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Study on the Physical and Chemical Properties of Some Laterite and Lateritic Forest Soils

Daw Tin Tin Ohn, B.Ag [Mdy.] M.S [U. F] Staff Officer,
Forest Research Institute
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Acknowledgement

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ဂဝံမြေနှင့် ဂဝံဆန်သော သစ်တောမြေ အချို့၏ ရူပ နှင့် ဓါတု ဂုဏ်သတ္တိများကိုလေ့လာခြင်း ။

ဒေါ်တင်တင်အုံ:? (B.Ag [Mdy.] M.S [U. F]) ဦးစီးအရာရှိ
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံ သစ်တောစိုက်ခင်းများ ပြန်လည်တည်ထောင်ခြင်းကို ဂဝံမြေနှင့် ဂဝံဆန်သော မြေအပါအဝင် မြေအတန်းအစားအမျိုးမျိုးပေါ်တွင် ဆောင်ရွက်လျက်ရှိပါသည်။ မှန်ကန်သော သစ်တောစိုက်ခင်း မြေနေရာများ ရွေးချယ်ရေးတွင် ၎င်းမြေ၏ ရူပ၊ ဓာတု ဂုဏ်သတ္တိများသည် အဓိကနေရာမှ ပါဝင်ပေရာ၊ သစ်တောစိုက်ခင်းများ ပြန်လည်ထူထောင်ရေးတွင် စိုက်ခင်းမြေ၏ ရူပ၊ ဓာတု ဂုဏ်သတ္တိများကို အကဲဖြတ်ပေးနိုင်ရန် ရည်ရွယ်ချက်ဖြင့် ဂဝံကျောက်များရှိသည့် ဒေသများနှင့် ဂဝံဆန်သော မြေများရှိသည့် မြန်မာနိုင်ငံအောက်ပိုင်းဒေသများမှ အချို့ ဒေသတို့၏ မြေနမူနာများကို ကောက်ယူလေ့လာခဲ့ပါသည်။ ဤစာတမ်းတွင် ဂဝံနှင့် ဂဝံဆန်သော သစ်တောစိုက်ခင်း မြေများ၏ ရူပ၊ ဓာတုဂုဏ် သတ္တိများကို လေ့လာထားပြီး ၎င်းမြေများနှင့် ယခင်လေ့လာခဲ့ပြီးဖြစ်သော အရှေ့ ပဲခူးရိုးမဒေသ၊ ကျွန်းစိုက်ခင်းဟောင်းများ၊ မိုးနည်းရေရှား ဒေသနှင့် ဒီရေတော သစ်တောမြေတို့၏ ရူပ၊ ဓာတုဂုဏ်သတ္တိများကို နှိုင်းယှဉ် ဆွေးနွေးတင်ပြထားပါသည်။ ဂဝံနှင့် ဂဝံဆန်သော မြေတို့သည် အနည်းငယ် အက်ဆစ်ဆန်သော မြေအမျိုးအစားဖြစ်ပြီး၊ မြေဆွေးခါတ် အသင့်အတင့်ရှိ၍ ကက်အိုင်းယွန်းများဖြစ်သည့် ဖလှယ်ထုတ်ယူနိုင်သည့် ကယ်လစီယမ်၊ ပိုတက်စီယမ်နှင့် ဆိုဒီယမ်ပါဝင်မှုတို့သည် နည်းသည်ကို တွေ့ရပါသည်။

Study on the Physical and Chemical Properties of Some Laterite and Lateritic Forest Soils

Daw Tin Tin Ohn, B.Ag [Mdy.], M.S [U. F] Staff Officer,
Forest Research Institute

Abstract

Reforestation have been made on different types of soil including laterites and lateritic soils in Myanmar. Since the physical and chemical properties of soils play a major role in suitable site selection, soil samples from laterite some lateritic area in lower Myanmar, are evaluated with the main objectives of assessing the site for reforestation. In this paper, not only physical and chemical properties of laterite and lateritic forest soils are presented, but also a comparative discussion of those soils in relation to the old Teak plantation soil, East Bago Yoma area soil, Dry zone soil and Mangrove forest soils was made. Acidic condition, fair amount of organic matter, low C. E. C., Low extractable actions such as calcium, magnesium and sodium were found in laterite and laeritic soils.

