

A Qualitative Land Assessment of Oil Palm Cultivation in Peninsular Malaysia

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ABSTRACT

The FAO Framework for Land Evaluation was used for the development of a land evaluation system for oil palm cultivation in Peninsular Malaysia. The combined limitation and parametric approach was used as it contributed to a more meaningful interpretation of the results. Twenty four soils were chosen to analyze the land evaluation system. The system of Sys et. al. (1991) was used for the evaluation using land characteristics. The results showed that the evaluation using land characteristics for land evaluation was preferred due to its simplicity and the data required are obtainable from soil survey reports.

***Keywords:** Land evaluation, land characteristic, oil palm, Peninsular Malaysia.*

Introduction

The development of qualitative land suitability classification is a prime requisite for land use planning and development because it guides decision on land utilization towards an optional utilization of land resources. The introduction of new agronomic techniques requires serious planning. A first choice to be made in land evaluation is the distinction between quantitative and qualitative classification. Quantitative is reserved to inform the user that the interpretative groupings are distinguished in precise numeral economic terms. In most tropical countries it is difficult to have precise information on inputs and outputs particularly for the traditional food crops. Therefore most evaluation work will be qualitative and based either on the evaluation of physical land characteristics or land qualities and their limitation. This paper employs parametric approach to determine the qualitative impact of land characteristics on oil palm cultivation in Peninsular Malaysia.

Materials and Methods

Peninsular Malaysia is located within the equatorial zone between latitudes 10 5' and 60 45'N and longitudes 990 and 1040 20'E with South China Sea lies to the east while Straits of Malacca to the west of the peninsula. Peninsular Malaysia has an area of

13.2 million hectares. Its greatest length is about 735 km and the maximum width is about 320 km. 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 peninsula. At the lower elevation sedimentary formations are more predominant. Recent riverine and marine alluvium occurs on coastal plains and low hills inland. The climate is of tropical type. The natural vegetation is tropical rain forest. A total of 24 land units derived from a varied geology and providing a range of particle size class as well as different profile development stages were used in this study. Table 1 shows the soil series and their associated parent material. Figure 1 shows map of Peninsular Malaysia showing the study profiles. The evaluation of land (Table 2) for oil palm cultivation by using land characteristics uses soil and landscape criteria given by Sys *et. al.* (1991) is shown in Table 3. The suitability classification is a qualitative classification. Classes are defined with regard to the number and the intensity of the limitations and are generally related to a specific value of land indices calculated for individual ratings of characteristics according to the general formula:

$$C = A \cdot \frac{B}{100} \cdot \frac{C}{100} \cdot \dots$$

Land suitability classification is an agreement with the FAO framework of land evaluation (FAO, 1976) defining orders, classes and subclasses. The class is indicated by an arabic number in sequence of decreasing suitability within each order. Therefore it reflects degree of suitability within each order. Based on these consideration orders and classes are defined as follows:

Order S: Suitable

Land units with no, slight or moderate limitations and no more than two severe limitations that however do not exclude the use of the land. The land index is > 25 to 100

Class S1: Highly suitable

Land units with no or only slight limitations which in combination give land index values ranging from 75 to 100

Class S2: Moderately suitable

Land units with slight or moderate limitations which in combination give land index values ranging from 50 to 74

Class S3: Marginally suitable

Land units with moderate limitations or normally not more than two severe limitations which in combination give land index values ranging from 25 to 49.

Order N: Not suitable

Land units with more than two severe limitations or with at least one very severe limitations that exclude the use of the land. The land index is normally 24 or less.

Class N1: Currently not suitable

Land units with severe or very severe limitations which may be overcome in time but which cannot be corrected with existing knowledge at current acceptable cost.

