows the simplified distribution of the vegetation types in Peninsular Malaysia.

1.4.2 Lowland Rain Forests

The lowland rain forest formation type occuring at elevations below 800 metres (± 2,500 ft), can be divided into Lowland Dipterocarp Forest and Hill Dipterocarp Forest. (Symington, 1943).

The Lowland Dipterocarp Forests which occur below 300 metres (± 1,000 ft) are dominated by the family Dipterocarpaceae with species of the Red Meranti Group of Shorea forming a high percentage of the upper storey. Variations in the dominant species with the different parts of the country is quite evident.

The Hill Dipterocarp Forests occur between altitudes of 300 to 800 metres (± 1,000 to 2,500 ft). Many of the lowland species become scarce and are replaced by species such as Shorea curtisii particularly on ridge tops. At elevations above 300 metres (± 1,000 ft) the tree fern Thelypteris chlamydophora is found and its population increases with elevation.

1.4.3 Lower Montane Rain Forests

Lower Montane rain forests occur between altitudes of 800 to 1,600 metres (± 2,500 to 5,00 ft). This formation type is subdivided

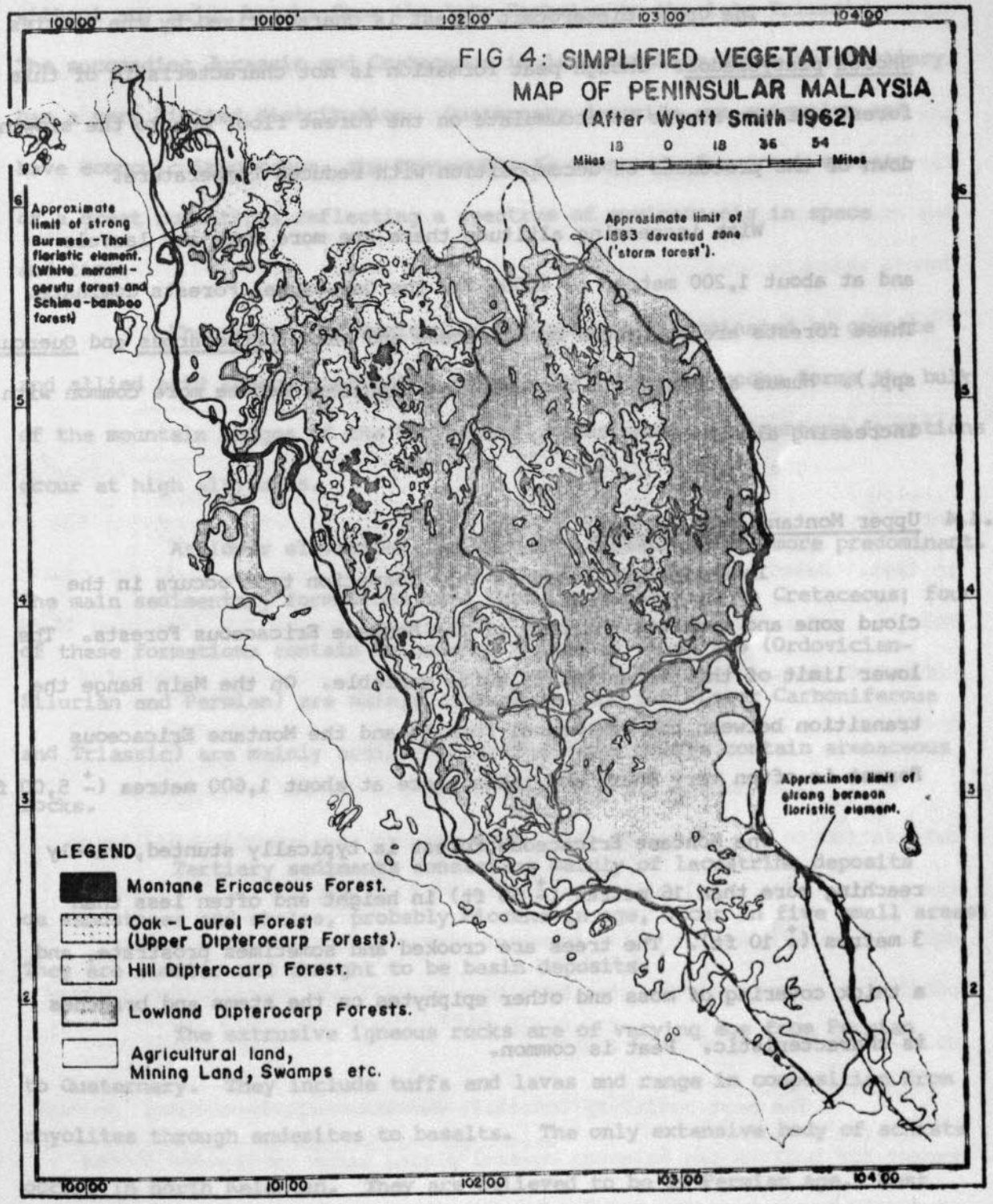


FIG 4: SIMPLIFIED VEGETATION MAP OF PENINSULAR MALAYSIA
(After Wyatt Smith 1962)
18 0 18 36 54
Miles Miles
100 00' 101 00' 102 00' 103 00' 104 00'
Approximate limit of strong Burmese-Thai floristic element. (White meranti-gerutu forest and Schima-bamboo forest)
Approximate limit of 1883 devasted zone ('storm forest').
Approximate limit of strong bornean floristic element.
LEGEND
Montane Ericaceous Forest.
Oak-Laurel Forest (Upper Dipterocarp Forests).
Hill Dipterocarp Forest.
Lowland Dipterocarp Forests.
Agricultural land, Mining Land, Swamps etc.

into the Upper Dipterocarp Forests between 800 to 1,200 metres (± 2,500 to 4,000 ft) and the Oak-Laurel Forests.

The Upper Dipterocarp Forest is characterized by the species Shorea platyclados. Though peat formation is not characteristic of this forest, litter starts to accumulate on the forest floor due to the slowing down of the processes of decomposition with reduced temperature.

With increasing altitude there are more oaks and laurels and at about 1,200 metres (± 4,000 ft) the Oak-Laurel Forests dominate. These forests are dominated by Lauraceae and oaks (Lithocarpus and Quercus spp.). Humus accumulation increases and ephytes become more common with increasing altitude.

1.4.4 Upper Montane Rain Forests

In Peninsular Malaysia this formation type occurs in the cloud zone and consists entirely of the Montane Ericaceous Forests. The lower limit of this formation is quite variable. On the Main Range the transition between the Oak-Laurel Forests and the Montane Ericaceous Forest is often very sharp and takes place at about 1,600 metres (± 5,00 ft)

The Montane Ericaceous Forest is typically stunted, rarely reaching more than 16 metres (± 50 ft) in height and often less than 3 metres (± 10 ft). The trees are crooked and sometimes prostrate, and a thick covering of moss and other epiphytes on the stems and branches is characteristic. Peat is common.

1.5 GEOLOGY

Peninsular Malaysia has a complete geological history without any major breaks from the late Cambrian to the late Triassic. The succeeding Jurassic and Cretaceous is less complete while the Tertiary has a very limited distribution. Quaternary deposits are extensive and have economic importance. The Peninsular is composed of a great variety of a great rock types reflecting a spectrum of environments in space and time.

The geology of Peninsular Malaysia is predominated by granite and allied acid igneous intrusive rocks. This group of rocks forms the bulk of the mountain ranges of the Peninsular. Occasionally sedimentary formations occur at high altitudes.

At lower elevations, sedimentary formations are more predominant. The main sedimentary formations date from Upper Cambrian to Cretaceous; four of these formations contain calcareous rocks, of which two (Ordovician-Silurian and Permian) are mainly calcareous, and two (Lower Carboniferous and Triassic) are mainly argillaceous; the other groups contain arenaceous rocks.

Tertiary sediments consisting mainly of lacustrine deposits os sandstones and shales, probably Miocene in age, occur in five small areas. They are similar and thought to be basin deposits.

The extrusive igneous rocks are of varying age from Permian to Quaternary. They include tuffs and lavas and range in composition from rhyolites through andesites to basalts. The only extensive body of schists occurs in north Kelantan. They are believed to be of Permian age. Most of the sedimentary formations have often undergone low grade metamorphism during the Jurassic.

Recent riverine and marine alluvium occur on the coastal plains and low hills inland particularly in Johore. Their thickness is variable but can attain depths reaching 160 metres (± 500 ft). On the west coast they are predominantly clayey while on the east coast they are distinctly sandy. As a result of Quaternary eustatic in sea level, riverine sediments have been deposited further inland than the present day coastal plain. This is particularly true for the southern part of Johore where unconsolidated sediments, known as the "Older Alluvium" form low hills (Burton, 1964).

1.6 Present Land Use:

The existing land use in Peninsular Malaysia has been estimated for the year 1966 by the use of aerial photographs taken throughout the count in 1966. Based on this study (Wong 1971) reported that 63.9% of Peninsular Malaysia under forest, 20.7% under agricultural use and the remaining 15.4% consisted of swampland, scrub grassland and urban and other associated areas.

The general pattern of development, is one of extensive cultivation on the plains of the west coast and the low hills adjoining the plains. The availability of extensive flat and undulating land with agriculturally suitable soils together with uniformly calm climatic conditions throughout the year have been significant contributing factors to the development of this region.

The east coast, by contrast, was less well developed; except for padi in the Kelantan coastal plain, large contiguous blocks of single crops were few and far between so that in comparison the pattern of development in the east coast was one of conglomeration of multiple variable small units.

Recent intensive development of these potential areas on the east coast by the Government has however changed the land use situation drastically. Large scale land development schemes such as the Jengka Triangle, Pahang Tenggara and Johor Tenggara have changed drastically the land use patterns in the east coast over the recent years.

The major land use categories in Peninsular Malaysia identified in the 1974 survey are given in Table 2.

TABLE 2. DISTRIBUTION OF AREA UNDER AGRICULTURE
(Based on 1974 statistics)

Crops	(hectares)
Rubber	1,693,052
Oil Palm	550.958
Rice	380,530
Coconuts	217,956
Cocoa	18,698
Coffee	7,530
Tapioca	11,562
Pineapple	21,842
Tea	3,354
Fruit trees	76,420
Other annual crops	173,371

Land area sq. km.	127,560.2
Total potential agricultural land (ha.)	8,100,000

Source: Land Use Section Department of Agriculture
Ministry of Agriculture Malaysia.

Crops	(Hectares)
Rubber	1,693,052
Oil Palm	590,958
Rice	800,230
Coconuts	217,956
Cocoa	16,898
Coffee	7,530
Tapioca	11,562
Pineapple	21,847
Tea	8,354
Other annual crops	173,371
Land area sq. km.	127,560.2
Total potential agricultural land (ha.)	8,100,000

Source: Land Use Section Department of Agriculture Ministry of Agriculture Malaysia.

2. PROFILE CHARACTERISTICS OF SELECTED SOILS

PEDON No. 1 : LANCHANG SERIES

Location:	Lanchang - Kg. Balok Road, Temerloh District; 88/092242
Parent Material:	Granodiorite
Topography:	Undulating
Elevation:	50 m
Slope:	6°
Vegetation/Land Use:	Secondary jungle
Drainage:	Well drained

Horizon	Depth	Profile Description
Ap	0 - 15 cm:	Dark yellowish brown (10 YR 4/4) clay loam; strong crumb and some fine medium subangular blocky; very friable; many fine and medium roots; many pores; many charcoal fragments; gradual wavy boundary.
B_1t	15 - 33 cm:	Yellowish brown (10 YR 5/6) clay; weak to moderate, medium and coarse subangular blocky breaking to medium and fine granules; friable; patchy discontinuous clayskins on ped faces and continuous along root channels; many fine and medium roots; many pores; few termite nests; diffuse boundary.
$B_{21}t$	33 - 58 cm:	Yellowish brown (10 YR 5/8) clay; coarse and medium subangular blocky; friable; discontinuous to continuous clayskins on large ped faces and along root channels; many fine roots; few channels; many pores, diffuse boundary.
$B_{22}t$	58 - 89 cm:	Yellowish brown (10 YR 5/8) clay; moderate to strong, medium and fine subangular blocky breaking to fine subangular blocky; friable; patchy to discontinuous clayskins on larger ped faces; few fine and medium roots; many pores; few channels; diffuse boundary.
$B_{23}t$	89 - 120 cm:	Yellowish brown (10 YR 5/8) clay; moderate coarse and medium subangular blocky; friable; discontinuous to continuous clayskins on large ped faces; few coarse and medium roots; few pores; no channels; diffuse boundary.

---ctd next..

PEDON No. 1 --(ctd)

$B_{24}t$	120 - 167 cm:	Yellowish brown (10 YR 5/8) clay; moderate coarse and medium subangular blocky; friable to slightly firm; discontinuous to continuous clayskins on large ped faces; few fine roots; no channels; few pores; diffuse boundary.
$B_{25}t$	167 - 210 cm:	Reddish yellow (7.5 YR 6/8) clay with few indistinct fine yellowish red (5 YR 5/8) mottles; moderate coarse and medium subangular blocky; friable to slightly firm; discontinuous to continuous clayskins on large ped faces; few fine roots; no channels; few pores; diffuse boundary.
B_3t	210 - 237 cm:	Reddish yellow (7.5 YR 6/8) clay with few fine and medium district yellowish red (5 YR 5/8) and brownish yellow (10 YR 6/8) mottles; moderate and coarse medium and fine subangular blocky; friable to slightly firm; discontinuous to continuous clayskins on larger ped faces; very few fine roots; no channels; few pores; sharp boundary.
C(R)	237 - 250 cm:	Weathering parent material with some weathered feldspars and few iron coated quartz gravel. Matrix colour strong brown (7.5 YR 5/8); massioc structure.

Classification:

a) Soil Taxonomy: TYPIC PALEUDULT (TYPIC KANDIUDULT)

b) FAO: DYSTRIC NITOSOL

PEDON 1. LANCHANG SERIES

Depth (cm)	Horizon	Granulometry				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N		
0-15	Ap	35.2	21.9	20.8	22.2	2.33	0.20	12	6.80
15-33	B_1t	50.9	19.0	13.5	16.6	0.93	0.14	7	7.41
33-58	$B_{21}t$	58.2	15.5	10.9	15.4	0.77	0.11	7	7.96
58-89	$B_{22}t$	61.3	14.3	10.4	14.0	0.54	0.10	5	8.22
89-120	$B_{23}t$	63.9	11.8	10.0	14.2	0.25	0.07	4	7.93
120-167	$B_{24}t$	63.6	13.4	11.1	11.9	0.22	0.06	4	8.23
167-210	$B_{25}t$	66.7	11.5	10.1	11.8	0.15	0.05	3	8.52
210-237	B_3t	65.3	14.7	9.7	10.3	0.21	0.04	5	8.91
237-250	C(R)	47.1	19.0	13.4	20.5	0.14	0.03	5	9.97

Horizon	Bulk Density gms/cc	Moisture (Volume %) at pF					Av. Moist (mn/m)		Porosity %
		0	1	2	2.54	4.19	⅓-15	1/10-15	
$B_{21}t$	1.17	66.9	53.8	46.7	43.0	38.6	44.0	81.0	56
$B_{23}t$	1.20	68.9	54.0	50.6	45.2	41.4	38.0	92.0	35
$B_{24}t$	1.21	73.6	58.1	51.4	47.8	44.8	30.0	66.0	55
$B_{25}t$	1.20	67.7	59.3	52.4	49.9	45.7	42.0	67.0	55
C(R)	1.17	70.9	62.0	55.8	49.0	45.2	38.0	106.0	56

Horizon	pH		△pH	1N - KCl		Exch. Cat.meq/100 gms Soil				Extr. Acidity
	H_2O	KCl		Al	H+	Ca	Mg	Na	K	
Ap	3.5	3.4	- 0.1	2.91	0.6	0.25	0.27	0.08	0.18	15.28
B_1t	3.8	3.7	- 0.1	2.3	0.4	0.04	0.06	0.03	0.16	8.88
$B_{21}t$	4.0	3.6	- 0.4	2.1	0.3	0.04	0.06	0.03	0.06	8.08
$B_{22}t$	4.5	3.8	- 0.7	1.7	0.2	0.07	0.06	0.05	0.03	6.88
$B_{23}t$	4.6	4.0	- 0.6	1.4	0.3	0.08	0.10	0.05	0.05	6.08
$B_{24}t$	4.9	4.4	- 0.5	0.6	0.1	0.07	0.03	0.03	0.03	5.10
$B_{25}t$	5.2	4.4	- 0.8	0.6	0.1	0.10	0.04	0.03	0.03	4.60
B_3t	5.3	4.8	- 0.5	0.6	0.1	0.07	0.03	0.03	0.04	4.88
C(R)	5.3	4.5	- 0.8	0.4	0.1	0.05	0.02	0.03	0.05	4.10

Pedon 1. --ctd.