Contents

1. Introduction

Since forest sector is major for foreign exchange earnner, reforestation is a essential activity for state economy. Because establishment of reforestations are being made also on lateritic soil, it is needed to be known their physical and chemical properties which reflect the growth and quality of forest trees.

The term laterite is derived from the latin word "later" which means brick and is equivalent the term ' itike cullu ' in Malayalam meaning " brick stone" This term has ever since been used for a variety of soil with red colour such as red soil, iron-pan occuring in the tropics. The process of laterzation is not yet exactly understeed, but there is general agreement that there is a removal of silica and an accumulation of oxide of iron and aluminum (Griffith A. L and Gupta R. S. 1935).

Lateritic soils are formed through the laterization process and defined in different ways by several investigators. The lateritic soil is a zone soil, formed in warm, temperature and tropical regions and included in the yellow pozolic, yellowish brown lateritic and laterite soil groups. (Prichett, 1975). According to the U. S. D. A soil classification system, most of the lateritic soils are Oxisols but it is classified as Ferrosols by the F. A. O system. (Soil survey staff, 1975).

Laterization is found in the inter-tropical zones with high temperature and extra leaching that favour rapid desili-cation and accumulation of ferric oxides under oxidizing condition. This process produces oxic horizon within 2 cm of the surface or plinthite that froms a continous phase within 30 cm of the mineral surface and with no spodic or orgillic horizon overlying the oxic horizon.

Joffe, (1936) summarized the reaction involved under intense weathering condition in the tropics as:

1. Rapid complete disintegration and decomposition of the parent rock and soil materials,
2. Release and removal of sillion from the surface horizon.
3. Separation of sequioxides and their fixation in the surface horizon,
4. Non-accumulation of organic matter, not with standing the abundance of vegetation and its complete mineralization,
5. Distinctive red colour of soil materials.

In Myanmar, lateritic soils are widely distributed in lower Myanmar and used for road construction and building purposes.

Investigation of physical and chemical properties of some lateric forest soils will provide some information for the correct site selection. The main objectives of this study is to assess the soil properties for reforestation programme.

1.1 Study Area

In this study, evaluation was made on laterite and lateritic forest soils in lower Myanmar.

Laterties **:** Three different location were selected as study area, namely;

(1) Phugyi Dam Watershed area, Taikkyi township, Yangon Division.
(2) Wanetchaung area, Hmawbi township, Yangon Division.
(3) Myainggalay unclass area, Hpa-an township, Kayin state.

Latertic forest soils **:** Fives different location were selected to study the Physical and chemical properties of soils these area were:

(1) Theinzayat plantation, Kyaikhto township, Mon state.
(2) Myaingalay Reserve, Hpa-an township, Kayin state.

(3) Htilon Reserve No. 32, Hlaingbwe township, Kayin state.
(4) Konbilin Reserve No. 2/87, Tharyarwady township, Bago Division.
(5) Min Hla Reserve No. 1/ 86, Min Hla township, Bago Division.

The detail characteristics of the study area were shown in the following table 1.

2. Materials and Methods

2.1 Field

Soil samples were collected from three different locations which are previously selected for laterites with the confinement of surface layer and sub layer (laterites).