Class N2: Permanently not suitable

The following subclasses are considered

t: topography limitations

w: wetness limitations

s: limitations of physical soil conditions

f: soil fertility limitations

Table 1: The Classification of the soils

Soil	Soil Taxonomy		FAO	Profile Number
	Order	Sub-group Level		
Linau	Entisol	Typic Sulfaquent	Thionic Fluvisol	1
Briah	Entisol	Typic Fluvaquent	Dystric Gleysol	2
Selangor	Inceptisol	Aeric Tropic Tropaquepts	Dystric Gleysol	3
Sedu	Inceptisol	Typic Sulfaquent	Thionic Fluvisol	4
Lunas	Ultisol	Typic Kandiaquult	Gleyic Acrisol	5
Rasau	Ultisol	Typic Kandiudult	Haplic Acrisol	6
Btg Merbau	Ultisol	Typic Paleudult	Haplic Acrisol	7
Durian	Ultisol	Plinthaquic Paleudult	Ferric Acrisol	8
Rengam	Ultisol	Typic Kandiudult	Haplic Acrisol	9
Kawang	Ultisol	Plinthic Kanhapludult	Plinthic Acrisol	10
Lanchang	Ultisol	Typic Kandiudult	Haplic Acrisol	11
Jeram	Ultisol	Typic Hapludult	Ferric Acrisol	12
Bungor	Ultisol	Typic Paleudult	Haplic Acrisol	13
Baling	Ultisol	Orthoxic Tropudult	Ferric Acrisol	14
Merapoh	Ultisol	Typic Paleudult	Eutric Nitisol	15
Tebok	Ultisol	Typic Paleudult	Haplic Acrisol	16
Kuala Brang	Ultisol	Orthoxic Tropudult	Orthic Acrisol	17
Malacca	Oxisol	Xanthic Hapludox	Xanthic Ferralsol	18
Segamat	Oxisol	Typic Kandiudox	Haplic Acrisol	19
Senai	Oxisol	Typic Hapludox	Haplic Acrisol	20
Yong Peng	Oxisol	Typic Kandiudox	Orthic Ferralsol	21
Kuantan	Oxisol	Typic Hapludox	Haplic Ferralsol	22
Jerangau	Oxisol	Typic Hapludox	Acric Ferralsol	23
Kg. Kolam	Oxisol	Typic Kandiudox	Acric Ferralsol	24