Horizon	CEC meq/100 grm soil			CHARGE meq/100 grms clay					Base Sat. %		Al Sat on
	ECEC	NH_4OAc	Sum	PC	ECEC	NH_4OAc	Sum	POC	NH_4OAc	Sum	
Ap	4.28	8.64	16.06	10.4	12.1	24.5	45.6	35.2	9.0	4.8	78.
B_1t	2.99	5.68	9.17	5.1	5.9	11.2	18.0	12.9	5.1	3.2	68.
$B_{21}t$	2.59	5.53	8.27	3.9	4.4	9.5	14.2	10.3	3.4	2.3	91
$B_{22}t$	2.11	4.72	7.09	3.1	3.4	7.7	11.6	8.5	4.4	3.0	89.
$B_{23}t$	1.98	4.36	6.36	2.6	3.1	6.8	9.9	7.3	6.4	4.4	83
$B_{24}t$	0.86	4.12	5.26	1.2	1.3	6.5	8.3	7.1	3.9	3.0	76
$B_{25}t$	0.90	4.40	4.80	1.2	1.3	6.6	7.2	6.0	4.5	4.2	75
B_3t	0.87	4.20	5.05	1.2	1.3	6.4	7.7	6.5	4.0	3.4	77
C(R)	0.65	3.40	4.25	1.2	1.4	7.2	9.0	7.8	4.4	3.5	72

Horizon	TOTAL ANALYSIS % (CLAY)									Molar Ratio
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O^-	H_2O+	SiO2 / Al2O3
$B_{21}t$	46.5	32.4	11.1	0.1	0.1	0.2	0.1	ND	ND	2.4
$B_{23}t$	42.5	31.2	10.3	0.1	0.1	0.2	0.3	ND	ND	2.3
$B_{25}t$	42.5	32.2	11.1	0.2	0.1	0.3	0.2	ND	ND	2.2
C	41.6	31.6	12.5	0.1	0.1	0.3	0.2	ND	ND	2.2

PEDON No. 2 SEGAMAT SERIES

Location:	11th Milestone Temerloh - Kuantan Road
Parent Material:	Andesite
Topography:	Gently undulating
Elevation:	55 m
Slope:	6^{o}
Vegetation/Land Use:	Secondary jungle
Drainage:	Somewhat excessive

Horizon	Depth	Profile Description
A_{1-3}	0 - 4 cm:	Dark reddish brown (2.5 YR 3/4) clay; strong crumb; very friable; many fine roots gradual boundary.
B_{1ox}	4 - 33 cm:	Dark red (2.5 YR 3/6) clay; moderate medium subangular blocky; very friable; thin coatings on ped faces; many medium and few fine roots; diffuse boundary.
B_{21ox}	33 - 66 cm:	Dark red (2.5 YR) clay; weak fine subangular blocky; friable; thin patchy coatings on ped faces; few medium roots; diffuse boundary.
B_{22ox}	66 - 115 cm:	Dark red (2.5 YR 3/6) clay; weak to moderate; medium and fine subangular blocky; friable; thin coatings on ped faces; few fine roots; diffuse boundary.
$B_{23}ox$	115 - 147 cm:	Dark red (2.5 YR 3/6) clay; moderate medium and fine subangular blocky; friable to firm; thin coating on ped faces; few fine roots.

Classification:

a) Soil taxonomy: HAPLIC ACROTHOX

b) FAO: ACRIC FERRALSOL

PEDON 2. SEGAMAT SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N		
0-4	A_{1-3}	51.2	33.9	12.5	2.4	2.99	0.37	8	18.04
4-33	B_{1ox}	65.8	28.1	3.7	2.4	1.45	0.09	17	17.50
33-66	B_{21ox}	70.2	24.0	3.8	2.0	0.66	0.20	3	18.57
66-115	B_{22ox}	73.7	22.4	2.3	1.6	0.41	0.06	7	16.79
115-147	B_{23ox}	66.4	26.1	5.4	2.2	0.38	0.05	8	16.43
147-200	B_{24ox}	75.1	21.5	2.3	1.1	0.05	0.05	6	16.79

Horizon	Bulk Density gms/cc	Moisture (Volume %) at pF					A. Moist. mm/m		Porosity %
		0	1	2	2.54	4.19	1/3-15	1/10-15	
B_{21ox}	0.94	65.15	54.15	47.69	46.39	39.06	73.3	86.3	65
B_{22ox}	1.01	74.52	61.64	55.20	52.23	43.00	92.3	122.0	62
B_{23ox}	1.10	66.11	62.29	59.48	56.55	47.50	90.5	119.8	59
B_{24ox}	1.10	75.67	63.50	56.07	53.61	45.92	76.9	101.5	59

Horizon	pH		ΔpH	IN-KCL Al	Exch. Cat. meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_{1-3}	5.2	4.9	-0.3	2.54	6.97	2.39	0.09	0.42	13.56
B_{1ox}	4.6	4.3	-0.3	1.72	1.16	0.69	0.07	0.19	12.12
B_{21ox}	4.8	4.3	-0.5	0.71	0.30	0.48	0.07	0.14	9.12
B_{22ox}	4.7	4.4	-0.3	0.39	0.10	0.37	0.03	0.07	8.31
B_{23ox}	5.2	4.7	-0.5	0.53	0.24	0.62	0.03	0.02	9.31
B_{24ox}	5.4	4.8	-0.6	0.58	0.25	0.36	0.03	0.02	9.45

Pedon 2. --ctd.

Horizon	CEC meq/100 gms SOIL			CHARGE meq/100 gms CLAY					Base Sat.%		Al Sat.%
	NH_4Cl	NH_4OAc	Sum	PC	NH_4Cl	NH_4OAc	Sum	PDC	NH_4OAc	Sum	
A_{1-3}	8.24	10.88	23.43	24.2	16.1	21.3	45.8	21.5	90.7	42.1	20.5
B_{1ox}	3.18	5.68	14.23	5.8	4.8	8.6	21.6	15.8	37.1	14.8	44.9
B_{21ox}	3.12	4.68	10.11	2.4	4.4	6.7	14.4	12.0	21.1	9.8	41.8
B_{22ox}	1.22	4.12	8.88	1.3	1.7	5.6	12.0	10.7	13.8	6.4	40.6
B_{23ox}	2.16	4.00	10.22	2.2	3.3	6.0	15.4	13.2	22.7	8.9	36.8
B_{24ox}	2.12	4.04	10.11	1.7	2.8	5.4	13.5	11.8	16.3	6.5	46.8

TOTAL ANALYSIS (SOIL)

Horizon	Si_0^2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O^-	H_2O^+	SiO_2 / Al_2O_3	SiO_2 / R_2O_3
A_{1-3}	34.0	35.2	17.7	0.3	0.1	0.1	0.1	2.4	10.3	1.6	1.2
B_{1ox}	34.1	35.0	18.0	0.2	Tr	0.1	Tr	2.2	10.4	1.6	1.2
B_{21ox}	33.3	36.0	18.0	0.2	Tr	0.1	Tr	2.2	10.0	1.6	1.2
B_{22ox}	31.9	36.2	18.4	0.1	Tr	0.1	Tr	2.4	10.3	1.5	1.1
B_{23ox}	33.3	35.7	18.6	0.1	Tr	0.1	Tr	2.3	10.6	1.6	1.2
B_{24ox}	32.8	35.7	18.3	0.2	Tr	0.1	Tr	2.2	10.5	1.5	1.2

TOTAL MICRONUTRIENTS (ppm)

Horizon	Mn	Cu	Zn	Co	Ni
A_{1-3}	935	138	168	125	3.8
B_{1ox}	550	102	175	125	3.8
B_{21ox}	435	108	243	100	10.8
B_{22ox}	650	120	211	75	2.0
B_{23ox}	585	126	183	65	2.0
B_{24ox}	420	146	175	90	7.2

PEDON No. 3 : BUNGOR SERIES

Location:	37 milestone Kuantan - Temerloh Road
Parent Material:	Shale interbedded with sandstone
Topography:	Undulating
Elevation:	50 m
Slope:	12^{o}
Vegetation/Land Use:	Poorly regenerating secondary forest
Drainage:	Well drained

Horizon	Depth	Profile Description
Ap	0 - 20 cm:	Dark greyish brown (10 YR 4/2) fine sandy loam; very weak fine subangular blocky and coarse crumbs; friable; high biological activity; common worm casts; common fine roots, few coarse roots; rather sharp boundary.
B_1	20 - 35 cm:	Brownish yellow (10 YR 6/6) fine sandy clay loam; weak medium and fine subangular blocky; friable; moderate biological activity few termite nests and many biopores; few fine roots; diffuse boundary.
$B_{21}t$	35 - 52 cm:	Brownish yellow (10 YR 6/6) fine sandy clay; weak medium and fine subangular blocky; very thin continuous clayskins on ped faces, friable; common biopores and few termite nests; few fine roots; diffuse boundary.
$B_{22}t$	52 - 70 cm:	Brownish yellow (10 YR 6/6) fine sandy clay; weak, medium and fine subangular blocky; continuous clay coatings on ped faces and in pores; friable; very few fine roots; diffuse boundary.
$B_{23}t$	70 - 90 cm:	Brownish yellow (10 YR 6/6) fine sandy clay; very weak subangular blocky; patchy coatings on ped faces; slightly firm; very few biopores and on occasional termite nest; very few roots; diffuse boundary.

---ctd next.

PEDON No. 3 --(ctd)

B_{31}	90 - 135 cm:	Brownish yellow (10 YR 6/6) very few fine reddish mottles; weak medium and fine subangular blocky; very few patchy coatings on ped faces; slightly firm; very little biological activity; very few roots; diffuse boundary.
B_{32}	135 - 190 cm:	Brownish yellow (10 YR 6/6) fine sandy clay with coarse distinct red (2.5 YR 4/8) mottles; slightly massive; no clayskins; firm; no biological activity; no roots; diffuse irregular boundary.
C_1	190 - 226 cm:	Yellow (10 YR 7/6) fine sandy clay with few coarse distinct red (2.5 YR 4/6) mottles (mottled areas have slightly sandier texture); massive; no clayskins; firm; no biological activity; no roots; diffuse boundary.
C_2	226 - 266 cm:	Yellow (10 YR 7/6) fine sandy clay loam with common to abundant coarse red (2.5 YR 4/6) mottles (mottled areas have slightly sandier texture); massive; firm; no roots; diffuse boundary.
C_3	266 - 300 cm:	Very pale brown (10 YR 7/4) fine sandy clay loam with common distinct (2.5 YR 4/6) mottles; massive; firm; no roots.

Classification:

a) Soil taxonomy: TYPIC PALEUDULT (TYPIC KANDIUDULT)

b) FAO: DYSTRIC NITOSOL

PEDON 3. BUNGOR SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N	
0-20	Ap	18.1	10.3	52.5	19.1	0.94	N.D	0.84
20-35	B_1	30.7	9.7	44.2	15.4	0.42	N.D	1.40
35-52	$B_{21}t$	35.3	9.0	41.2	14.4	0.32	N.D	1.58
52-70	$B_{22}t$	36.1	9.1	41.1	13.7	0.26		1.58
70-90	$B_{23}t$	41.2	8.4	38.5	11.9	0.20		1.60
90-135	B_{31}	44.3	8.1	36.4	10.2	0.20		1.87
135-190	B_{32}	47.1	7.7	35.2	10.0	0.19		2.06
190-226	C_1	39.0	8.8	40.8	11.4	0.11		1.88
226-266	C_2	32.9	9.6	44.4	13.1	0.09		1.77
266-300	C_3	31.0	10.5	33.1	15.4	0.06		1.12

Horizon	pH		Δ pH	IN-KCl Al	Exch. Cat.meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
Ap	4.8	4.2	-0.6	1.89	0.22	0.15	0.04	0.12	5.50
B_1	4.6	4.0	-0.6	2.28	0.10	0.06	0.04	0.06	4.90
$B_{21}t$	4.9	4.1	-0.8	2.28	0.14	0.07	0.07	0.07	4.80
$B_{22}t$	5.0	4.2	-0.8	2.22	0.08	0.05	0.04	0.02	4.40
$B_{23}t$	5.0	4.1	-0.9	2.22	0.10	0.04	0.04	0.02	4.28
B_{31}	5.1	4.1	-1.0	2.24	0.08	0.04	0.03	0.02	4.23
B_{32}	5.1	4.0	-1.1	2.28	0.04	0.03	0.04	0.07	4.18
C_1	5.6	4.4	-1.2	2.28	0.07	0.02	0.04	0.02	3.82
C_2	5.3	4.3	-1.0	2.13	0.03	0.02	0.02	0.03	3.42
C_3	5.2	4.3	-0.9	1.83	0.03	0.02	0.04	0.02	3.02

Pedon 3. --ctd.

Horizon	CEC meq/100 gms SOIL		CHARGE meq/100 gms CLAY				Base Sat.%		Al Sat.% on PC
	NH_4OAc	Sum	PC	NH_4OAc	Sum	POC	NH_4OAc	Sum	
Ap	3.06	6.03	13.4	16.9	33.3	19.9	17	9	78
B_1	3.12	5.16	8.2	10.2	16.8	8.6	8	5	90
$B_{21}t$	3.53	5.15	7.4	10.0	14.6	7.2	10	7	87
$B_{22}t$	3.05	4.59	6.6	8.4	12.7	6.1	6	4	92
$B_{23}t$	3.39	4.48	5.8	8.2	10.9	5.1	6	4	92
B_{31}	3.39	4.40	5.4	7.6	9.9	4.5	5	4	93
B_{32}	3.37	4.36	5.2	7.1	9.3	4.1	5	4	93
C_1	2.82	3.97	6.2	7.2	10.2	4.0	5	4	93
C_2	2.52	3.52	6.8	7.7	10.7	3.9	4	3	95
C_3	2.39	3.13	6.9	7.7	10.1	3.2	5	3	94

PEDON No. 4: RASAU SERIES

Location:	12½ milestone Kuantan - Temerloh Road
Parent Material:	Sub-recent alluvium
Topography:	Level-gently undulating river terrace
Elevation:	29 m
Vegetation/Land Use:	Secondary jungle
Drainage:	Moderately well drained.

Horizon	Depth	Profile Description
A_{11}	0 - 25 cm:	Loamy fine sand; dark brown (10 YR 4/3); weak fine, subangular blocky and weak coarse crumbs; friable; many foots; high biological activity; diffuse boundary.
A_{12}	25 - 35 cm:	Loamy fine sand; brown (10 YR 5/3); weak, fine subangular blocky breaking to fine crumb; friable; medium biological activity; many fine and medium roots; rather diffuse boundary.
B_1	35 - 55 cm:	Loamy fine sand; light yellowish brown (2.5 Y 6/4); weak, coarse and medium subangular blocky; friable; high biological activity; many termite tests; few fine and medium roots; rather diffuse boundary;
B_{21}	55 - 75 cm:	Fine sandy loam; pale yellow (2.5 Y 7/4); few, faint, medium, pale yellow (2.5 Y 8/4 mottles); weak, medium and fine subangular blocky; friable; few distinct mottles along old root channels (yellowish red 5 YR 5/8); few large roots; gradual boundary.
B_{22}	75 - 110 cm:	Fine sandy loam; yellow (2.5 Y 7/6); weak to moderate, medium to fine, subangular blocky; friable; few faint, medium pale yellow (2.5 Y 8/4 mottles; no clayskins; very few roots; diffuse boundary.
B_3	110 - 136 cm:	Fine loamy sand; pale yellow (2.5 Y 7/4); few distinct white (2.5 Y 8/2) mottles; very weak subangular blocky, friable; no roots; diffuse boundary.
C_{11}	136 - 160 cm:	Fine loamy sand; pale yellow (2.5 Y 7/4); few distinct white (2.5 Y 8/2) mottles increasing with depth; very weak subangular blocky to structureless; very friable; no roots.