Table 1. **The characteristics of the study area.**

Site	Topography a. sl (m)	Annual rainfall mm	Temperature (min)-(max) ^{o}C	Species and Age yrs.	Sampling Date	Remarks
I. Laterites						
(1) Phugyi Dam Watershed area	1.5 -150	2700	17.5 - 38.0	-	13-8-92	-
(2) Wanetchaung	150	2700	17.5 - 38.0	-	13-5-92	-
(3) Myainggalay	16.10	4489	16.0 - 36.0	-	14-12-92	-
II. Lateritics Soils						
(1) Theinzayat Plantation	-	2000 3830	21.0 - 40 ^{o}C	*Ecalpptus* spp.8	13-3-88	-
(2) Myainggalay	16.10	4489	16.0 - 36.0	*Tectona grandis* 3	22-1-88	-
(3) Htilon Reserve No. 32		2540 38201	22.0 - 39.0	Species Trial 2	22-1-85	-
(4)Konbilin Reserve No. 2/87	-	2045	26.0 - 41.0	*Pterocarpus Macrocarpus* 2	22-1-88	-
(5))MinHla Reserve No. 1/86	-	1670	21.0 - 41.0	*Cassia siamea* 2	19-1-88	-

As a lateritic soils, five locations were selected to make comparative study with laterites. Soil sampling was done on each selected location with five different depth (0-10, 20-30, 40-50, 60-70, 80-90 cm). Collected soil samples were placed in separated plastic bags and taken to the laboratory for chemical analysis. Soil properties were described according to the guide line for soil profile description (F. A. O, 1977).

2.2 Laboratory method

Soil samples were airdried, ground and sieved to separate the fine earth (2 mm) from the coarse materials. The coarse materials (laterite gravel) were ground by Rock lab grinding machine and the fine fraction was used for subsequent laboratory analysis.

The texture (or) particle size distribution was carried out through the mechanical analysis with hydrometer method. Soil p^H (Soil : Water 1 : 2 : 5) was determined by using Corning p^H meter model 12. Total Nitrogen were expressed as Kjeldhalls Nitrogen and assessed by using labconco micro and macro Kjeldhal digestion and distillation unit. Electrical Conductivity (E.C) were measured as suspension with the soil to water ratio of 1:2.5 and stand for one hour stirring at intervals and read with Conductivity Bridge Model 81. Organic metter was determined by loss on Ignition method at 550 ^{o}C and ignited for two hour.

The extractable nutrients of Calcium, Magnesium, Potassium and Sodium were extracted with double acid (Melich 1) and measured by using Perkin Elemer model 2280 atomic absorption spectrophotometer. Phosphorus was extracted with double acid extract and determined by mean of molybdenum blue method with ascobic acid which develop blue colour and measured by Perkin Elmer spectrophotometer 55 E at 660 mm wave length.

Table 2. **Some Physical and Chemical Properties of Laterite**

Description	Depth (cm)	P^H	Organic Matter (%)	Total	Extractable Nutrients					Electrical Conluctivity um hos/ cm	Texture (%)		
				N	P	K	Ca	Mg	Na		Sand	Slit	Clay
				---------- mg / 100 gm ----------									
Phugyi	A layer (0-30/60)	4.3-5.4	3.4-4.5	20-70	0.08-0.56	6-20	70-112	9-13	6.6-7.5	1.0-5.0	67-86	4-6	9-20
Taikgyi Township	B layer (30-200)	4.4-5.0	1.2-2.0	20-40	0.02-0.08	10-20	30-92	6-11	5.9-7.7	2.5-2.8	55-70	6-16	8-20
Yangon Division													
Wanetchaung	A layer	4.2-5.0	2.5-4.5	80-120	5.0-5.5	6-11	50-60	4-11	6.9-13.5	2.5-3.5	45-58	8-10	8-20
Hmawbi Township	B layer	4.3-4.6	0.8-2.0	90-110	3.0-5.0	11-16	50-70	4-10	11.0-13.0	2.5-3.0	40-60	8-14	15-30
Yangon Division													
Myainggalay	Alayer (0-20/60)	4.7-5.0	3.8-4.9	183-303	-0.02	13-15	13-35	T-4	0.05-1.5	2.0 -	45-50	20-28	14-22
Hpa-an Township		5.0-5.3	3.0-3.2	34-120	-0.06	10-23	24-75	T-2	1.9-2.9	1.0-1.5	40-65	12-30	10-20
Kayin State													