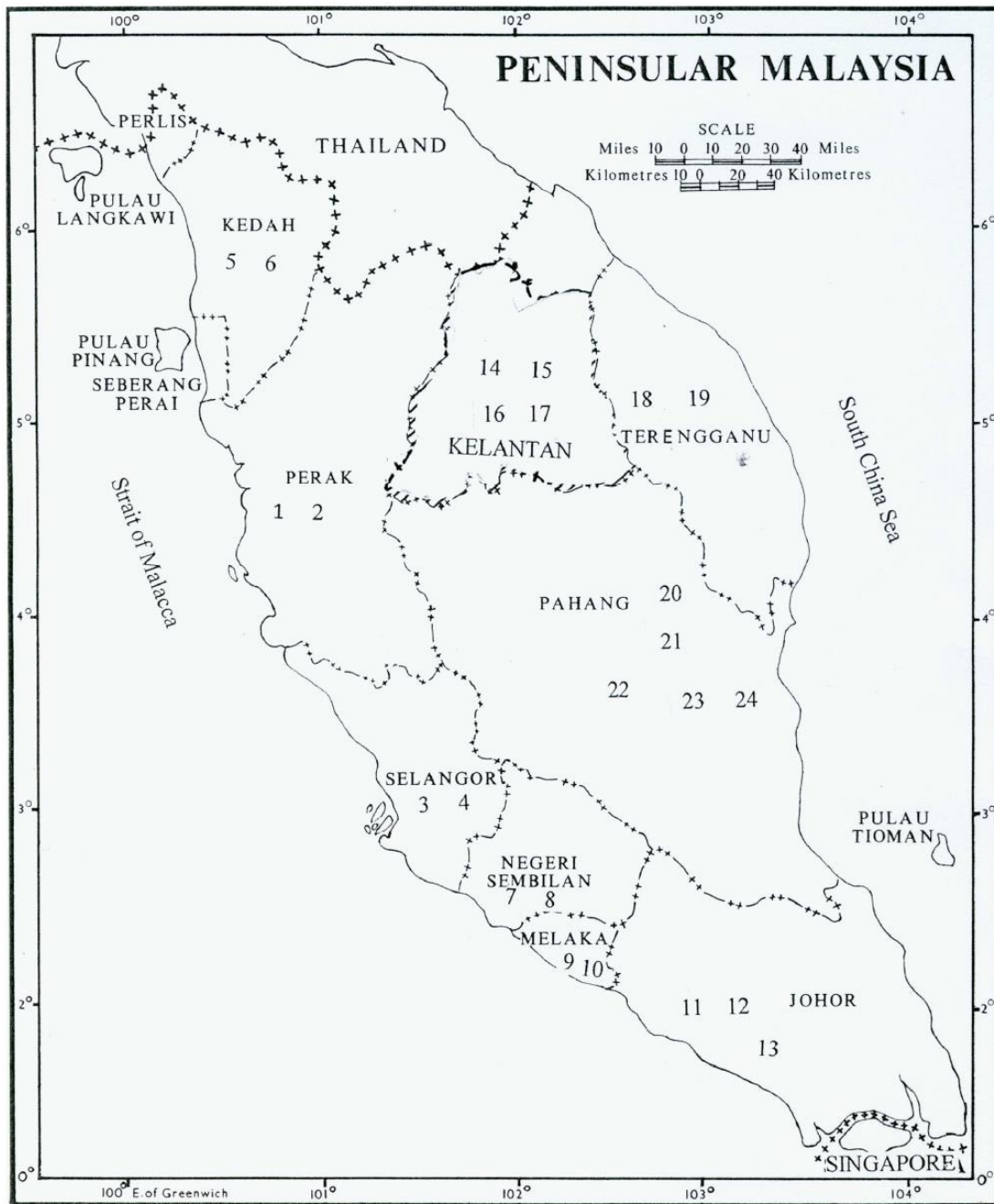


Figure 1: Map of Peninsular Malaysia Showing the Study Profiles

Table 2: Land Characteristics of Representative Land Units in Peninsular Malaysia

Land Unit	Topography/ Slope (t) (%)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			
		Flooding	Drainage	Texture/ Structure	Depth (cm)	CEC (cmol(+)/kg soil)	BS (%)	pH (H ₂ O)	Organic carbon (%)
Linau	2	F2	Poorly drained	SiCs	47	36.8	19.6	3.5	6.5
Briah	2	F2	Somewhat imperf. drained	SiCs	98	28	34	4.2	2.6
Selangor	16	No	Imperf. drained	Cs	120	19.5	9.1	3.5	2.5
Sedu	2	No	Imperf. drained	SiCL	80	31.5	4	2.9	5.3
Lunas	6	No	Mod. well drained	SCL	69	4.8	4.9	4.5	0.7
Rasau	1	No	Well drained	SCL	148	7.3	22.3	4.2	0.9
Btg. Merbau	2	No	Mod. Well drained	Cs	160	4.9	3.3	4.1	1.2
Durian	9	No	Mod. well drained	C	140	7.7	3.8	4.2	0.4
Rengam	7	No	Well drained	SCL	150	3.5	6.2	4.8	1.6
Kawang	14	No	Mod. well drained	SC	66	6.1	34	5.2	0.5
Lanchang	14	No	Well drained	Cs	210	6.5	5.5	3.8	1.3
Pohoi	18	No	Mode. well drained	Cs	97	5.8	3.6	4.5	1.4
Jeram	18	No	Well drained	CL,SC	95	7.5	6.1	4.6	0.8
Bungor	22	No	Well drained	SCL	190	3.2	12.2	4.8	0.6
Baling	15	No	Well drained	SC	100	4.8	9.1	4.9	0.7

Table 2: (Cont'd)

Land Unit	Topography/ Slope (t) (%)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			
		Flood	Drainage	Texture/ Structure	Depth (cm)	CEC (cmol(+)/kg soil)	BS (%)	pH (H ₂ O)	Organic carbon (%)
Merapoh	4	No	Mod. well drained	SC	110	6.7	186.3	6.7	3.8
Tebok	4	No	Well drained	Cs	129	8.8	5.4	4.2	0.6
Kuala Brang	10	No	Well drained	SC	78	6.8	8.1	4.7	1.3
Malacca		No	Well drained	Cs	152	5.2	11.3	4.5	1.2
Segamat	8	No	Well drained	Cs	137	9.2	2.4	4.4	1.1
Senai	22	No	Well drained	Cs	76	5.1	19.3	4.7	0.9
Yong Peng	16	No	Well drained	Cs	150	8.1	10.8	4.5	0.7
Kuantan	3	No	Well drained	Cs	150	11.1	2.1	4.5	1.9
Jerangau	12	No	Well drained	Cs	152	3.1	4.1	4.1	0.7
Kg. Kolam	18	No	Well drained	SC	200	7.2	4.1	4.7	0.9

Table 3: Land Suitability Requirements for Oil Palm Based on Land Characteristics