Note: Additional Samples: C_{12} 160 cm - 180 cm
C_{13} 180 cm - 200 cm

Classification:

a) Soil taxonomy: OXIC DYSTROPEPT

b) FAO: FERRALIC (DYSTRIC) CAMBISOL

PEDON 4. RASAU SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	
0-25	A_{11}	10.2	4.7	48.9	36.3	1.75	0.34
25-35	A_{12}	13.0	3.7	51.3	32.0	1.04	0.35
35-55	B_1	13.0	5.2	50.0	31.8	0.51	0.39
55-75	B_{21}	15.3	4.1	50.7	29.9	0.25	0.35
75-110	B_{22}	14.5	5.1	48.9	31.5	0.22	0.49
110-136	B_{13}	14.4	5.0	53.0	27.6	0.17	0.45
136-160	C_{11}	15.9	3.4	50.5	30.2	0.17	0.32
160-180	C_{12}	15.1	4.6	50.1	30.2	0.11	0.39
180-200	C_{13}	14.9	5.1	54.2	25.9	0.09	0.32

Horizon	pH		ΔpH	IN-KCL Al	Exch. Cat. meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_{11}	4.3	3.9	-0.4	2.73	0.31	0.23	0.04	0.12	9.92
A_{12}	4.4	4.0	-0.4	2.53	0.09	0.06	0.04	0.05	6.74
B_1	4.6	4.1	-0.5	1.83	0.04	0.05	0.04	0.07	4.82
B_{21}	5.1	4.2	-0.9	1.43	0.05	0.03	0.04	0.02	2.70
B_{22}	4.4	4.2	-0.2	1.58	0.02	0.03	0.04	0.02	3.14
B_{13}	4.8	4.1	-0.7	1.48	0.08	0.05	0.04	0.02	3.00
C_{11}	4.7	4.1	-0.6	1.43	0.09	0.06	0.04	0.02	2.54
C_{12}	4.9	4.2	-0.7	1.48	0.08	0.08	0.04	0.03	2.46
C_{13}	4.9	4.1	-0.8	1.34	0.08	0.07	0.06	0.03	2.16

Pedon 4. --ctd.

Horizon	CEC meq/100 gms SOIL		CHARGE meq/100 gms CLAY				Base Sat.%		Al Sat.% on PC
	NH_4OAc	Sum	PC	NH_4OAc	Sum	POC	NH_4OAc	Sum	
A_{11}	6.08	10.62	33.6	59.6	104.1	70.5	12	7	79
A_{12}	4.10	6.98	21.3	31.5	53.7	32.4	6	3	91
B_1	2.39	5.02	15.6	18.4	38.6	23.0	8	4	90
B_{21}	1.64	2.84	10.3	10.7	18.6	8.3	8	5	91
B_{22}	1.70	3.25	11.6	11.7	22.4	10.8	6	3	93
B_3	1.84	3.19	11.6	12.8	22.1	10.5	10	6	87
C_{11}	1.70	2.75	10.3	10.7	16.9	6.6	12	8	87
C_{12}	1.70	2.69	11.3	11.3	17.8	6.5	14	8	86
C_{13}	1.68	2.40	10.6	11.3	16.1	5.5	14	10	85

PEDON No. 5 : LUNAS SERIES

Location: 12½ milestone, Kuantan - Temerloh Road

Parent Material: Recent alluvium

Topography: Level

Elevation: Less than 29 m

Vegetation/Land Use: Secondary jungle

Drainage: Poor

Horizon	Depth	Profile Description
A_{1-3}	0 - 13 cm:	Loamy sand; brown (10 YR 5/3); weak fine, sub-angular blocky, friable; common fine and medium roots; diffuse boundary.
B_1	13 - 30 cm:	Sandy loam to fine sandy clay loam; very pale brown (10 YR 7/3); very few, faint mottles; white (10 YR 8/2); moderate to weak coarse subangular blocky; friable; few fine roots; no clayskins; gradual boundary.
B_{21}	30 - 50 cm:	Sandy clay loam; light grey (2.5 Y 7/2); weak coarse subangular blocky; friable; patchy coatings on ped faces; few medium distinct white (10 YR 8/2) mottles; diffuse boundary.
B_{22}	50 - 74 cm:	Sandy clay loam; light grey; (2.5 Y 7/2); weak medium and coarse subangular blocky; friable; thin patchy coatings on ped faces; white (10 YR 8/2) mottles increasing with depth; diffuse boundary.
B_{23}	74 - 94 cm:	Sandy clay loam; light grey (2.5 Y 7/2); weak coarse subangular blocky; slightly sticky; white (10 YR 8/2) mottles becoming more abundant; diffuse boundary.
B_{24}	94 - 112 cm:	Sandy clay loam; light grey (2.5 Y 7/2); weak coarse subangular blocky; slightly sticky; white (10 YR 8/2) mottles and few distinct reddish yellow (7.5 YR 6/6) mottles; diffuse boundary.
IIC_1	112 - 131 cm:	Sandy clay; light grey (2.5 Y 8/2); many fine to medium distinct reddish yellow (7.5 YR 6/6) and white (10 YR 8/2) mottles; massive; diffuse boundary.

Note: Additional Samples: IIC_2 - 131 - 150 cm
$IIIC_3$ - 150 - 185 cm

Classification:

a) Soil taxonomy: AQUIC PALEUDULT (AQUIC KANDIUDULT)

b) FAO: DYSTRIC NITOSOL

PEDON 5. LUNAS SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	
0-13	A_{1-3}	11.8	4.9	51.1	32.2	0.80	0.18
13-30	B_1	18.9	6.2	36.0	38.9	0.40	0.23
30-50	B_{21}	23.8	7.0	40.9	28.3	0.23	0.22
50-74	B_{22}	23.2	7.4	40.6	28.8	0.15	0.16
74-94	B_{23}	22.7	7.2	39.3	30.8	0.12	0.12
94-112	B_{24}	27.6	6.1	32.1	34.2	0.10	0.14
112-131	IIC_1	39.9	8.8	23.8	27.5	0.11	0.32
131-150	IIC_2	41.8	10.2	21.4	26.6	0.11	0.34
150-185	$IIIC_3$	67.1	9.3	12.7	10.8	0.10	0.45

Horizon	pH		pH	IN-KCL Al	Exch. Cat.meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_{1-3}	4.5	3.9	-0.6	2.08	0.04	0.08	0.09	0.15	5.08
B_1	4.4	3.7	-0.7	2.13	0.02	0.04	0.06	0.09	4.46
B_{21}	4.5	3.8	-0.7	2.28	0.02	0.02	0.04	0.05	3.92
B_{22}	4.5	3.7	-0.8	2.08	0.01	0.01	0.04	0.06	3.42
B_{23}	4.4	3.6	-0.8	2.08	0.01	0.01	0.04	0.06	3.12
B_{24}	4.4	3.5	-0.9	2.28	0.05	0.02	0.07	0.04	3.36
IIC_1	4.4	3.6	-0.8	3.17	0.02	0.02	0.04	0.05	4.40
IIC_2	3.9	3.5	-0.4	3.50	0.07	0.16	0.06	0.13	5.84
$IIIC_3$	4.3	3.6	-0.7	5.03	0.07	0.03	0.06	0.08	6.26

Pedon 5. ---ctd.

Horizon	CEC meq/100 gms SOIL		CHARGE meq/100 gms CLAY				Base Sat. %		Al Sat.% on PC
	NH_4OAc	Sum	PC	NH_4OAc	Sum	POC	NH_4OAc	Sum	
A_{1-3}	3.12	5.44	20.7	26.4	46.1	25.4	12	7	85
B_1	2.72	4.67	12.4	14.4	24.7	12.3	8	4	91
B_{21}	2.73	4.05	10.1	11.5	17.0	6.9	5	3	95
B_{22}	2.70	3.54	9.5	11.6	15.2	5.7	4	3	94
B_{23}	2.54	3.24	9.7	11.2	14.3	4.6	5	4	94
B_{24}	3.13	3.54	8.9	11.3	12.8	3.9	6	5	93
IIC_1	4.53	4.53	8.3	11.3	11.3	3.0	3	3	96
IIC_2	6.00	6.26	9.4	14.3	15.0	5.6	7	7	89
$IIIC_3$	5.71	6.50	7.8	8.5	9.7	1.9	4	4	95

PEDON No. 6 : KUANTAN SERIES

Location:	Bukit Goh Oil Palm Scheme, Kuantan district, Pahang.
Parent Material:	Basalt
Topography:	Gently undulating
Elevation:	30 m
Slope:	4^{o} midslope
Vegetation/Land Use:	Oil Palm
Drainage:	Somewhat excessive

Horizon	Depth	Profile Description
A_{1-3}	0 - 18 cm:	Brown to dark brown (10 YR 4/3) clay; weak fine subangular blocky and strong crumb; friable to firm; few medium roots; few channels; diffuse boundary.
B_{21ox}	18 - 46 cm:	Dark yellowish brown (10 YR 4/4) clay; weak, medium subangular blocky; very friable; few fine roots; few channels; thin coatings on ped faces; diffuse boundary.
B_{22ox}	46 - 121 cm:	Dark yellowish brown (10 YR 4/4) clay; weak, medium and coarse subangular blocky; very friable; few fine roots; thin coatings on ped faces; diffuse boundary.
B_{23ox}	121 - 200 cm:	Dark yellowish brown (10 YR 4/4) clay; weak, medium and fine subangular blocky; friable; few fine roots; thin coatings on ped faces.

Classification:

a) Soil taxonomy: HAPLIC ACRORTHOX

b) FAO: ACRIC FERALLSOL

PEDON 6. KUANTAN SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	N		
0-18	A_{1-3}	59.8	24.7	8.3	7.3	1.93	0.29	7	12.42
18-46	B_{21ox}	65.2	24.1	6.7	4.0	0.40	0.12	3	12.51
46-121	B_{22ox}	65.3	20.3	10.8	3.6	0.30	0.06	5	13.04
121-200	B_{23ox}	69.1	21.0	6.9	2.9	0.18	0.06	3	14.92

Horizon	Bulk Density	Moisture (Volume %) at pF					A. Moist mm/m		Porosity %
		0	1	2	2.54	4.19	1/3-15	1/10-15	
B_{21ox}	0.86	68.4	55.4	38.0	31.9	23.7	82	143	68
B_{22ox}	0.89	72.6	59.6	43.0	35.5	29.0	65	140	67
B_{23ox}	0.88	74.1	61.3	44.3	38.9	31.1	78	132	67
B_{23ox}	0.93	66.6	62.4	48.9	46.6	37.9	87	110	65

Horizon	pH		ΔpH	IN-KCL Al	Exch. Cat. meq/100 gms SOIL				Extr. Acidit
	H_2O	KCl			Ca	Mg	Na	K	
A_{1-3}	4.3	3.9	-0.4	1.66	0.70	0.32	0.03	0.12	11.7
B_{21ox}	4.6	4.1	-0.5	0.82	0.15	0.07	0.02	0.04	9.8
B_{22ox}	4.8	4.2	-0.6	0.80	0.12	0.05	0.02	0.02	8.5
B_{23ox}	4.8	4.3	-0.5	0.55	0.17	0.04	0.02	0.02	7.5

Horizon	CEC meq/100 gms SOIL			CHARGE meq/100 gms CLAY					Base Sat. %		Al Sat %
	NH_4Cl	NH_4OAc	Sum	PC	NH_4Cl	NH_4OAc	Sum	PDC	NH_4OAc	Sum	
A_{1-3}	2.32	9.24	12.87	4.7	3.9	15.4	21.5	16.8	12.7	9.1	58.
B_{21ox}	0.90	5.20	10.08	1.7	1.4	8.0	15.5	13.7	5.4	2.8	74.
B_{22ox}	0.82	4.08	8.71	1.5	1.2	6.2	13.3	11.8	5.1	2.4	79.
B_{23ox}	0.72	3.16	7.75	1.1	1.0	4.6	11.2	10.0	7.9	3.2	68.

Pedon 6. --ctd.

TOTAL ANALYSIS (SOIL)

Horizon	Si_0^2	$Al_2^0_3$	$Fe_2^0_3$	CaO	MgO	K_2^0	Na_2^0	H_2^{0-}	H_2^{0+}	SiO2 / Al203	SiO2 / R203
A_{1-3}	26.0	36.5	19.0	0.1	0.1	0.1	Tr	3.2	14.3	1.2	0.9
B_{21ox}	26.1	36.7	20.4	Tr	0.1	Tr	Tr	2.8	14.1	1.2	0.9
B_{22ox}	23.6	39.8	20.2	Tr	0.1	Tr	Tr	2.5	14.1	1.2	0.8
$B_{23}ox$	25.4	36.2	20.6	0.1	0.1	Tr	Tr	2.7	14.2	1.2	0.8

TOTAL MICRONUTRIENTS (ppm)

Horizon	Mn	Cu	Zn	Co	Ni
A_{1-3}	297	172	157	60	64.2
B_{21ox}	290	190	168	50	39.5
B_{22ox}	314	204	168	100	46.5
B_{23ox}	430	208	168	110	41.2

PARTIAL ANALYSIS (CLAY)

Horizon	Si_0^2	$Al_2^0_3$	$Fe_2^0_3$	SiO2 / Al203	SiO2 / R203
A_{1-3}	31.7	31.0	19.3	1.8	1.3
B_{21ox}	33.7	31.0	20.6	1.9	1.3
B_{22ox}	35.0	34.6	18.6	1.7	1.3
B_{23ox}	33.0	37.8	19.3	1.5	1.1

PEDON No. 7 : RUDUA SERIES

Location:	MARDI Experimental Station, Sg. Baging
Parent Material:	Marine sandy
Topography:	Level
Elevation:	Less than 15 m.
Vegetation/Land Use:	Shrub, coconut and cashew
Drainage:	Excessively drained.

Horizon	Depth	Profile Description
A_1	0 - 10 cm:	Sand; pale brown (10 YR 6/3); structureless; few fine roots; no biological activity; clear boundary.
A_{21}	10 - 25 cm:	Sand; white (10 YR 8/1); structureless; very loose; very few grass roots; no biological activity; diffuse boundary.
A_{22}	25 - 55 cm:	Sand; white (10 YR 8/1); structureless; very loose; roots up to a depth of about 35 cm. sand consists almost entirely of quartz; diffuse boundary.
A_{23}	55-94/100 cm	Sand; white (10 YR 8/1); lower part grey (10 YR 6/1); structureless loose; no roots; no biological activity; sharp wavy boundary.
B_{21h}	94/100-104 cm:	Sand; black (10 YR 2/1); hard cemented humic pan which can be broken with the fingers. Quartz grains are coated, no roots; no biological activity; diffuse boundary.
B_{22h}	104 - 122 cm:	Sand; very dark grey (10 YR 3/1); weak cemented humic layer, easily broken between fingers, sand grains coated, no roots; no biological activity; diffuse boundary
B_{23hir}	122 - 150 cm:	Sand; strong brown (7.5 YR 5/8), friable coated sand containing a few yellowish red nodules (5 YR 5/8) which can be broken by pressure between the fingers; no roots; no biological activity; diffuse boundary.
B_{24hir}	150 - 200 cm:	Sand; yellowish brown (10 YR 5/6), friable.

NOTE: Samples also taken: C_1 - 200 - 235 cm.
C_2 - 235 - 270 cm.