Fig.1 Site condition in Phugi (1) Taikgyi Township

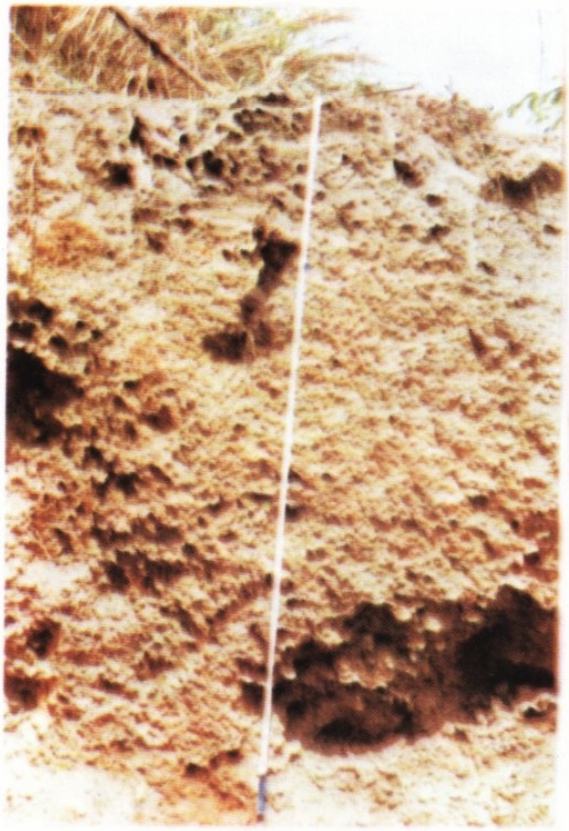

Fig.2 Soil Profile in Phugi (1)
Taikgyi Township

Fig.3 Site condition in Phugi (2) Taikgyi Township
(50 years old Pyinkado Plantation)