Land Characteristic	Class, Degree of Limitation and Rating Scale					
	S1	S2	S3	N1	N2	
	0	1	2	3	4	
	100	95	85	60	40	25
Topography (t)						
Slope (%)	0 – 4	5 – 9	10 – 16	17 – 30	31 – 50	> 50
Wetness (w)						
Flooding	F ₀	F ₀	F ₁	F ₂	-	F ₃
Drainage	Well drained	Mod. Well drained	Imperf. drained	Poor (aeric) (easily drained)	Poor (typic) difficult	Very poor
Physical Soil Characteristic (s)						
Texture/ Structure	CL, Co, SC, Cs	L, SCL, SiCL	SL, LSf	LSc, LSc Cm, SiCm, Sf	Sm, Sc	LcS, S
Soil Depth (m)	>100	100 – 80	79 – 60	59 – 45	44 – 25	< 25
Soil Fertility Characteristic (f)						
CEC (cmol(+)kg ⁻¹ soil)	> 16	< 16(-)	< 16(+)			
Base saturation (%)	> 35	34 – 20	< 20			
Organic Carbon (%)	> 1.5	1.4 – 0.6	< 0.6			

For texture/structure, the suffixes: o = weak structure and consistence of the oxic horizon, s = angular or subangular structure, m = massive, f = fine, m = medium, c = coarse

Source: Sys et al. (1991)

Results and Discussion

Land Evaluation by Land Characteristics

The actual suitability of the land units consider the land in its original condition without any improvement measures at the time of land clearing from primary forest conditions prior to subsequent cultivation. Even if oil palm can be grown, the control of plant diseases is not done. The results showed that the actual suitability classification of the land unit are ranked as follows: Selangor, Batang Merbau, Segamat, Kuantan soil series are moderately suitable: Lunas, Rasau, Durian, Rengam, Kawang, Lanchang, Jeram, Bungor, Merapoh, Tebok, Baling, Kuala Brang, Malacca, Senai, Yong Peng, Jerangau, and Kampong Kolam soil series are marginally suitable; Linau, Biah, and Sedu soil series are currently not suitable (Table 4).

The potential suitability of the land refers to its suitability after improvements have been made on the land. The improvement that may be required include the control of flooding, the drainage of water-logged land, the control of soil erosion hazards or the construction of roads and paths to increase accessibility and trafficability. Minor improvements of the land include the use of fertilizers to improve soil fertility status for the low nutrient of the soils. The standard agronomic practices include the establishment of legume covers, the control of weeds and diseases. The ranking of the potential suitability classification of the land units are as follows: Selangor, Rasau, Batang Merbau, Rengam, Tebok, Segamat, Senai, Kuantan, Bungor, Jerangau and Kampong Kolam soil series are highly suitable: Lunas, Durian, Kawang, Jeram, Baling, Benta, Keledang, Kuala Brang, Malacca and Yong Peng Series are moderately suitable: Biah and Sedu soil series are marginally suitable: Linau series is currently not suitable (Table 5).

Table 4: Actual Suitability Classification of the Land Units for Oil Palm Cultivation by Using Land Characteristics

Land Unit	Topography Slope (t)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			Land Index	Suitability Class
		Flood	Drainage	Texture/Structure	Depth	CEC	BS	OC		
Linau	0 (100)	3(60)	3(60)	1(95)	3(55)	0(100)	2(85)	0 (100)	6	N _w
Briah	0 (100)	4(30)	4(40)	1(95)	1(92)	0(100)	2(80)	0 (100)	8	N _{wf}
Selangor	0 (100)	0(100)	1(85)	0(100)	0(100)	0(100)	2(80)	0 (100)	63	S _{2wf}
Sedu	0 (100)	3(60)	3(60)	1(95)	1(85)	0(100)	2(80)	0 (100)	22	N _{wf}
Lunas	1 (90)	0(100)	1(90)	1(95)	2(75)	2(80)	2(80)	1(85)	29	S _{3fc}
Rasau	0 (100)	0(100)	0(100)	0(100)	0(100)	2(80)	1(90)	1(90)	48	S _{3f}
Batang Merbau	0(100)	0(100)	1(90)	0(100)	0(100)	1(90)	2(80)	1(90)	54	S _{2f}
Durian	1(85)	0(100)	1(90)	1(89)	0(100)	1(90)	2(80)	2(80)	36	S _{3f}
Rengam	1(90)	0(100)	0(100)	0(100)	0(100)	1(90)	2(80)	2(80)	45	S _{3f}
Kawang	2(70)	0(100)	1(90)	0(100)	1(75)	1(90)	1(95)	1(85)	29	S _{3t}
Lanchang	2(70)	0(100)	0(100)	0(100)	0(100)	1(90)	2(80)	1(90)	38	S _{3f}
Jeram	3(55)	0(100)	0(100)	0(100)	1(90)	1(90)	2(80)	1(95)	29	S _{3f}
Bungor	3(55)	0(100)	0(100)	1(95)	0(100)	1(90)	2(80)	1(85)	27	S _{3f}
Baling	2(70)	0(100)	0(100)	0(100)	2(85)	2(80)	2(80)	1(85)	25	S _{3f}