Classification:

a) Soil taxonomy: TYPIC TROPORTHOD

b) FAO: ORTHIC PODZOL

PEDON 7. RUDUA SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	
0-10	A_1	0.7	1.8	38.8	58.6	0.68	0.09
10-25	A_{21}	0.9	0.7	41.7	56.5	0.23	0.02
25-55	A_{22}	0.5	1.1	38.3	60.1	0.09	Tr
55-94/100	A_{23}	NIL	1.2	46.4	52.4	0.03	0.01
94/100-104	B_{21h}	1.6	0.3	32.7	65.3	0.65	0.32
102-122	B_{22h}	0.7	0.6	40.2	58.5	0.40	0.52
122-150	B_{23hir}	0.1	1.2	34.1	64.7	0.24	0.90
150-200	B_{24hir}	0.4	0.4	17.2	82.0	0.11	1.10
200-235	C_1	NIL	0.9	25.3	73.9	0.05	0.66
235-270	C_2	0.8	NIL	30.9	68.3	0.03	0.42

Horizon	pH		ΔpH	IN-KCl Al	Exch. Cat. meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_1	5.0	4.3	-0.7	0.29	0.22	0.06	0.06	0.04	1.66
A_{21}	4.9	4.2	-0.7	0.11	0.55	0.03	0.06	0.03	0.48
A_{22}	4.8	4.4	-0.4	0.57	0.02	0.02	0.06	0.02	0.36
A_{23}	4.7	4.4	-0.3	0.63	0.01	0.01	0.06	0.02	0.12
B_{21h}	4.6	4.0	-0.6	0.94	0.02	0.01	0.06	0.02	6.68
B_{22h}	4.5	4.2	-0.3	0.38	0.01	0.01	0.06	0.01	3.98
B_{23hir}	4.6	4.5	-0.1	0.32	0.01	0.01	0.01	0.02	2.48
B_{24hir}	4.7	4.4	-0.3	0.13	0.02	0.01	0.06	0.06	1.56
C_1	4.9	4.4	-0.5	0.16	0.01	0.01	0.06	0.02	0.66
C_2	5.4	4.8	-0.6	0.53	0.03	0.03	0.06	0.02	0.32

Pedon 7. --ctd.

Horizon	CEC meq/100 grm SOIL		Base Sat. %	
	NH_4OAc	Sum	NH_4OAc	Sum
A_1	1.20	2.04	32	19
A_{21}	0.41	0.65	41	26
A_{22}	0.24	0.48	50	25
A_{23}	0.06	0.22	167	45
B_{21h}	2.16	6.79	5	2
B_{22h}	1.02	4.07	9	2
B_{23hir}	0.54	2.58	18	4
B_{24hir}	0.18	1.71	83	9
C_1	0.19	0.76	53	13
C_2	0.10	0.46	140	30

PEDON No. 8: RENGAM SERIES

Location:	12th milestone Kuantan - Kuala Trengganu Road
Parent Material:	Granite
Topography:	Hilly
Elevation:	50 m
Slope:	15°
Vegetation/Land Use:	Secondary jungly
Drainage:	Well drained

Horizon	Depth	Profile Description
A_{1-3}	0 - 9 cm:	Coarse sandy loam; dark yellowish brown (10 YR 4/4); weak medium and fine subangular blocky and weak, fine crumb; few roots; few pores; very few worm casts; diffuse boundary.
B_{21ox}	9 - 38 cm:	Coarse sandy clay loam; strong brown (7.5 YR 5/8); weak, medium and fine, subangular blocky; very few roots, few, small termite nests; diffuse boundary.
B_{22ox}	38 - 63 cm:	Coarse sandy clay loam; strong brown (7.5 YR 5/8); weak, coarse to medium, subangular blocky; no clay skins; no roots; rather diffuse boundary.
B_{23ox}	63 - 100 cm:	Coarse sandy loam; strong brown (5 YR 5/8); weak, medium to fine subangular blocky; no clay skins; no roots; rather diffuse boundary.
B_3	100 - 150 cm:	Coarse sandy loam; red (2.5 YR 5/8); weak fine subangular blocky; few, thin, clay skins in pores; no roots; diffuse boundary.
C_1	150 - 275 cm:	Coarse sandy loam; red (2.5 YR 4/8); massive; pores lined with cutans; diffuse boundary.
C_2	275 - 500 cm:	Coarse sandy loam; red (2.5 YR 4/8); slightly variegated; few white (10 YR 7/2) mottles, elongated vertical streaks; cutan like material present in some voids; diffuse boundary.
C_3	500 - 800 cm:	Coarse sandy loam; yellowish red (5 YR 5/8); massive; bleached spots increasing; rather diffuse boundary.
C_4	800 - 950 cm:	Sandy loam; strong brown (7.5 YR 5/6) with common light grey (10 YR 7/2) streaks; few kaolinised feldspars, white; rather diffuse boundary.

---ctd next..

PEDON No. 8 --(ctd)

C_5	950 - 1250 cm:	Gravelly clay loam; dark yellowish brown (7.5 YR 5/8) with many red (10 YR 4/6) and white (10 YR 8/2) coarse mottles; many kaolinised feldspars; diffuse boundary;
C_6	1250 - 1360 cm:	Gravelly clay loam; as previous horizon but with increasing white (10 YR 8/2) patches; kaolinised feldspars increasing; rather abrupt boundary.
C_7	1360 - 1500 cm:	As above but more compact, rock structure evident; diffuse boundary.
C_8	1500 - 1600 cm:	Gravelly clay; white (10 YR 8/2); many kaolinised feldspars; few red (10 YR 6/8) mottles rather abrupt boundary.
$(R)_1$	1600 - 1660 cm:	Weathering rock; white (10 YR 8/1); with reddish sports (10 YR 5/9); rock structure intact.
$(R)_2$	1660 - 1850 cm:	Weathering rock, matrix colour white (10 YR 8/1); many slightly weathered feldspars; few reddish yellow (7.5 YR 5/8) mottles; wet; abrupt contact with rock.
R_3	1850 - 1900 cm:	Weathering crust of relatively fresh granite.

Classification:

a) Soil taxonomy: TROPEPTIC HAPLORTHOX

b) FAO: ORTHIC FERRALSOL

PEDON 8. RENGAM SERIES

Horizon	Depth (cm)	GRANULOMETRY					% Silt / % Clay	pH (1:1) H_2O	pH (1:1) KCl	ΔpH
		Clay	Silt	Fine Sand	Coarse Sand	Gravel				
A_{1-3}	0-9	36.7	7.9	39.2	16.2	5.0	0.22	4.36	3.90	-0.46
B_{21ox}	9-38	37.5	10.8	46.2	5.5	7.1	0.29	4.40	3.90	-0.50
B_{22ox}	38-63	36.7	12.2	46.2	4.9	31.3	0.33	4.20	4.00	-0.20
B_{23ox}	63-100	32.5	5.7	57.8	4.0	33.3	0.18	4.20	4.00	-0.20
B_3	100-150	37.6	7.9	49.7	4.8	37.4	0.21	-	-	
C_2	275-500	18.1	13.8	62.5	5.6	31.8	0.76	4.40	4.10	-0.30
C_3	500-800	20.1	27.9	44.4	7.6	27.4	1.39	4.60	3.75	-0.85
C_4	800-950	10.2	35.5	46.6	7.9	37.5	1.77	4.70	4.00	-0.70
C_5	950-1250	18.4	32.5	33.1	16.0	37.5	1.77	4.70	4.00	-0.70
C_6	1250-1360	15.5	25.9	44.6	14.0	32.7	1.67	4.84	3.85	-0.99
C_7	1360-1500	11.7	22.5	45.0	20.8	40.0	1.92	4.80	3.85	-0.95
C_8	1500-1600	8.5	21.7	51.0	18.8	47.0	2.55	4.85	3.85	-1.00
$(R)_1$	1600-1660	10.5	29.7	41.4	18.4	38.2	2.82	-	-	-
$(R)_2$	1660-1850	-	-	-	-	53.4	-	-	3.90	-
R_3	1850-1900	-	-	-	-	-	-	-	-	-

- not determined

Pedon 8. --ctd.

Horizon	O.C. %	N %	C/N	Exchangeable (meq/100 g Soil) Ca	Mg	K	Sum of bases	CEC NH_4OAc	% Free Fe_2O_3
A_{1-3}	1.34	0.146	9.79	0.38	0.26	0.15	0.79	5.91	3.16
B_{21ox}	0.76	0.087	8.74	0.08	0.25	0.17	0.50	3.84	3.90
B_{22ox}	0.59	0.078	7.56	0.06	0.21	0.14	0.41	3.02	4.20
B_{23ox}	0.35	0.046	7.61	0.06	0.08	0.07	0.21	3.03	4.18
B_3	0.30	0.041	7.32	0.13	0.12	0.09	0.34	2.01	3.92
C_2	0.12	0.080	1.50	0.01	0.02	0.01	0.04	1.88	3.04
C_3	0.08	-	-	0.02	0.05	0.01	0.08	3.09	3.13
C_4	0.05	-	-	0.02	0.07	0.01	0.10	4.03	1.92
C_5	-	-	-	0.02	0.08	0.01	0.11	6.16	2.78
C_6	-	-	-	0.02	0.09	0.02	0.13	6.39	2.93
C_7	0.03	-	-	0.03	0.07	0.04	0.14	6.66	2.39
C_8	0.01	-	-	0.02	0.07	0.05	0.14	7.70	1.81
$(R)_1$	-	-	-	0.03	0.07	0.03	0.13	7.09	2.44
$(R)_2$	-	-	-	0.02	0.08	0.09	0.19	6.61	2.25

- not determined

Pedon 8. --ctd.

Horizon	Depth (cm)	(meq/100 g soil) Exchangeable (IN KCl) Acidity	Al	H^+	Extractable Acidity	ECEC	CEC Sum
B_{21ox}	9-38	0.98	0.62	0.36	9.44	1.48	9.94
B_{23ox}	63-100	0.73	0.48	0.25	5.12	0.94	5.33
B_3	100-150	0.48	0.25	0.23	3.52	0.82	3.86
C_2	275-500	0.79	0.52	0.27	2.56	0.83	2.60
C_4	800-950	1.72	1.33	0.39	6.08	1.82	6.18
C_5	950-1250	2.77	2.26	0.56	8.80	2.88	8.91
C_7	1350-1500	2.59	2.05	0.54	8.96	2.73	9.10
$(R)_1$	1600-1660	2.84	2.22	0.62	8.16	2.97	8.29
$(R)_2$	1660-1850	2.61	2.00	0.61	7.52	2.75	7.66

Horizon	(meq/100 g clay) Permanent Charge (P.C.)	pH dependent Charge (P.D.C.)	P.C/ P.D.C	Base Saturation % P.C.	CEC NH_4OAc	CEC Sum	Al Saturation % P.C.	ECEC
B_{21ox}	2.99	23.52	0.13	44.6	13.02	5.03	55.35	41.81
B_{23ox}	2.12	14.28	0.15	30.6	6.93	3.93	69.57	51.06
B_3	1.57	8.70	0.18	57.6	16.90	8.80	42.37	30.49
C_2	3.09	11.27	0.27	7.1	2.12	1.53	92.86	62.65
C_4	14.02	46.57	0.30	7.0	2.48	1.61	93.00	73.08
C_5	12.88	35.54	0.36	4.6	1.78	1.23	95.38	78.47
C_7	18.72	59.06	0.32	6.4	2.10	1.53	93.60	75.09
$(R)_1$	22.38	56.57	0.40	5.5	1.83	1.56	94.47	74.75
$(R)_2$	-	-	-	6.5	2.11	1.82	93.46	72.73

PEDON No. 9 : KUALA BRANG SERIES

Location: Marina beach, Kuantan - Kemaman Road

Parent Material: Sandy shale with vein quartz; often slightly metamorphosed to schist.

Topography: Hilly, strong dissected

Elevation: 50 m

Slope: 18°

Vegetation/Land Use: Poorly regenerated forest with ferns, (Nephrolepis biserata).

Drainage: Well drained

Horizon	Depth	Profile Description
A_{1-3}	0 - 10 cm:	Fine sandy loam; dark brown (10 YR 4/3); weak medium fine subangular blocky; very friable; many fine and medium roots; rather sharp boundary.
B_{11}	10 - 28 cm:	Fine sandy clay loam; brownish yellow (10 YR 6/6) with few fine faint yellowish red (5 YR 5/8) mottles; weak medium subangular blocky; very friable; no clayskins; few roots; organic stains along root channels; diffuse boundary.
B_{12}	28 - 48 cm:	Fine sandy clay loam; brownish yellow (10 YR 6/6), many medium diffuse yellowish red (5 YR 5/8) mottles; weak medium subangular blocky; thin patchy coatings on ped faces; friable; few fine roots; diffuse boundary.
$B_{21}t$	48 - 71 cm:	Fine sandy clay loam with occasional quartz gravel; brownish yellow (10 YR 6/6) with many medium distinct yellowish red (5 YR 5/8) mottles; moderate medium and coarse subangular blocky; discontinuous clayskins on ped faces to firm; few fine roots; diffuse boundary.
$B_{22}t$	71 - 96 cm:	Fine sandy clay loam; brownish yellow (10 YR 6/6) many medium distinct yellowish red (mottles; strong, medium and coarse subangular blocky; continuous clayskins on ped faces; firm; diffuse boundary.

---ctd next..

PEDON No. 9 --(ctd)

$B_{23}t$	96 - 122 cm:	Sandy clay loam with gravels consisting of vein quartz and iron coasted shales; brownish yellow (10 YR 6/6) with common medium prominent red (2.5 YR 4/8) mottles; weak, medium and fine subangular blocky; friable to firm; diffuse boundary.
$B_{31}l$	122 - 153 cm:	Fine sandy clay; light grey (5 Y 7/2) with many large prominent red (2.5 YR 4/8) mottles; weak, medium and coarse angular blocky; friable; diffuse boundary.
C_1	153 - 198 cm:	Silty clay; variegated yellow (5 Y 7/3) and red (2.5 YR 4/8); massive; firm; diffuse boundary.
C_2	198 - 232 cm:	Silty clay with layer vein quartz; variegated yellow (5 Y 7/3) and red (2.5 YR 4/8); massive; firm; diffuse boundary.
C_3	232 - 280 cm:	Fine sandy loam; yellow (5 Y 7/3) with common, large prominent red (2.5 YR 4/8) mottles; massive; firm; diffuse boundary.
C_4	280 - 350 cm:	Same as above but with rock structure becoming more prominent.
C_5	350 - 500 cm:	Silt loam; material showing prominent lamination along bedding planes; light grey (2.5 YR 5/0) common laterized shale and vein quartz.

Classification:

a) Soil Taxonomy: TYPIC PALEUDULT (TYPIC KENDIUDULT)

b) FAO: DYSTRIC NITOSOL

PEDON No. 10: ORGANIC CLAY

Location: 12th milestone, Kuantan - Pekan Road.

Parent Material: Marine clay.

Topography: Level; swamp.

Elevation: 10 m.

Vegetation/Land Use: Oil Palm

Drainage: Very poorly drained.

Horizon	Depth	Profile Description
Ap_1	0 - 15 cm:	Clay with some fine sand; brown (10 YR 4/3); weak medium and fine subangular blocky; friable; many fine and few medium roots; rather sharp boundary.
Ap_2	15 - 25 cm:	Clay, brown (10 YR 4/3); weak coarse angular blocky; few fine roots; some remnants of woody material partly decomposed; rather sharp boundary.
$(B)_2$	25 - 52 cm:	Humic clay; very dark brown (10 YR 2/2); weak medium and coarse angular blocky; slightly sticky; many large undercomposed pieces of wood; common fine roots with fine root mottles; diffuse boundary.
$(B)_3$	52 - 99 cm:	Humic clay with many undercomposed and partly decomposed wood; very dark grey (10 YR 3/1); massive structure sticky; few fine roots; sharp boundary.
C_1	99 - 115 cm:	Large piece of wood; slightly decomposed
IIC_2	115 - 150 cm:	Clay with occasional pockets of whitish (10 YR 8/1); massive many medium and large vertical roots which are pastly decomposed;

Classification:

a) Soil taxonomy: SULFIC TROPAQUEPT

b) FAO: THIONIC FLUVISOL

PEDON No. 11 : TAI TAK SERIES

Location: 22nd mile, J.B. - Kota Tinggi Road (G.R. 144047/131)

Parent Material: Alluvium

Topography: Gently undulating terrace

Elevation: 30 m

Vegetation/Land Use: Rubber

Drainage: Well drained.

Horizon	Depth	Profile Description
A_{13}	0 - 13 cm:	Sandy clay; dark yellowish brown (10 YR 4/4); weak, fine, subangular blocky with fine, crumb; many fine roots; sharp boundary.
$B_{21}t$	13 - 42 cm:	Clay; brownish yellow (10 YR 6/8); strong, coarse and medium, subangular blocky; continuous clay skins on ped faces; root channels stained with organic matters; diffuse boundary.
$B_{22}t$	42 - 81 cm:	Clay; brownish yellow (10 YR 6/8); moderate, coarse and medium subangular blocky; continuous clay skins on ped faces and in pores; firm; few roots; diffuse boundary,
$B_{23}t$	81 - 101 cm:	Clay; reddish yellow (7.5 YR 6/8); moderate to weak; fine, subangular blocky; firm; continuous clay skins on ped faces; very few roots; rather sharp boundary.
B_{3tcn}	101 - 120 cm:	Gravelly clay; reddish yellow (7.5 YR 6/8); weak, fine subangular blocky; patchy clay skins; gravel composed of rounded petroplinthite, rather sharp boundary.
C	120 cm. +	Clay with coarse sand; reddish yellow (7.5 YR 6/8); massive; common, sand-sized muscovite.