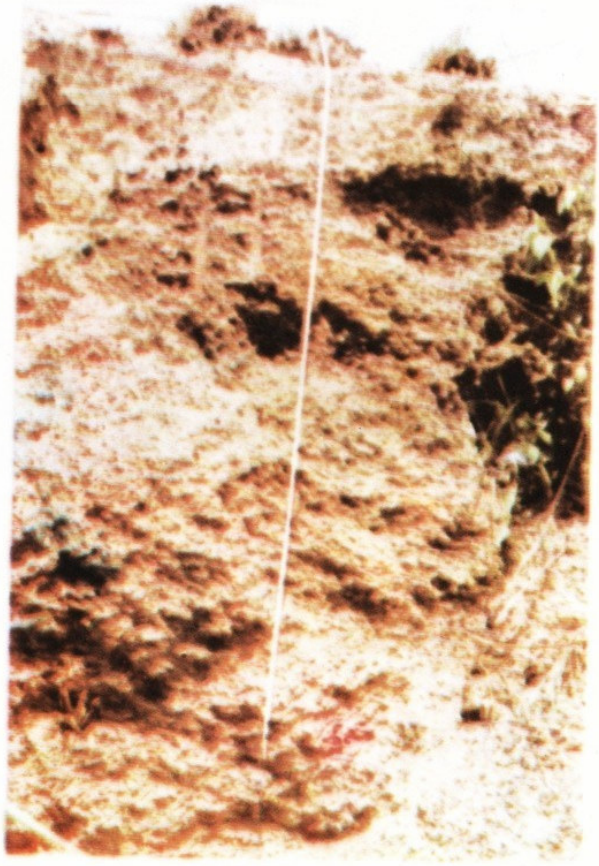

Fig.4 Soil profile im Phugi (2)
Taikgyi Township

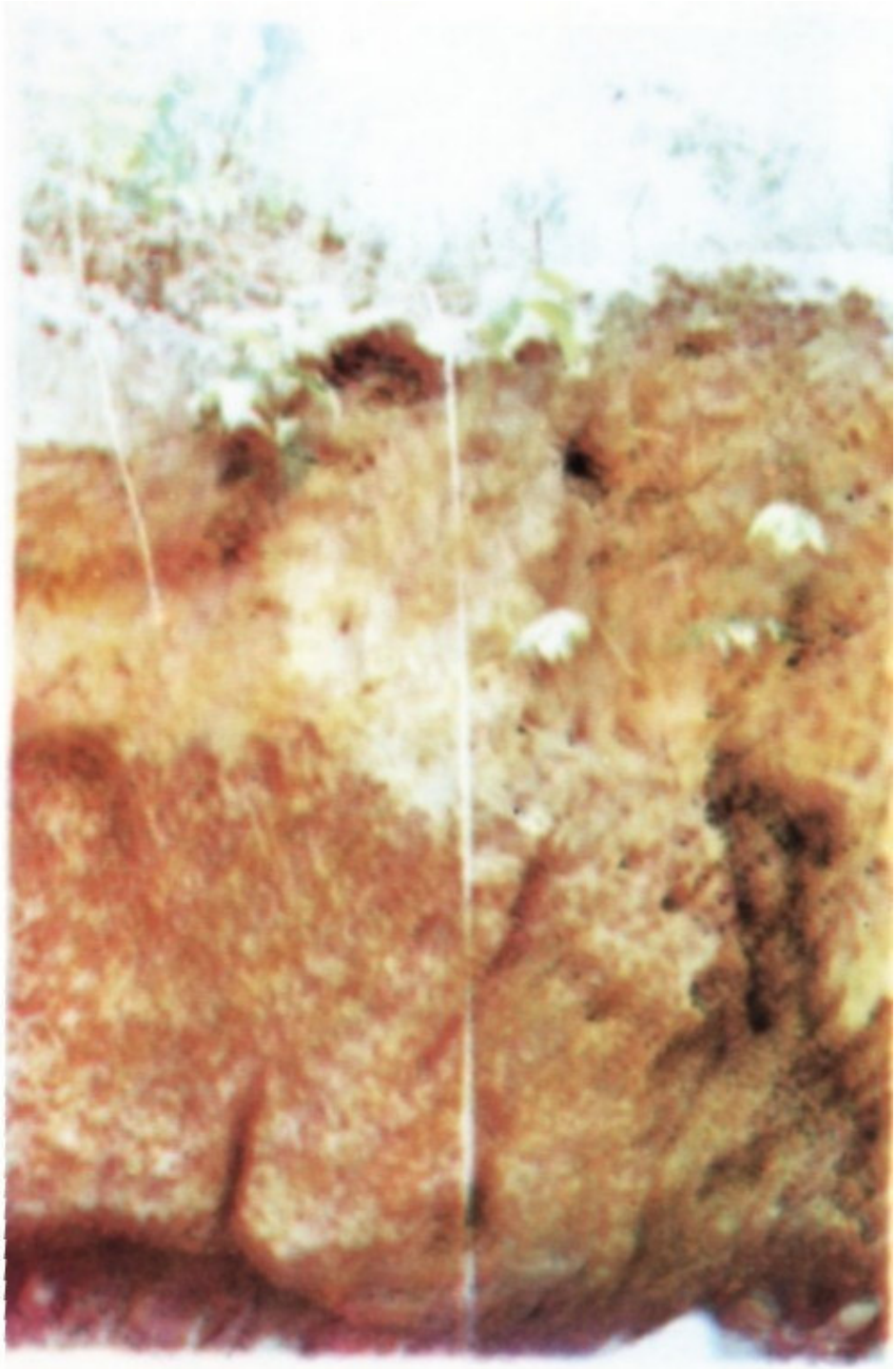

Fig.5 Soil Profile in Phugi (3)
Taikgyi Townsip

Fig.6 Soil Profile in Phugi (4) Taikgyi Township

Fig.7 Soil Profile in Phugi (4) Taikgyi Township

Fig.6 Soil Profile in Phugi (4) Taikgyi Township

Fig.7 Soil Profile in Phugi (4) Taikgyi Township

Fig. 10 Study area of Myaingalay (unclass)