Table 4: (Cont'd)

Land Unit	Topography Slope (t)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			Land Index	Suitability Class
		Flood	Drainage	Texture/Structure	Depth	CEC	BS	OC		
Merapoh	0(100)	0(100)	1(95)	0(100)	1(85)	1(90)	1(90)	1(90)	39	S _{3f}
Tebok	0(100)	0(100)	0(100)	0(100)	1(90)	1(90)	1(90)	1(85)	41	S _{3f}
Kuala Brang	2(85)	0(100)	0(100)	0(100)	2(80)	1(90)	1(90)	1(90)	33	S _{3s}
Malacca	0(100)	0(100)	0(100)	0(100)	0(100)	2(80)	2(80)	1(90)	30	S _{3f}
Segamat	2(83)	0(100)	0(100)	0(100)	0(100)	1(90)	2(85)	1(90)	51	S _{2f}
Senai	3(55)	0(100)	0(100)	0(100)	0(100)	2(80)	1(90)	1(90)	25	S _{3tf}
Yong Peng	2(60)	0(100)	0(100)	0(100)	2(82)	2(80)	2(84)	2(85)	31	S _{3f}
Kuantan	0(100)	0(100)	0(100)	0(100)	0(100)	2(80)	2(84)	0(100)	57	S _{2f}
Jerangau	2(80)	0(100)	0(100)	0(100)	0(100)	2(70)	2(84)	1(85)	34	S _{3f}
Kampong Kolam	2(75)	0(100)	0(100)	0(100)	0(100)	2(80)	2(70)	1(90)	32	S _{3f}

Table 5: Potential Suitability Classification of the Land Units for Oil Palm Cultivation by Using Land Characteristics

Land Unit	Topography Slope (t)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			Land Index	Suitability Class
		Flooding	Drainage	Texture/ Structure	Depth	CEC	BS	OC		
Linau	0(100)	3(65)	3(65)	1(95)	3(55)	0 (100)	0 (100)	0 (100)	22	N _{wf}
Briah	0(100)	2(70)	2(70)	1(95)	1(92)	0 (100)	0 (100)	0 (100)	40	S _{3w}
Selangor	0(100)	0(100)	2(85)	0 (100)	0(100)	0 (100)	0 (100)	0 (100)	84	S ₁
Sedu	0(100)	2(75)	2(75)	1(95)	1(85)	0 (100)	0 (100)	0 (100)	45	S _{3w}
Lunas	0(100)	0(100)	0(100)	1(95)	2(75)	0(100)	0(100)	0(100)	64	S _{2s}
Rasau	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	90	S ₁
Btg. Merbau	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	94	S ₁
Durian	0(90)	0(100)	0(100)	1(89)	0(100)	0(100)	0(100)	0(100)	71	S _{2s}
Rengam	0(100)	0(100)	0(100)	1(95)	0(100)	0(100)	0(100)	0(100)]	90	S ₁
Kawang	2(75)	0(100)	0(100)	0(100)	2(75)	0(100)	0(100)	0(100)]	56	S _{2s}
Lanchang	2(75)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)]	74	S _{2t}
Jeram	2(75)	0(100)	0(100)	0(100)	1(90)	0(100)	0(100)	0(100)]	67	S _{2t}
Bungor	1(90)	0(100)	0(100)	1(95)	0(100)	0(100)	0(100)	0(100)]	84	S ₁
Baling	2(75)	0(100)	0(100)	0(100)	2(85)	0(100)	0(100)	0(100)]	57	S _{2t}