Classification:

a) Taxonomy: ORTHOXIC TROPUDULT (LEPTIC KANDIUDULT)

b) FAO: DYSTRIC NITOSOLS

Remarks:

a) The sand-sized muscovite decrease abruptly (though still present) from 100 cm. towards the surface.

b) There is possible a lithological discontinuity from the B_3t though not very evident in the field.

PEDON 11. TAI TAK SERIES

th	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	N		
-13	A_{1-3}	24.5	28.3	19.9	27.4	1.75	0.19	9	4.06
-42	$B_{21}t$	36.9	29.8	12.3	21.0	0.72	0.09	8	5.18
-81	$B_{22}t$	47.7	18.8	10.0	23.5	0.53	0.07	8	5.31
-101	$B_{23}t$	51.2	15.1	8.9	24.9	0.44	0.06	7	6.56
-120	B_3tcn	43.4	16.7	11.6	28.3	0.28	0.04	7	9.51
120+	C	40.1	20.6	10.4	28.9	0.22	0.03	7	5.98
		• Gravels 37% stones 29%							

rizon	pH		ΔpH	IN-KCl Al	Exch. Cat. meq/100 grms SOIL			
	H_2O	KCl			Ca	Mg	Na	K
A_{1-3}	4.2	3.7	-0.5	1.69	0.16	0.18	0.13	0.22
$B_{21}t$	4.3	3.8	-0.5	1.92	0.01	0.04	0.05	0.07
$B_{22}t$	4.4	4.1	-0.3	2.03	0.01	0.03	0.05	0.05
$B_{23}t$	4.4	3.8	-0.6	2.31	0.01	0.02	0.03	0.03
B_3tcn	4.7	4.0	-0.7	2.30	0.04	0.05	0.03	0.03
C	4.6	4.0	-0.6	2.41	0.01	0.02	0.03	0.04

Horizon	CEC meq/100 gms SOIL	CHARGE meq/100 CLAY		Base Sat. %	Al Sat. % on PC.
	NH_4OAc	PC	NH_4OAc	NH_4OAc	
A_{1-3}	6.80	9.7	27.7	10	71
$B_{21}t$	5.40	5.6	14.6	3	92
$B_{22}t$	4.64	4.5	9.7	3	93
$B_{23}t$	3.76	4.7	7.3	2	96
B_3tcn	2.81	5.6	6.5	5	94
C	3.15	6.2	7.8	3	96

PEDON No. 12 : ULU TIRAM SERIES

Location: 11¼ milestone J.B. - Kota Tinggi Road.

Parent Material: Old alluvium

Topography: Level, upper terrace

Elevation: 50 m

Vegetation/Land Use: Rubber

Drainage: Imperfectly drained

Horizon	Depth	Profile Description
Ap	0 - 22 cm:	Sandy loam; dark greyish brown (10 YR 4/2); weak, medium, subangular blocky and weak, fine crumb; many roots; few worm channels and casts; sharp boundary.
$(B)_2$	22 - 42 cm:	Sandy loam; yellow (2.5 Y 7/6); weak medium and fine subangular blocky; few roots; few channels; abrupt boundary.
IIB_3	42 - 83 cm:	Gravelly clay; pale yellow (2.5 Y 7/4); weak, coarse, angular blocky; many gravel size weathering feldspars or decomposed quartz; few large channels; rather abrupt boundary.
IIIC	83 cm. +	Sandy clay loam with some gravel; white (2.5 Y 8/2); with distinct coarse, mottles, yellowish red (5 YR 5/8); massive; lower down, reddish mottles (10 R 4/8).

Classification:

a) Soil taxonomy: TYPIC DYSTROPEPT

b) FAO: FERRALIC CAMBISOL

PEDON 12. ULU TIRAM SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N		
0-22	Ap	10.6	17.3	31.3	40.7	0.87	0.11	8	0.64
22-42	$(B)_2$	23.0	12.8	22.8	41.4	0.39	0.06	7	0.93
*42-83	IIB_3	32.4	10.4	16.3	40.9	0.23	0.04	6	0.88
83-150	$IIIC_1$	29.2	11.9	16.2	42.7	0.11	0.02	6	0.31
150^+	$IIIC_2$	24.4	13.0	17.2	45.4	0.06	0.02	3	0.44

* Gravels - 53%

Horizon	pH		ΔpH	IN-KCl Al	Exch. Cat. meq/100 grms SOIL			
	H_2O	KCl			Ca	Mg	Na	K
Ap	4.2	3.8	-0.4	1.01	0.07	0.07	0.03	0.12
$(B)_2$	4.5	3.8	-0.8	1.57	0.02	0.03	0.05	0.09
IIB_3	4.2	3.8	-0.4	1.13	0.02	0.08	0.05	0.09
$IIIC_1$	4.6	3.7	-0.9	1.32	0.01	0.14	0.03	0.11
$IIIC_2$	4.6	3.6	-1.0	1.47	0.07	0.16	0.03	0.20

Horizon	CEC meq/100 grm SOIL	CHARGE meq/100 grms CLAY		Base Sat. %	Al. Sat. % on PC
	NH_4OAc	PC	NH_4OAc	NH_4OAc	
Ap	5.02	12.3	47.3	6	77
$(B)_2$	4.98	7.6	21.6	4	89
IIB_3	6.99	4.2	21.6	3	82
$IIIC_1$	9.12	5.5	31.2	3	82
$IIIC_2$	7.68	7.9	31.5	6	76

PEDON No. 13 : SENAI SERIES

Location:	Senai Rubber Estate, Senai, Johore
Parent Material:	Gabbro
Topography:	Hilly
Elevation:	45 m
Slope:	12°
Vegetation/Land Use:	Mature Rubber (Hevea)
Drainage:	Well drained

Horizon	Depth	Profile Description
Ap_1	0 - 10 cm:	Clay; dark brown (7.5 YR 4/4); moderate, medium subangular blocky; firm; few roots; many biopores; clear boundary
Ap_2	10 - 25 cm:	Clay; dark brown (7.5 YR 4/4); moderate, medium to fine subangular blocky; firm; many biopores; rather sharp boundary.
B_{1ox}	25 - 52 cm:	Clay; strong brown (7.5 YR 5/6); moderate, coarse prismatic, breaking into moderate, medium subangular blocky; friable; few roots; few biopores; diffuse boundary.
B_{21ox}	52 - 110 cm:	Clay; yellowish red (5 YR 5/6); moderate, coarse prismatic breaking easily into moderate, medium subangular blocky; friable; few roots; few biopores; diffuse boundary.
B_{22ox}	110 - 140 cm:	Clay; yellowish red (5 YR 5/6); moderate, coarse to fine subangular blocky; very friable; very few roots; diffuse boundary.
B_3	140 cm+	Clay; strong brown (7.5 YR 5/6); weak, fine subangular blocky.

Classification:

a) Soil taxonomy: HEPLIC ACRORTHOX

b) FAO: ACRIC FERRALSOL

PEDON 13. SENAI SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N		
0-10	Ap_1	25.9	20.0	30.0	24.0	1.59	0.16	10	13.40
10-25	Ap_2	40.2	25.2	19.4	15.2	1.28	0.12	11	12.68
25-52	B_{1ox}	56.4	18.9	14.7	10.0	0.94	0.09	10	11.97
52-110	B_{21ox}	64.2	18.4	9.7	7.7	0.55	0.06	9	12.59
110-140	B_{22ox}	66.6	18.1	8.2	7.0	0.45	0.05	9	11.88
140+	B_3	51.9	17.2	18.5	12.4	0.44	0.05	9	14.47

Horizon	Bulk Density	Moisture (Volume %) at pF					A. Moist.mm/m		Porosity %
		0	1	2	2.54	4.19	1/3-15	1/10-15	
Ap_2	1.17	53.7	49.3	39.0	37.6	32.1	55	69	56
B_{1ox}	1.17	59.3	47.1	41.2	38.5	34.3	42	69	56
B_{21ox}	1.12	60.2	46.3	37.9	37.9	31.7	62	62	58
B_{22ox}	1.12	51.7	45.6	38.0	36.2	30.7	55	73	58

Horizon	pH		ΔpH	IN-KCL Al	Exch. Cat.meq/100 gms SOIL				Extr. Acidity
	H20	KCl			Ca	Mg	Na	K	
Ap_1	4.1	3.9	-0.2	2.20	0.06	0.07	0.05	0.06	10.3
Ap_2	4.4	4.0	-0.4	0.62	0.02	0.04	0.05	0.04	8.2
B_{1ox}	4.6	4.1	-0.5	0.41	0.02	0.03	0.03	0.07	7.5
B_{21ox}	4.6	4.3	-0.3	0.32	0.02	0.03	0.05	0.03	8.4
B_{22ox}	4.7	4.4	-0.3	0.33	0.01	0.02	0.03	0.01	8.7
B_3	4.9	4.7	-0.2	0.27	0.01	0.02	0.03	0.03	8.1

Horizon	CEC meq/100 gms SOIL			CHARGE meq/100 gms CLAY					Base Sat. %		Al Sat. %
	NH4Cl	NH40Ac	Sum	PC	NH4Cl	NH40Ac	Sum	PDC	NH40Ac	Sum	
Ap_1	1.24	5.78	10.54	9.4	4.8	22.3	40.7	31.3	4.1	2.3	90.2
Ap_2	1.06	5.02	8.35	1.9	2.6	12.5	20.8	18.8	3.0	1.8	80.5
B_{1ox}	1.44	3.38	7.65	1.0	2.5	6.0	13.6	12.6	4.4	2.0	73.2
B_{21ox}	0.60	3.31	8.53	0.7	0.9	5.1	13.3	12.6	3.9	1.5	71.1
B_{22ox}	0.70	2.17	8.77	0.6	1.0	3.2	13.2	12.6	3.2	0.8	82.5
B_3	0.60	2.01	8.19	0.7	1.1	3.9	15.8	15.1	4.5	1.1	75.0

PEDON No. 14 : JERANGAU SERIES

Location:	20½ mile Air Hitam - Johor Baru Road
Parent Material:	Granodiorite
Topography:	Undulating to rolling
Elevation:	35 m
Slope:	10°
Vegetation/Land Use:	Shrub and other secondary vegetation.
Drainage:	Well drained.

Horizon	Depth	Profile Description
Ap	0 - 25 cm:	Clay loam; dark brown (7.5 YR 4/4); moderate, fine, subangular blocky and coarse crumbs; many fine roots; many biopores; rather sharp boundary.
B_1	25 - 57 cm:	Clay; yellowish red (5 YR 5/8); weak, medium subangular blocky; no clayskins; very friable; many fine roots; few biopores; diffuse boundary.
B_{21ox}	57 - 89 cm:	Clay; yellowish red (5 YR 5/8); weak, medium to fine subangular blocky; no clayskins; few roots; diffuse boundary.
B_{22ox}	89 - 130 cm:	Clay; yellowish red (5 YR 5/8); weak, fine, subangular blocky; very friable; few, patchy clayskins in pores; no roots; diffuse boundary.

Classification:

a) Soil Taxonomy: TYPIC ACRORTHOX

b) FAO: ACRIC FERRALSOL

PEDON 14. JERANGAU SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C	N		
0-25	Ap	51	2	20	27	1.80	0.17	10	11.4
25-57	B_1	51	1	18	30	0.90	0.15	6	12.1
57-89	B_{21ox}	51	3	16	30	0.48	0.09	5	12.2
89-130	B_{22ox}	50	2	14	34	0.24	0.07	3	11.8
130+	B_{23ox}	50	2	16	32	0.12	0.07	2	12.4

Horizon	pH		ΔpH	IN-KCl Al	Exch. Cat.meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
Ap	4.5	3.9	-0.6	1.10	1.32	0.91	0.08	0.15	12.2
B_1	4.5	4.1	-0.4	0.74	0.10	0.11	0.01	0.14	9.8
B_{21ox}	4.7	4.3	-0.4	0.32	0.06	0.05	0.01	0.06	8.6
B_{22ox}	4.5	4.3	-0.2	0.30	0.04	0.04	0.01	0.07	7.6
B_{23ox}	4.6	4.6	0	0.14	0.05	0.03	0.01	0.08	8.0

Horizon	CEC meq/100 grms SOIL			CHARGE meq/100 gms CLAY					Base Sat. %		Al Sat. %
	NH_4Cl	NH_4OAc	Sum	PC	NH_4Cl	NH_4OAc	Sum	PDC	NH_4OAc	Sum	
Ap	1.89	13.8	14.66	7.0	3.7	27.1	28.7	21.8	17.8	16.8	30.9
B_1	1.51	8.5	10.16	2.2	3.0	16.7	19.9	17.8	4.2	3.5	67.3
B_{21ox}	1.21	8.5	8.78	1.0	2.4	16.7	17.2	16.2	2.1	2.0	64.0
B_{22ox}	1.32	7.2	7.76	0.9	2.6	14.4	15.5	14.6	2.2	2.1	45.2
B_{23ox}	1.32	7.6	8.17	0.6	2.6	15.2	16.3	15.7	2.2	2.1	45.2

PEDON No. 15 : BATU ANAM SERIES

Location:	Department of Agriculture Station, Ayer Hitam, Johore, 103° 11'E, 1° 56'N.
Parent Material:	Argillaceous shale
Topography:	6° slope
Elevation:	30-45 m
Vegetation/Land Use:	Secondary jungle
Drainage:	Moderately well drained to imperfectly well drained.

Horizon	Depth	Profile Description
Ap	0 - 15 cm:	Light grey to grey (10 YR 6/1); clay, moderately strong medium and few coarse subangular and angular blocky and few medium crumbs; moist friable; many pores; many roots; clear boundary.
$(B)_1$	15 - 45 cm:	Pale yellow (2.5 Y 7/4); clay; strong coarse prismatic and few subangular and angular blocky; moist very firm; common pores; few roots; common; fine, distinct, Brownish Yellow (10 YR 6/8) blotches of mottlings; few termite channels; diffuse boundary.
$(B)_2$	45 - 63 cm:	Pale yellow (2.5 Y 8/4); clay; moderate strong coarse and very coarse prismatic; moist very fine; few pores; roots nil; many fine, medium, prominent dark Yellowish brown (10 YR 4/4) and brownish yellow (10 YR 6/8) blotches of mottlings; clear boundary.
B_{2cn}	63 - 75 cm:	Light grey (10 YR 8/2); clay; a band of somewhat compact gravelly laterite (60-70%) and gravelly quartzite (5-10%); many fine and medium prominent, Brownish yellow (10 YR 6/3) blotches of mottlings clear boundary.
C	75 - 138 cm:	Light grey (10 YR 8/1); clay weak; coarse and very coarse subangular and angular blocky and few coarse prismatic; moist very firm; few pores; roots nil; with abundant, medium and coarse prominent brownish yellow (10 YR 6/8) blotches and streaks of mottlings.

Classification:

a) Taxonomy: OXIC PLINTHAQUEPT

b) FAO: FERRALIC CAMBISOLS

Remarks: It is suggested that a new subgroup viz. "oxic" be introduced into the "Soil Taxonomy" to take into account the C.E.C. of $\angle$ 24 m.e/100 g clay. In Soil Taxonomy, only the great group is provided.