Fig. 11 Soil Profile in Myaingalay (unclass)

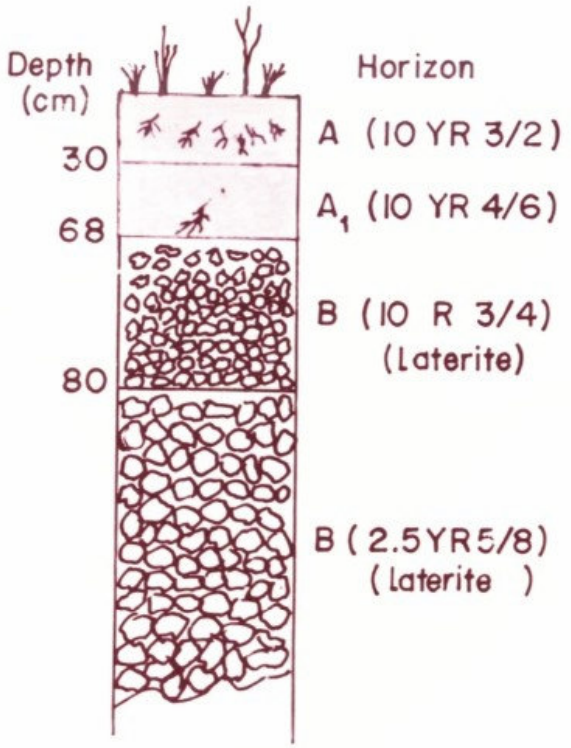

Fig A 1. Soil Profile in Phugyi (1)

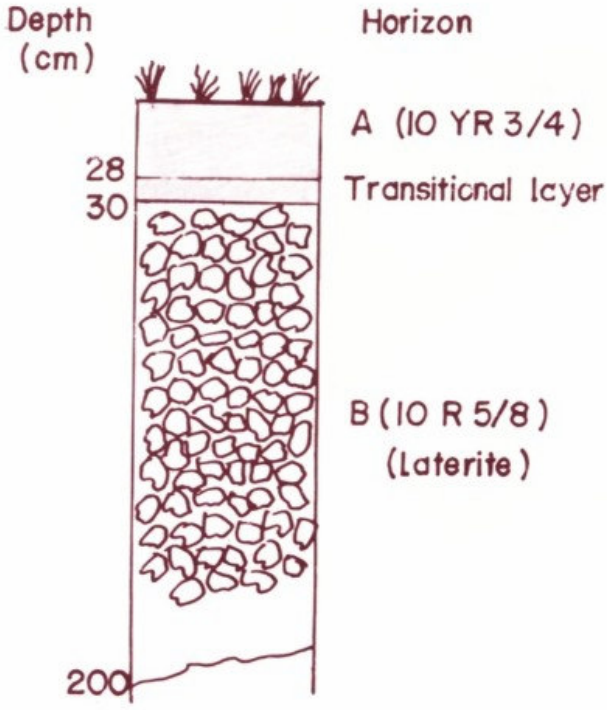

Fig A2. Soil Profile in Phugyi (2)

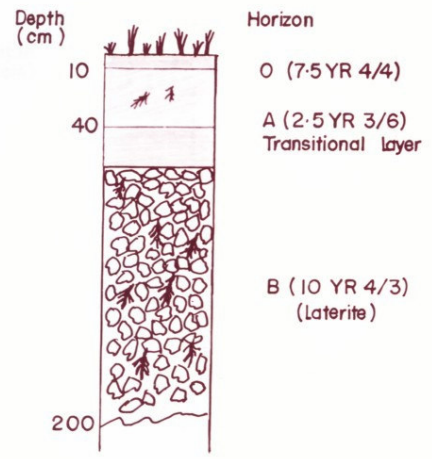

Fig A 3. Soil Profile in Phugyi (3)