Table 5: Cont'd

Land Unit	Topography Slope (t)	Wetness(w)		Physical Soil Characteristics (s)		Soil Fertility Characteristics at 50cm depth (f)			Land Index	Suitability Class
		Flooding	Drainage	Texture/ Structure	Depth	CEC	BS	OC		
Merapoh	0(100)	0(100)	0(100)	0(100)	1(85)	0(100)	0(100)	0(100)	77	S1
Tebok	0(100)	0(100)	0(100)	0(100)	1(90)	0(100)	0(100)	0(100)	81	S1
Kuala Brang	0(100)	0(100)	0(100)	0(100)	2(80)	0(100)	0(100)	0(100)	72	S2 _s
Malacca	0(100)	0(100)	0(100)	2(60)	0(100)	0(100)	0(100)	0(100)	54	S2 _s
Segamat	1(95)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	94	S1
Senai	2(85)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	80	S1
Yong Peng	2(75)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	74	S2 _s
Kuantan	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	95	S1
Jerangau	1(90)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	86	S1
Kg.Kolam	2(85)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	0(100)	81	S1

Soil Properties and Management Implications

Three soils namely Linau, Bria and Sedu are located in the coastal areas of Peninsular Malaysia at an elevation of less than 15 m a.s.l. In their natural state, they are often water-logged and subjected to constant inundation. Drainage and flood control are pre-requisites before these soils can be cultivated. However, an efficient flood control is expensive and difficult because of the large seasonal and random variations in river discharges. The oil palm tree is sensitive to wet conditions, resulting in poor growth and yields. During drainage, care has to be taken not to lower the water-table in Linau and Sedu series below 50cm as the C horizons contain sulfidic materials. An excessive drainage leads to the subsequent oxidation of the sulfidic conditions which are unfavourable for oil palm growth. Linau and Bria series have a high inherent fertility but Bria series has unfavourable soil physical condition mainly structural for root penetration. Sedu series has low fertility status. The individual soil limitations when combined explain the low suitability of the three soils for oil palm cultivation. Selangor series has no unfavourable soil physical condition and the fertility status is high (Goh, 1997) except that the soil has low pH. Lime has to be added in sufficient amount to raise the soil pH to maintain good yields of oil palm. The Ultisols, Lunas series is moderately deep and shallow soil respectively. The Ultisols namely Rasau and Lanchang series are deep soils.

The seven soil series namely Batang Merbau, Durian, Rengam, Bungor, Tebok, Baling and Merapoh series are deep soils while Jeram and Kuala Brang series are moderately deep soils. In oil palm cultivation, a good creeping leguminous crop has to be established early during planting to cover the ground and to prevent soil loss. Generally, the fertility status of these soils is low and complete fertilizers have to be added in sufficient amounts to maintain good yields of oil palm. Oxisols namely Malacca, Segamat, Senai, Yong Peng, Kuantan and Kampong Kolam series have good physical properties which permit easy root penetration. Malacca series contains 50% by volume of loosely packed gravels from 8 cm downwards. The gravels create difficulties during planting. Babalola and Lal (1977) reported that the gravels pose problems to root penetration and proliferation. It is important to preserve the organic matter in the top soil. The data showed that for impoverished soils such as the Oxisols, the upper horizons with

higher organic matter contents contribute significantly to higher cation retention capacities and larger nutrient reserve. Soong (1977) reported that the organic matter also contributes substantially in maintaining a good soil structure. Similarly, the Oxisols are low in nutrients and oil palm grown on these soils requires an ample supply of fertilizers.

Conclusion

Considering the planting of oil palm on the basis of land suitability evaluation showed that Selangor, Rasau, Batang Merbau, Rengam, Tebok, Segamat, Senai, Kuantan, Bungor, Jerangau and Kampong Kolam soil series can be devoted to large scale oil palm plantation while Lunas, Durian, Kawang, Jeram, Baling, Benta, Keledang, Kuala Brang, Malacca and Yong Peng soil series for moderate scale of plantation. Biah and Sedu soil series are marginally suitable and Linau soil series is currently not suitable. For rainfed agriculture oil palm planting on the respective suitable soil series will deal mainly with maintenance of soil fertility. The evaluation work is based on survey of natural resources of land units, the final decision for planting of oil palm should be made after integrating with investigations such as socio-economic conditions, agricultural services and human resources.

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