PEDON 15. BATU ANAM SERIES

Horizon	Depth (cm)	GRANULOMETRY				pH		O.C. %	N %
		Clay	Silt	Fine Sand	Coarse Sand	H_2O	KCl		
Ap	0-15	50.6	38.8	4.9	1.1	4.70	3.86	1.38	.167
$(B)_1$	15-45	58.7	35.9	5.8	0.9	4.70	3.68	0.46	.111
$(B)_2$	45-63	62.5	32.0	6.3	1.5	4.92	3.80	0.38	.098
$+B_{2cn}$	63-75	64.0	26.9	5.2	4.6	4.95	3.92	0.38	.114
C	75-138	68.4	31.0	4.2	0.3	4.90	3.92	0.25	.097
	+ contains 8.4 % gravels, 7.4 % stones								

Horizon	C.E.C. NH_4OAc me/100 g Soil	Exch. Cations (me/100 g.s.)					Base Saturation %	
		Ca	Mg	Na	K	Al	NH_4OAc	Perm. Charge
Ap	6.70	0.42	0.46	0.05	0.19	2.69	16.0	28.5
$(B)_1$	6.50	0.21	0.31	0.04	0.11	5.38	9.7	10.5
$(B)_2$	5.92	0.14	0.26	0.05	0.09	4.79	8.3	9.3
B_{2cn}	5.95	0.10	0.14	0.05	0.06	2.75	5.0	9.8
C	3.88	0.10	0.28	0.05	0.05	2.51	11.1	14.6

Pedon 15.---ctd.

Horizon	me/100 g soil			p.p.m.		%
	K	Ca	Mg	P	Mn	Al_2O_3
Ap	3.52	0.78	1.70	100	41	15.31
$(B)_1$	4.00	0.60	1.74	64	31	15.31
$(B)_2$	3.72	0.57	1.65	59	58	18.90
B_{2cn}	3.77	1.39	1.87	72	99	22.51
C	3.58	1.03	1.60	61	40	24.30

Horizon	Exch./Total Cations			Charge Characteristics (me/100g clay)	
	K	Ca	Mg	NH_4OAc	Perm. Charge
A_p	0.054	0.54	0.27	7.4	13.2
$(B)_1$	0.028	0.35	0.18	10.2	11.7
$(B)_2$	0.024	0.25	0.16	8.4	9.5
B_{2cn}	0.016	0.07	0.07	4.8	9.3
C	0.014	0.10	0.18	4.3	5.7

PEDON No. 16 : DURIAN SERIES

Location: Department of Agriculture Station, Ayer Hitam, Johore, 103° 11'E, 1° 56'N.

Parent Material: Argillaceous shale.

Topography: 6° slope

Elevation: 30 - 45 m

Vegetation/Land Use: Secondary jungle.

Drainage: Moderately well drained to imperfectly well drained.

Horizon	Depth	Profile Description
A_1	0 - 10 cm:	Pale brown (10 YR 6/3); clay loam; strong medium and fine subangular blocky and fine crumbs; moist friable; abundant pores; abundant roots; clear boundary.
$B_{21}t$	4 - 24 cm:	Reddish Yellow (7.5 YR 7/8); clay; moderately strong coarse and medium subangular and angular blocky; moist firm; common pores; common roots; few termite channels; patchy clayskins; clear boundary.
$B_{22}t$	60 - 68 cm:	Reddish yellow (7.5 YR 7/8): clay; a band of loosely packed gravelly laterite (30%) and some gravelly quartzite (20%) and weathering finc-grained sandstone and shale (10%) clear boundary.
B_{3t}	68 - 108 cm:	Slightly variegated layer of reddish yellow (5 YR 6/8) and reddish yellow (7.5 YR 7/6) white (2.5 Y 8/2) clay; moderately strong coarse and medium subangular blocky and angular blocky; moist; slightly firm; common pores; roots nil; some few (10%) of medium and fine gravelly quartzite and some weathering parent material (10%); gradual boundary.

---ctd next..

PEDON No. 16 --(ctd)

C 108 - 150 cm: Strongly variegated layer of reddish yellow (5 YR 6/8); reddish yellow (7.5 YR 7/6) white (2.5 YR 8/2); clay; moderate coarse and few medium subangular and few angular blocky; moist; slightly firm; few pores; roots nil; presence of semi-weathered parent material (20%) towards depth.

Classification:

a) Taxonomy: PLINTHOXIC TROPUDULTS

b) FAO: DYSTRIC NITOSOLS

Remarks:

It is suggested that a new subgroup viz. "plinthoxic" be introduced into the "Soil Taxonomy" to take into account the presence of 5% plinthite indicating "plinthic" property, and 24 m.e/100 g clay indicating "oxic" property.

PEDON 16. DURIAN SERIES

Horizon	Depth (cm)	GRANULOMETRY %				pH		O.C. %	N %
		Clay	Silt	Fine Sand	Coarse Sand	H_2O	KCl		
A_1	0-10	36.4	39.3	11.0	10.4	4.75	3.85	1.88	.190
$B_{21}t$	10-60	50.3	33.6	10.4	8.2	4.60	3.70	0.39	.090
$B_{22}t$	60-68	52.2	30.2	9.4	8.2	4.75	3.70	0.27	.068
B_3t	68-108	50.4	33.4	9.0	7.7	5.18	3.85	0.25	.064
C	108-150	39.7	36.6	15.9	9.4	5.30	3.95	0.11	.042

Horizon	C.E.C. NH_4OAc me/100 g soil	Exch. Cations (me/100 g soil)					Base saturation %	
		Ca	Mg	Na	K	Al	NH_4OAc	Perm. Charge
A_1	11.09	0.31	0.69	0.05	0.27	5.87	11.9	18.4
$B_{21}t$	9.6	0.09	0.43	0.04	0.09	8.46	6.8	7.1
$B_{22}t$	11.6	0.09	0.23	0.05	0.06	9.44	3.7	9.8
B_3t	11.8	0.11	0.31	0.05	0.05	8.67	4.4	5.7
C	12.4	0.10	0.10	0.05	0.10	6.65	2.8	5.0

Pedon. 16 --ctd.

Horizon	me/100 g soil			p.p.m.		Al_2O_3
	K	Ca	Mg	P	Mn	
A_1	4.45	0.92	2.52	77	27	14.40
$B_{21}t$	5.03	0.15	2.75	43	24	16.20
$B_{22}t$	6.56	0.17	3.54	47	33	21.15
B_3	4.62	0.19	2.62	34	35	21.15
C	3.94	0.22	2.28	30	29	16.20

Horizon	me/100 g soil			Charge Characteristics (me/100 g clay)	
	K	Ca	Mg	NH_4OAc	Perm. Charge
A_1	0.60	0.34	0.27	19.8	32.7
$B_{21}t$	0.018	0.60	0.16	18.1	19.1
$B_{22}t$	0.009	0.53	0.06	18.9	22.2
B_3	0.010	0.58	0.12	18.3	23.4
C	0.025	0.45	0.04	17.6	31.2

PEDON No. 17 : PARIT BOTAK SERIES

Location:	Pontian District, Johor Barat
Parent Material:	Mixed estuarine/marine deposit
Topography:	Flat
Vegetation/Land Use:	Under coconut and dusun
Drainage:	Somewhat poorly drained. Water table 60 cm from surface

Horizon	Depth	Profile Description
Ap	0 - 20 cm:	Clay; very dark grey 10 YR 3/1; moderate medium to fine subangular blocky and crumb; Hard; rich in decomposed organic matter and the soil is peaty; few faint mottling along root channels; common medium to fine roots; clear wavy boundary to,
A_3	20 - 30 cm:	Clay; dark brown 7.5 YR 3/2; weak to moderate medium subangular blocky; firm; no mottles; common medium to fine roots; common, fresh and semi-decomposed organic matter and the soil is slightly peaty; clear but wavy boundary to,
$(B)_1$	30 - 40 cm:	Clay; brown 10 YR 5/3; very weak medium subangular blocky; sticky; common, medium, distinct, sharp, pale yellow 2.5 Y 8/4 jarosite; coarse semi-decomposed organic matter; no roots; diffuse boundary to,
$(B)_2$	40 - 50 cm:	Clay; dark grey brown 10 YR 4/2; weak, medium subangular blocky; sticky; common, medium to coarse, prominant, sharp, yellow 2.5 Y 8/8 jarosite; few coarse semi-decomposed organic matter; clear boundary to,
B_{3g}	50 - 65 cm:	Clay; grey 5 Y 5/1 (STD: olive grey 2.5 GY 5/1); weak to moderate coarse subangular blocky; sticky; common coarse jarosite, color as above, clear boundary to,
Cg	65 cm+	Clay; greenish grey 10 GY 5/1 (STD); massive; unripe; few semi-decomposed roots; coarse blotch of dark grey brown 10 YR 4/2 material (organic rich).

Classification:

a) Taxonomy: TYPIC SULFAQUEPT

b) FAO: ORTHIC GLEYSOLS

PEDON 17. PARIT BOTAK SERIES

Horizon	Depth (cm)	GRANULOMETRY %				pH		Fresh pH H_2O (1:1)	O.C. %
		Clay	Silt	Fine Sand	Coarse Sand	H_2O	KCl		
Ap	0-20	50	36	24		5.9	5.1	5.6	5.2
A_3	20-30	66	30	6		3.5	2.8	3.7	3.6
B_1	30-40	58	34	7		3.0	2.1	3.2	3.0
$(B)_2$	40-50	48	42	10		2.7	2.1	3.0	3.2
B_{3g}	50-65	64	29	7		2.0	2.0	3.4	2.0
C_g	65-90	57	36	7		2.6	2.0	3.4	3.0
C_g	90-120	63	30	8		2.8	2.2	6.6	3.9

Horizon	Al meq.soil 1N (KCl)	Exch. Cat. (meq/soil)				(pH8.2)	C.E.C.	
		Ca	Mg	K	Na		NH_4OAc	NH_4Cl
Ap	0.3	25	35	tr	1	24	24	34
A_3	7.8	2	3	tr	1	47	47	18
$(B)_1$	12.7	1	tr	tr	tr	46	50	16
$(B)_2$	17.8	1	tr	tr	tr	47	57	16
B_{3g}	26.0	1	tr	tr	tr	37	67	15
C_g	42.0	-	-	-	-	-	-	16
C_g	19.5	2	11	tr	tr	29	48	17

Horizon	Free Fe_2O_3	% SO_4 Total	Conductivity m/Mhos	L.I.	CEC NH_4OAc (pH)
Ap	1.7	0.234	350	14.4	45
A_3	1.1			10.5	37.2
$(B)_1$	1.7	1.062	1000	10.1	3.6
$(B)_2$	1.5	1.329	700	10.0	37.5
B_{3g}	2.0	1.174	1000	7.6	32.2
C_g	1.2	1.131	770	7.5	32.2
C_g	1.1	1.402	550	7.5	28.8

PEDON No. 18 : LINAU SERIES

Location:	Kampong Bukit Batu, Batu Pahat district
Parent Material:	Estuarine swamp over marine clay.
Topography:	Flat, coastal plain
Vegetation/Land Use:	Cleared old rubber
Drainage:	Moderately well drained. Water level at 35 cm from surface.

Horizon	Depth	Profile Description
Oe_1	0 - 10 cm:	Peat; dark brown 7.5 YR 3/2; moderate medium subangular blocky and crumbs; fine root abundant; gradual boundary to,
Oe_2	10 - 48 cm:	Peat; very dark brown 10 YR 2/2; weak medium to fine crumb; sticky; frequent fine and coarse roots; semi-decomposed organic matter; clear boundary to,
IIC	48 - 83 cm:	Silty clay; very dark grey 10 YR 3/1; common fine roots and semi-decomposed coarse root remains. Rich in decomposed organic matter; lower boundary very wavy.
IIIC	83 cm+	Clay; olive grey 5 GY 5/1 (STD); massive; unripe; plastic; common semi-decomposed organic matter; coarse blotch of IIC material; lower boundary undiscernable.

Classification:

a) Taxonomy: HISTIC FLUVAQUENT

b) FAO: GLEY HISTOSOL

PEDON 18. LINAU SERIES

Horizon	Depth (cm)	GRANULOMETRY %				pH		Fresh pH H_2O (1:1)	O.C. %
		Clay	Silt	Fine Sand	Coarse Sand	H_2O	KCl		
Oe_1	0-10	65	36			3.3	2.8	3.3	14.2
Oe_2	10-47	49	30			3.1	2.7	3.0	9.8
IIC	47-65/86					2.2	1.5	4.0	10.1
IIIC	65/86+	68	24			2.7	2.2	6.7	3.1

Horizon	Al meq.soil 1N (KCl)	Exch.cat. (meq.soil) NH4Cl				(pH8.2)	C.E.C	
		Ca	Mg	K	Na		NH_4OAc	NH_4Cl
Oe_1	6.2	2	3	tr	tr	53	53	17
Oe_2	11.5	1	3	tr	tr	57	57	18
IIC	79.5	1	14	tr	tr	5	102	17
IIIC	27.0	(9)		tr	tr	31	47	18

Horizon	Free Fe_2O_3	% SO_4 Total	Conductivity m/Mhos	L.I.	CEC NH_4OAc (pH)
Oe_1	1.4	0.214	330	89	60
Oe_2	0.7	0.083	350	79	54.8
IIC	1.3	2.503	550	24	47.3
IIIC	1.5	1.721	475	10	31.6

PEDON No. 19 : MALACCA SERIES

Location:	7½ milestone Malacca - Muar Road
Parent Material:	Schist
Topography:	Level
Elevation:	12 m
Vegetation/Land Use:	Old rubber
Drainage:	Excessive.

Horizon	Depth	Profile Description
A_{1-3}	0 - 10 cm:	Gravelly clay; strong brown (7.5 YR 5/6); few roots; no biological activity; sharp boundary;
B_{21ox}	10 - 110 cm:	Gravelly clay; strong brown (7.5 YR 5/6); few roots; structure not discernable; diffuse boundary;
B_{22x}	110 - 200 cm:	Gravelly clay; composed almost completely of loose pisolitic laterite gravels; no roots; diffuse boundary
B_{230x}	200 - 310 cm:	Gravelly clay; strong brown (7.5 YR 5/6); no roots; compact gravel; abrupt boundary.
B_3	310 - 400 cm:	Gravelly clay; red (2.5 YR 4/6); Weak, coarse, angular blocky breaking to fine granules; patchy clay skins on ped faces and pores; abrupt boundary;
C_1	400 - 550 cm:	Clay, red (2.5 YR 4/6); massive; few weathering rock fragments; sharp boundary.
C_2	550 - 750 cm:	Clay loam; dark red (2.25 YR 3/6); bands of weathered schist; massive; breaking according to clevage planes.
C_3	750 - 850 cm:	Weathering rock. Pallid zone.
C_4	850 - 950 cm:	Weathering rock. Pallid zone
C_5	950 -1150 cm:	Weathering rock. Pallid zone.

Classification:

a) Soil taxonomy: HAPLIC ACRORTHOX

b) FAO: AQUIC FERRALSOL

PEDON 19. MALACCA SERIES

Depth (cm)	Horizon	GRANULOMETRY				ORIGINAL		O.C. %	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	Gravels	Stones		
0-10	A_{1-3}	45.4	18.1	21.0	15.5	30.0	28.0	1.01	13.7
10-110	B_{21ox}	49.8	25.6	9.8	14.8	12.6	74.8	0.53	18.4
110-200	B_{22ox}	43.5	27.9	11.7	16.9	16.3	64.3	0.29	20.4
200-310	B_{23ox}	30.9	29.8	12.9	26.4	39.3	9.5	0.13	12.3
310-400	B_3	34.8	38.8	16.8	9.6	NIL	NIL	0.10	10.2
400-500	C_1	26.7	39.7	24.8	8.8	NIL	NIL	0.07	45.7
550-750	C_2	22.1	32.8	35.5	9.6	NIL	NIL	0.06	39.2
750-850	C_3	13.3	57.0	27.6	2.1	NIL	NIL	0.05	12.7
850-950	C_4	19.8	64.0	12.6	3.6	NIL	NIL	0.05	11.3
950-1150	C_5	12.3	60.2	18.0	9.5	NIL	NIL	0.05	1.6

Horizon	pH		ΔpH	IN-KCl Al	Exch. Cat. meq/100 g soil				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_{1-3}	4.6	4.1	-0.5	1.71	0.04	0.08	0.08	0.06	
B_{21ox}	4.6	4.5	-0.1	1.82	0.09	0.12	0.05	0.04	
B_{22ox}	4.8	4.6	-0.2	1.51	0.07	0.09	0.04	0.03	
B_{23ox}	5.1	5.0	-0.1	0.21	0.08	0.04	0.05	0.08	
B_3	5.1	4.5	-0.6	0.25	0.08	0.02	0.03	0.02	
C_1	5.7	4.9	-0.8	0.01	0.04	0.01	0.03	0.03	
C_2	5.0	4.4	-0.6	0.31	0.06	0.03	0.06	0.04	
C_3	4.3	4.0	-0.3	1.51	0.08	0.06	0.09	0.03	
C_4	4.7	4.2	-0.5	1.57	0.13	0.06	0.09	0.03	
C_5	4.6	4.0	-0.6	1.82	0.02	0.04	0.02	0.80	

Pedon 19. --ctd.

Horizon	CEC meq/100 grm SOIL	CHARGE meq/100 g CLAY		Base Sat. %	Al^{3+} Sat.% on PC
	NH40Ac	P.C.	NH40Ac	NH40Ac	
A_{1-3}	3.78	4.25	8.32	6	87
B_{21ox}	2.98	4.25	5.98	10	86
B_{22ox}	3.72	4.00	8.55	6	87
B_{23ox}	2.14	1.49	6.92	12	46
B_3	2.96	0.86	8.50	5	83
C_1	2.64	0.44	9.88	4	8
C_2	2.31	2.26	10.45	8	62
C_3	4.56	13.3	34.28	6	85
C_4	4.98	9.49	25.15	6	83
C_5	4.78	21.95	38.86	18	67

PEDON No. 20 : BRIAH SERIES

Location:	Kampong Tasek, Telok Gong, Malacca, 25 m from road.
Parent Material:	Riverine alluvium.
Topography:	River floodplain.
Elevation:	∠ 17 m
Slope:	Level.
Vegetation/Land Use:	Mature rubber.
Drainage:	Imperfectly drained.

Horizon	Depth	Profile Description
Ap	0 - 14 cm:	Clay; greyish brown (2.5 Y 5/2); strong, coarse angular blocky; sticky; common distinct (5 YR 5/6) mottles, predominantly along root channels; many fine roots; few coarse roots; low biological activity; rather sharp boundary.
B_{1g}	14 - 31 cm:	Clay; light brownish grey (2.5 Y 6/2); weak, coarse angular blocky; sticky; many (5 Y 5/8) mottles along root channels and in matrix; few coarse roots; some charcoal fragments; diffuse boundary.
$(B)_{2g}$	31 - 62 cm:	Clay; light grey (2.5 Y 7/2); moderate, coarse prismatic; sticky; common (5 YR 6/8) root streaks adjoining void walls and diffused outwards; common large distinct (2.5 YR 5/8) mottles on ped faces; few fine roots; diffuse boundary.
B_{3g}	62 - 94 cm:	Clay; light grey (2.5 Y 7/2); weak, coarse prismatic; sticky; common large distinct (2.5 YR 5/8) mottles on ped faces; no roots; rather sharp boundary.
CG	94 - 110+cm:	Clay; grey (N 6/0); massive; water-table at 110 cm.

Classification:

a) Soil Taxonomy: TYPIC TROPAQUEPT

b) FAO: GLEYIC CAMBISOL

PEDON 20. BRIAH SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	
0-14	Ap	55.1	34.0	10.6	0.3	1.99	1.90
14-31	$(B)_{1g}$	57.3	32.3	10.1	0.2	1.12	2.01
31-62	$(B)_{2g}$	62.3	28.3	9.2	0.2	0.47	4.04
62-94	B_{3g}	51.8	26.0	21.7	0.5	0.34	1.93
94-110	CG	45.8	25.3	28.8	0.2	0.43	1.92

Horizon	pH		ΔpH	1N-KCl Al	Exch. Cat. meq/100 grms Soil			
	H_2O	KCl			Ca	Mg	Na	K
Ap	4.6	4.2	-0.4	2.80	5.42	4.11	0.20	0.30
$(B)_{1g}$	4.8	4.2	-0.6	4.73	3.67	3.74	0.26	0.15
$(B)_{2g}$	4.7	3.9	-0.8	8.60	1.97	4.11	0.46	0.21
B_{3g}	4.9	4.2	-0.7	5.33	2.98	5.75	0.73	0.20
CG	5.3	4.5	-0.8	1.27	2.81	5.91	0.85	0.20

Horizon	CEC meq/100 grm SOIL	CHARGE meq/100 grms CLAY		Base Sat.%	Al Sat. % on PC
	NH_4OAc	PC	NH_4OAc	NH_4OAc	
Ap	15.66	23.3	28.42	64	22
$(B)_{1g}$	15.78	17.1	27.5	50	20
$(B)_{2g}$	16.96	17.3	27.2	40	80
B_{3g}	15.81	22.4	30.5	61	46
CG	16.21	25.5	35.4	60	16

PEDON No. 21 : SUNGEI MAS SERIES

Location: 5th milestone, Kuala Pilah - Tampin Road.

Parent Material: Serpentinite

Topography: Gently undulating

Elevation: 80 m

Slope: 8°

Vegetation/Land Use: Primary jungle

Drainage: Excessively drained.

Horizon	Depth	Profile Description
A_{1-3}	0 - 10 cm:	Clay loam; brown (10 YR 4/3); moderate medium subangular blocky and coarse granular; very friable; many fine roots, rather sharp boundary.
B_{21ox}	10 - 57 cm:	Clay; dark yellowish brown (10 YR 4/4); very weak coarse prisms breaking down to fine granules; friable; many fine roots; very few pores; diffuse boundary.
B_{22ox}	57 - 171 cm:	Clay; dark yellowish brown (10 YR 4/4); very weak, coarseprisms breaking down to fine subangular blocky with granules; coarse prisms appear to have coatings on ped faces; very friable; few termite activity; many fine and medium roots; boundary diffuse.
B_{23ox}	171 - 213 cm:	Clay; dark yellowish brown (10 YR 4/4); weak prisms breaking down to weak, medium and fine subangular blocky; very friable; many patchy coatings on ped faces; boundary abrupt.
B_{24}	213 - 283 cm:	Clay; reddish brown (5 YR 4/3); coarse prismatic, compact - present as a distinct horizon; few roots, plenty of continuous clayskins on ped faces; boundary very abrupt.
B_{25}	283 - 333 cm:	Clay; reddish brown (5 YR 4/4); weak coarse prismatic breaking down to fine subangular blocky; continuous clayskins on ped faces; few roots; boundary diffuse.
B_{26}	333 - 483	Clay; brown (7.5 YR 4/4). Other features same as previous horizon.

Note: The compact pan at 213 cm to 283 cm is probably due to bulldozers going over the soil to make terraces at the roadcutting.

Classification:

a) Soil taxonomy: HAPLIC ACRORTHOX

b) FAO: ACRIC FERRALSOL

PEDON 21. SUNGEI MAS SERIES

Depth (cm)	Horizon	GRANULOMETRY				Percentage		C/N	% Free Iron
		Clay	Silt	Fine Sand	Coarse Sand	O.C.	N		
0-10	A_{1-3}	26.8	29.9	34.7	8.6	0.05	0.18	11	25.19
10-57	B_{21ox}	28.2	19.4	44.7	7.7	0.79	0.09	9	27.33
57-171	B_{22ox}	41.5	21.8	31.2	5.5	0.41	0.05	8	27.87
171-213	B_{23ox}	43.1	22.1	29.1	5.4	0.38	0.05	8	28.58
213-283	B_{24}	34.4	23.8	35.0	6.9	0.67	0.11	10	27.33
283-333	B_{25}	43.1	23.6	28.5	4.8	0.50	0.03	17	27.87
333-483	B_{26}	38.2	21.0	35.2	5.6	0.22	0.03	7	29.29

Horizon	Bulk Density	Moisture (Volume %) at pF					A. Moist. mm/m		Porosity %
		0	1	2	2.54	4.19	1/3-15	1/10-15	
B_{21ox}	1.18	55.6	52.8	40.7	36.4	28.0	84	127	56
B_{22ox}	1.27	59.1	48.8	40.0	39.3	30.3	90	97	52
B_{23ox}	1.31	65.0	54.2	45.8	39.1	30.1	90	157	51
B_{24}	1.47	56.9	48.3	44.6	41.5	35.8	57	88	45
B_{26}	1.31	48.4	44.1	44.0	39.7	32.5	72	115	51

Horizon	pH		ΔpH	1N-KCL Al	Exch. Cat. meq/100 gms SOIL				Extr. Acidity
	H_2O	KCl			Ca	Mg	Na	K	
A_{1-3}	4.4	4.0	-0.4	0.98	0.08	0.56	0.05	0.19	11.2
B_{21ox}	4.8	4.7	-0.1	0.82	0.14	0.17	0.05	0.05	10.7
B_{22ox}	5.4	5.0	-0.4	0.71	0.05	0.27	0.03	0.03	8.1
B_{23ox}	5.5	5.0	-0.5	0.55	0.03	0.13	0.03	0.03	8.3
B_{24}	4.7	4.5	-0.2	0.41	0.07	0.28	0.03	0.08	8.6
B_{25}	5.6	4.9	-0.7	0.32	0.02	0.06	0.03	0.02	7.5
B_{26}	5.6	5.1	-0.5	0.31	0.02	0.18	0.03	0.02	7.7

Pedon 21. --ctd.

Horizon	CEC meq/100 gms SOIL			CHARGE meq/100 gms CLAY					Base Sat. %		Al Sat.%
	NH_4Cl	NH_4OAc	Sum	PC	NH_4Cl	NH_4OAc	Sum	PDC	NH_4OAc	Sum	
A_{1-3}	2.34	6.00	12.08	5.8	8.7	22.4	25.1	38.1	14.7	7.3	52.7
B_{21ox}	0.92	1.88	11.11	4.4	3.3	6.7	39.4	35.0	21.8	3.7	66.7
B_{22ox}	0.78	1.52	8.48	2.6	1.9	3.7	20.4	17.8	25.0	4.5	65.1
B_{23ox}	1.16	1.48	8.52	1.8	2.7	3.4	19.8	18.0	14.9	2.6	71.4
B_{24}	1.68	2.64	9.06	2.5	4.9	7.7	26.3	23.8	17.4	5.1	47.1
B_{25}	1.38	1.48	7.63	1.0	3.2	3.4	17.7	16.6	8.8	1.7	71.1
B_{26}	1.02	1.20	7.95	1.5	2.7	3.1	20.8	19.3	20.8	3.1	55.4

TOTAL ANALYSIS (SOIL)

Horizon										SiO2	SiO2
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na2O	H_2O^-	H_2O^+	Al_2O_3	R_2O_3
A_{1-3}	33.6	20.9	26.6	0.1	0.1	0.1	Tr	2.2	16.4	2.8	1.5
B_{21ox}	32.7	21.7	28.9	0.1	0.1	0.1	0.1	2.1	14.2	2.6	1.4
B_{22ox}	33.7	21.1	29.1	Tr	0.1	Tr	Tr	2.1	14.3	2.7	1.4
B_{23ox}	32.7	20.5	29.6	Tr	0.1	Tr	Tr	2.1	15.1	2.7	1.4
B_{24}	31.6	20.5	30.0	0.1	0.1	0.1	0.1	2.2	15.4	2.6	1.3
B_{25}	31.4	22.0	28.9	0.1	0.1	0.1	0.1	2.3	15.2	2.5	1.3
B_{26}	29.0	22.0	31.0	0.1	0.1	0.1	Tr	2.2	15.3	2.3	1.2

Pedon 21. --ctd.

TOTAL MICRONUTRIENTS (ppm)					
Horizon	Mn	Cu	Zn	Co	Ni
A_{1-3}	1,000	196	175	160	128
B_{21ox}	970	214	160	175	142
B_{22ox}	1,070	218	175	150	98
B_{23ox}	970	236	183	180	123
B_{24}	900	225	290	130	128
B_{25}	885	214	175	175	124
B_{26}	1,270	254	175	250	137

TOTAL ANALYSIS (CLAY)											
Horizon	Si02	A1203	Fe203	Ca0	Mg0	K20	Na20	$H20^-$	$H20^+$	Si02/A1203	Si02/R203
B_{21ox}	15.2	29.7	33.3	0.1	Tr	0.1	0.1	2.3	17.5	0.9	0.5
B_{22ox}	16.2	31.2	34.7	0.1	Tr	Tr	0.1	1.7	16.9	0.9	0.5

3. SOIL SUITABILITY FOR PERENNIAL TREE CROPS

3. SOIL SUITABILITY FOR PERENNIAL TREE CROPS

INTRODUCTION

Recent work in Malaysia has shown that there is considerable variability in the physical and nutrient characteristics of soils in Peninsular Malaysia. The influence of these two factors and their interactions on the performance of Hevea and other perennial crops in Malaysia have been discussed by various workers. This has resulted in considerations for different soil suitability ratings for different crops. A soil suitable for optimum growth of any plant is one which encourage vigorous roots development and ensures a firm anchorage and also, provides an adequate storehouse for water and plant nutrients which are readily avaialble to the tree. The suitability of a soil for a crop is therefore very much dependent on the physical and chemical make-up of the soil. Besides the soil factor, the crop requirement and environmental characteristics are also important considerations. The purpose of this section is to highlight these aspects in the light of recently acquired data.

On the basis of results obtained from appropriate agronomic experiments and semi-quantitative assessments made from agronomic survey data obtained from estates as well as field observations, a number of criteria can be sieved out as principal crop requirements of the various tree crops on soils and their physiographic environment. Thus, for example, Hevea yield performance and foliar nutrient status have been related to the 'effective' depth of soil to a pan hindrance, to soil texture and to soil slope; to soil properties as influenced by covers; and to soil nutrient status.

Relationships of other important soil properties like structure, aggregation, water-holding capacities, bulk densities, permeabilities with the rooting habit of the trees and to the growth of common covers have also been shown. By appropriate interpolation, the favourable effects of these properties on performance of tree crops either directly or indirectly are implied.

In the case of soil properties like soil consistencies, presence or absence of thick peat and acid sulphate layers in influencing performance, data is limited. Therefore for these properties, a semi-quantitative and a qualitative assessment based on ad hoc data and field experience are used.

As the physical properties of soil are more intrinsic and durable than the chemical properties, which are amenable to change by management practices, the former is given predominant importance in assessing the merits of any soil situation. Thus, based on the above principles and the agronomic data synthesized so far, the suitability of the soils are indicated.

It must be emphasised however that climate and management can overide all the factors discussed, and thus all factors should be considered in an integrated manner and not taken in isolation. Information on rubber, oil palm and cocoa only is provided.

Degree in severity of limitation / Soil properties	Desirable range	Minor Limitation	Serious Limitation	Very serious limitation
I. Physical properties				
Rock Outcrop (%)	Absence	< 50	> 50 -75	> 75
Effective depth: (a)	> 150 cm	> 100 - 150 cm	> 60 - 100 cm	< 60 cm
(b)	> 100 cm	> 60 - 100 cm	> 25 - 60 cm	< 25 cm
Texture	Almost proportionate amounts of sand and silt + clay	i) Sandy loam (> 50-70% sand) ii) Clayey (> 50-70% clay) iii) Silty clayey (> 50-70% silt + clay)	i) Very sandy (> 70-90% sand) ii) Very clayey (> 70%-90% clay) iii) Very silty clayey (> 70-90% silt + clay)	i) Extremely sandy (> 90% sand) ii) Extremely clayey (> 90% clay) iii) Extremely silty clayey (> 90% silt+clay)
Consistency				
Dry	Soft	Slightly hard	Hard Loose	Very hard
Moist	Friable - Very friable	Firm	Very firm Loose	Extremely firm
Wet (a) Stickiness	Slightly sticky	Sticky Non sticky	Very Sticky	Extremely sticky
(b) Plasticity	Slightly plastic	Non plastic Plastic	Very plastic	Extremely plastic
Structure				
Prismatic)	Weak - moderate	1) Moderate-strong medium	Strong	Strong
Columnar)	Fine-very fine	2) Weak coarse	Coarse	Very coarse

Table 1. --ctd.

Soil properties \ Degree in severity of limitation	Desirable range	Minor Limitation	Serious Limitation	Very serious limitation
Angular blocky	1) Moderate - strong	Weak coarse (for texture coarser than clay loam)	Strong Coarse	Strong Very coarse Weak coarse (finer than clay loam)
Internal drainage[b]	Class D - well drained	Class C - Moderately drained	Class B - Imperfectly drained Class E - somewhat excessively drained	Class A - Poorly drained Class F - excessively drained
Peaty layer	Absence of peat	Acid peat >50 cm from surface; <25 cm thick peat	Acid peat 25 cm-50 cm from surface; >25 - 50 cm thick peat	Acid peat layer <25 cm from surface; >50 - 100 cm thick peat
Acid sulphate layer	Absence of acid	Acid SO_4 layer 50 cm from surface; 25 cm thick	Acid SO_4 layer 25 cm - 50 cm from surface; > 25-50 cm thick	Acid SO_4 layer < 25 cm from surface; >50-100 cm thick.
Moisture retention (available water in cm/m)	>150 cm	>100 - 150 cm	>50 - 100 cm	< 50 cm
Permeability[c]	Moderate	Moderately slow or Moderately rapid	Slow or rapid	Very slow or very rapid
Erodibility[c]	Class 1 (slightly eroded)	Class 2 (Moderately eroded)	Class 3 (Severely eroded)	Class 4 (Very severely eroded)

Table 1. --ctd.

Soil properties / Degree in severity of limitation	Desirable range	Minor Limitation	Serious Limitation	Very serious limitation
II. Chemical properties				
(a) pH	Mean 4.5 Range 4.3-4.6	> 4.6 - 5.0; 3.9 - 4.3	>3.6 - 3.9 >5.0 - 6.0	< 3.6 >6.0
(b) Nutrient content	High content	medium	low	Extremely low or extremely high in trace element
III. Physiographic features				
Terrain(d)	0 - 8°	>8° - 15°	>15° - 33°	>33°
Susceptibility to flooding	No flooding	Floods after very heavy downpours	Flood after heavy downpours	Floods after light downpours
Stagnation of water at surface	No stagnation	Water stagnates for a few hours	Water stagnates for 3 days	Water stagnates for 3 days

Compiled by Chan, Noordin and Pushparajah.

Footnotes:

(a) considers depth to hard pan (limestone laterite layer, quartz vein, compact parent material, etc.,) or to permanent water table

(b) considers depth of loose laterite

(c) based on the definitions of U.S.D.A. 1960

(d) refers to more commonly occurring slopes only

TABLE 2. SOIL RATINGS FOR RUBBER*

Pedon No.	Soil Series	Terrain	Depth	Laterite	Texture	Structure and Consistence	Permeability	pH	Nutrient content Major	Nutrient content Minor	Normal Yield range (Kg/ha/year, Panel A)	Suitability
1	LANCHANG	3 to 2	3 - 2	3	3	3	3	3	2	3	1250 - 1350	I
2	SEGAMAT	3 to 2	3	3	3	3	3	3	2	3	1250 - 1350	I
3	BUNGOR	3 to 2	3	3	3	3	3	3	2	3	1250 - 1350	I
4	RASAU	3	3	3	2	2	1	3	1	2	1000 - 1150	III
5	LUNAS	3	1	3	1	2	1	3	1	2	850 - 1000	V
				Remarks: Very poor drainage and make this soil unsuitable for rubber								
6	KUANTAN	3	3	3	3	3	2	3	2	3	1250 - 1350	I
7	RUDUA	3	2	3	0	1	1	3	1	2	850	V
				Remarks: Very poor texture and structure make this soil unsuitable for rubber								
8	RENGAM	3 to 2	3	3	3	2	3	3	2	3	1150 - 1350	I
				Remarks: Downgraded to class 2 in steep terrain								
9	KUALA BRANG	3 to 2	2 - 1	3	2	1	3	3	1	2	850 - 1000	IV
				Remarks: Shallow depth is the main limitation								
10	ORGANIC CLAY	3	2	3	1	2	0	3	3	3	850	V
				Remarks: Poor drainage is the main limitation								
11	TAI TAK	3	3	3	2	2	1	3	2	3	1000 - 1150	III
12	ULU TIRAM	3	2	3	1	2	1	3	2	2	1000 - 1150	III
13	SENAI	3 to 2	3	2-3	3	3	3	3	2	3	1150 - 1250	II
14	JERANGAU	3 to 2	3	3	3	3	3	3	2	3	1150 - 1350	I

--ctd next..

Table 2. (ctd)

Kg/ha/year, Panel A

Pedon No.	Soil Series	Terrain	Depth	Late-rite	Tex-ture	Structure and Consistency	Permea-bility	pH	Nutrient content Major	Minor	Normal Yield range	Suita-bility
15	BATU ANAM	3	1	1	1	1	1	3	3	3	750 - 1000	IV
				Remarks:	Shallow soil depth and poor structure are the main limitations.							
16	DURIAN	3 to 2	1	1	1	2	1	3	3	3	1000 - 1150	III
				Remarks:	Shallow soil depth is the main limitation							
17	PARIT BOTAK	3	1	3	3	3	1	0	1	2	850	V
				Remarks:	High acidity is the main limitation							
18	LINAU	3	1	3	3	1	0	0	1	2	850	V
				Remarks:	High acidity is the main limitation.							
19	MALACCA	3 to 1	2 - 0	2-1	3	3	3	3	1	2	900 - 1250	II-IV
				Remarks:	Growth and yield depends very much on effective soil depth							
20	BRIAH	3	1	3	2	2	1	2	2	3	850 - 1000	IV
21	SUNGEI MAS	3	3	3	3	2	2	1	0	0	750	V
				Remarks:	Toxic levels of manganese, nickel, cobalt and chromium is the main limitation							

KEY TO CODES

3 - desirable range
2 - minor limitation
1 - serious limitation
0 - very serious limitation

Class I - highly suitable
II - suitable
III - moderately suitable
IV - marginal
V - unsuitable

• Compiled by H.Y. Chan, E. Pushparajah, Noordin Daud.

Class I

The soils in this class have no physical limitation to rubber cultivation but may have one minor chemical limitation.

Class II

The soils in this class have one or more minor limitations to rubber.

Class III

The soils in this class have at least one serious limitation to rubber cultivation.

Class IV

The soils in this class have more than one serious limitation to rubber cultivation.

Class V

The soils in this class have at least one very serious limitation to rubber cultivation.

TABLE 3. PRINCIPAL CRITERIA IN GRADING OF SOIL SUITABILITY CLASSES FOR ELAEIS QUINEENSIS*.

Soil properties \ Degree in severity of limitation	Desirable range	Minor Limitation	Serious limitation	Very serious limitation
Texture	Sandy clay loam and heavier	Loam, sandy loam	Loamy sand	Sand.
Effective soil depth	90 cm	75 - 90 cm	50 - 75 cm	50 cm
Structure and Consistency	Friable to Moderately firm	Firm	Serious	Very serious
Laterite	Nil	Nil	Up to 25% nodular on fragmental laterite. 15 - 30 cm	25% laterite and massive laterite
pH	4.0	3.5 - 4.0	3.2 - 3.5	3.2
Peat layer	0 - 30 cm	30 - 75 cm	75 - 100 cm	150 cm
Permeability and drainage	Moderately well-drained to well drained	Imperfect to well drained	Poorly drained or excessively drained	Very poorly drained
Terrain	0 - 12°	12 - 16°	16 - 23°	23°
Nutrient Content	Low application of fertilisers only required	Moderately to high quantities of fertilisers required. Application normally economic.	High to very high fertiliser applications required. May not be economic at times of low palm oil prices	Very high fertiliser applications and extra care in applications required. Probable economic rates only at times of high palm oil price.

*Compiled by P.S. Chew

TABLE 4. SOIL RATINGS FOR OIL PALMS

Pedon No.	Soil Series	Terrain	Depth	Late-rite	Tex-ture	Structure and Consistency	Permea-bility	pH	Nut. Content Major	Nut. Content Minor	tons FFB/acre Normal yield range	tons FFB/acre Highest yields	Suita-bility
3	BUNGOR	3 to 1	3	3	3	3	3	3	2	3	8 to 10	10	HS
			Remarks:	Steep terrain and severe erosion are usual main limitations and rating is downgraded to moderately suitable in steep terrain									
4	RASAU	3	3	3	2	2	1	3	1	2	7 to 9*	10*	M
5	LUNAS	3	1	3	3	2	2	3	1	2	7 to 9*	10*	M
6	KUANTAN	3	3	3-1	3	3	1	3	2	3	8 to 10	10	MS
			Remarks:	Excessive drainage is the main limitation									
7	RUDUA	3	2	3	0	1	1	3	0	1	3 to 5*	5*	X
			Remarks:	Very poor texture and structure make this soil unsuitable for oil palm									
8	RENGAM	3 to 1	3	3	3	2	3	3	2	3	8 to 10	12	HS
			Remarks:	Downgraded to moderately suitable in steep terrain									
9	KUALA BRANG	2 to 1	2 - 1	3	2	2	3	3	1	2	7 to 9	10	M
			Remarks:	Terrain and shallow soil depth may be serious limitation Hazards of erosion are great									
10	ORGANIC CLAY	3	2	3	3	3	2	2	3	3	10 to 12	13	MS
			Remarks:	Poor drainage is the main limitation and can limit effective soil depth									
11	TAI TAK	3	3	3	3	3	3	3	2	3	8 to 10*	12*	HS
12	ULU TIRAM	3	2	3	1	2	1	2	1	2	7 to 8*	8*	M
13	SENAI	3 to 1	3	3	3	3	3	3	2	3	8 to 10*	12*	HS
14	JERANGAU	3 to 1	3	3	3	3	3	3	2	3	8 to 10*	12*	HS

--ctd next..

Table 4 (ctd.)

Pedon No.	Soil Series	Terrain	Depth	Laterite	Texture	Structure and Consistency	Permeability	pH	Nut. Content Major	Nut. Content Minor	tons FFB/acre Normal yield range	tons FFB/acre Highest yields	Suitability
15	BATU ANAM	3	1	1	3	1	2	3	2	2	6 to 8*	10	M
				Remarks:		Good yields of 10 tons FFB have been obtained with heavy fertilisation in N. Johore							
16	DURIAN	3 to 1	3	1	3	2	2	3	2	3	8 to 10*	10	MS
				Remarks:		Laterite bands often present and may be serious limitation if effective soil depth is less than 50 cm							
17	PARIT BOTAK	3	1	3	3	3	1	0	1	0	3 to 5*	5*	X
				Remarks:		The acidity of the soil can be ameliorated by raising water-tables above the acid sulphate layer and by very high applications of bunch ash or liming materials. Yields can be raised to 6 to 8 tons/acre in such areas							
18	LINAU	3	1	3	3	1	0	0	1	2	3 to 4*	4*	X
				Remarks:		Very highly acid soil and very high applications of bunch ash or liming materials are required to improve productivity of the palms. Yields can be raised to 5 to 7 tons.							
19	MALACCA	3 to 1	0	0	3	3	3	3	0	2	4 to 6	8	X
				Remarks:		Growth and yield depends very much on effective soil depth							
21	SUNGEI MAS	2	3	3	3	3	1	?	?	?	?	?	?
				Remarks:		Toxic levels of manganese, nickel, cobalt and chromium reported. Susceptibility of oil palms to these heavy metals not known							

KEY TO CODES

3 - desirable range
2 - minor limitation
1 - serious limitation
0 - very serious limitation

HS - highly suitable
MS - moderately suitable
M - marginal
X - unsuitable

Note: Data from Pedon 1, 2 and 20 are not available

Suitability grading	Physical properties
1. Highly suitable	Soils possessing all properties in desirable range of not more than 1 property in minor limitation grade.
2. Moderately suitable	Soils possessing not more than 3 properties in minor limitation grade and 1 property in serious limitation grade or not more than 4 properties in minor limitation grade.
3. Marginal	Soils possessing not more than 3 properties in serious limitation grade or 2 properties in serious limitation grade and 1 in very serious limitation grade.
4. Unsuitable	Soils possessing not more than 2 properties in serious limitation grade and 1 in very serious limitation grade or more than 2 properties in very serious limitation grade.

TABLE 5. PRINCIPAL CRITERIA IN GRADING OF SOIL SUITABILITY CLASSES FOR COCOA*.

Degree in severity of limitation / Soil properties	Desirable range	Minor Limitation	Serious Limitation	Very serious limitation
Texture	Sandy clay loam to clay	Loam, sandy loam, silty clay, very loamy clay	Loamy sand	Sand
Effective soil depth	100 cm	75 - 100 cm	60 - 75 cm	60 cm
Structure	Strongly developed	Moderately developed	Weak or massive	Weak or massive
Consistence	Friable to Moderately firm	Firm	Very firm	Very firm
Laterite	Nil	Nil	25% nodular or fragmented laterite 30 cm in thickness	25% nodular or fragmented laterite >30 cm in thickness Presence of massive laterite
pH	5.5 - 7.5	4.0 - 5.5	3.5 - 4.0	<3.5
Peat layer	Nil	0 - 30 cm	>30 cm	>30 cm
Permeability	Moderately well drained to well	Imperfect drainage or very well drained	Poorly drained	Very poorly drained or excessively drained.
Terrain	0 - 6°	6 - 12°	12 - 16°	16°
Nutrient Content	Low applications of fertilisers only required.	Moderate to high quantities of fertilisers required. Application normally economic	High to very high fertiliser application required. May not be economic at low cocoa prices.	Very high fertiliser applications required. Probably economic rates only at times of high cocoa prices.

* Compiled by P.S. Chew

TABLE 6. SOIL RATINGS FOR COCOA

Pedon No.	Soil Series	Terrain	Depth	Laterite	Texture	Structure and Consistence	Permeability	Chemical attributes: pH	Nutrient Content: Major	Nutrient Content: Minor	Estimated yields (lb/ac.)	Suitability
3	BUNGOR	2 to 0	3	3	3	2	3	2	2	3	1600 - 2000	S
			Remarks: Steep terrain. May make area marginal or unsuitable									
4	RASAU	3	3	3	2	1	2	2	1	2	1300 - 1700	MS
			Remarks: Performance of cocoa will improve with increase clay contents									
5	LUNAS	3	1	3	3	1	2	2	1	2	800 - 1400	M
6	KUANTAN	2	3	3	3	3	0	2	2	3	800 - 1400	M
7	RUDUA	3	1	3	0	0	0	2	0	2	800	X
8	RENGAM	2	3	3	3	2	3	2	2	3	1600 - 2000	S
9	KUALA BRANG	2	2	3	2	0	3	2	2	3	800 - 1400	M
10	ORGANIC CLAY	3	2	3	2	2	2	2	2	3	1600 - 2000	S
11	TAI TAK	3	3	3	3	2	3	2	2	3	1600 - 2000	S
12	ULU TIRAM	3	2	1	2	1	2	2	1	2	800 - 1400	M
			Remarks: Excessive gravel in soil may be a serious to very serious limitation									
13	SENAI	2	3	3	3	2	3	2	2	3	1600 - 2000	S
			Remarks: Steep terrain and lateritic bands may be encountered									
14	JERANGAU	2	3	3	3	2	3	2	2	3	1600 - 2000	S
			Remarks: Steep terrain may be encountered and suitability will be downgraded in these areas									
15	BATU ANAM	2	1	1	3	1	2	2	2	3	800 - 1400	M

--ctd. next..

Table 6. (ctd.)

Pedon No.	Soil Series	Terrain	Depth	Laterite	Texture	Structure and Consistence	Permeability	Chemical attributes pH	Nutrient Content Major	Minor	Estimated yields (lb/ac.)	Suitability
16	DURIAN	2	2	1	3	2	2	2	2	3	1300 - 1700	MS
				Remarks: Soil may be downgraded depending on depth and nature of lateritic band.								
17	PARIT BOTAK	3	0	3	3	2	0	0	1	1	800	X
18	LINAU	3	1	3	2	1	0	0	1	2	800	X
19	MALACCA	2	0	0	3	2	3	2	1	2	800	X
21	SG. MAS	2	3	3	3	2	0	?	?	?	?	?
				Remarks: Toxic levels of heavy metals reported. Susceptibility of cocoa not known.								

KEY TO CODES

3 - desirable range
2 - minor limitation
1 - serious limitation
0 - very serious limitation

MS - moderately suitable
S - suitable
M - marginal
X - unsuitable

TABLE 6. SOIL RATINGS FOR COCOA

Suitability grading

1. Suitable	:	Soils possessing not more than 4 properties in minor limitation grade and other properties in desirable range.
2. Moderately suitable	:	Soils possessing more than 4 properties in minor limitation and lower grades but not more than 2 properties in serious limitation grade.
3. Marginal	:	Soils possessing not more than 2 properties in serious limitation and 1 property in serious limitation grade.
4. Unsuitable	:	Soils possessing more than 2 properties in serious limitation grade and 2 properties in very serious limitation grade or more than 2 properties in very serious limitation grade.