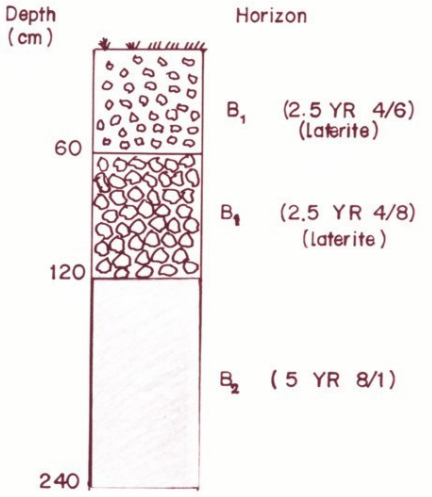

Fig A 4. Soil Profile in Phugyi (4)

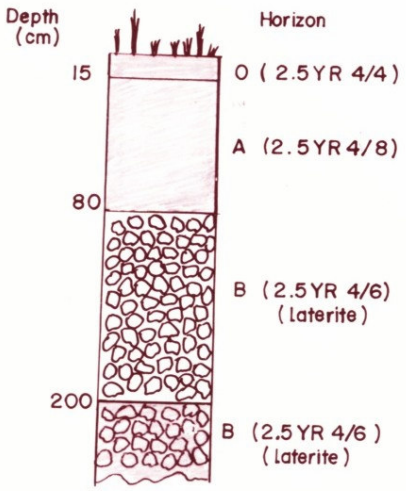

Fig A 5. Soil Profile in Wanetchaung 1

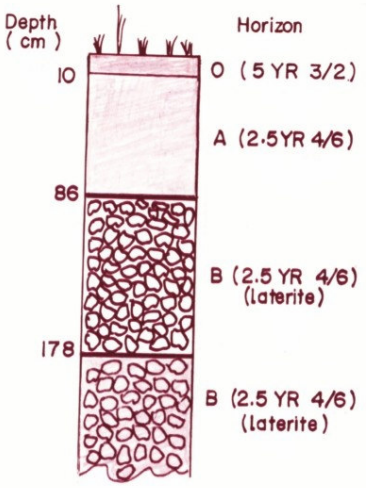

Fig A 6. Soil Profile in Wanetchaung 2

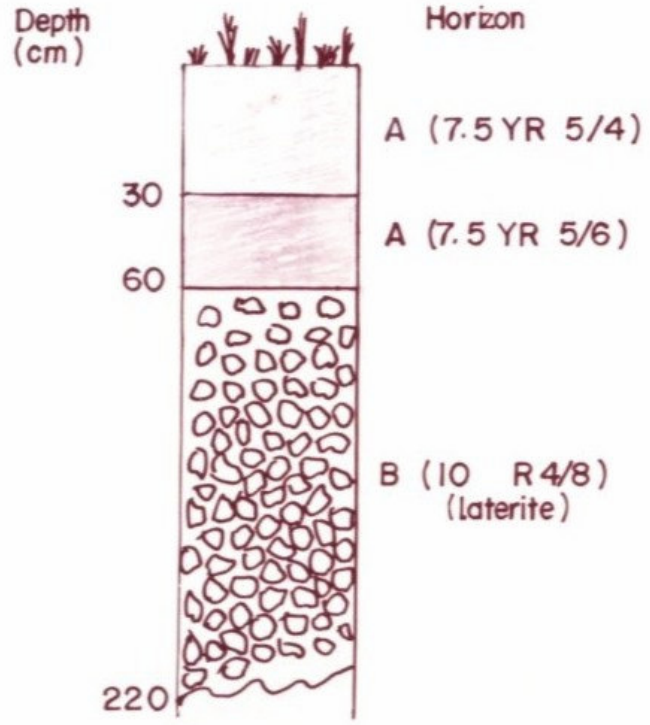

Fig A7. Soil Profile in Myainggalay unclass (1)

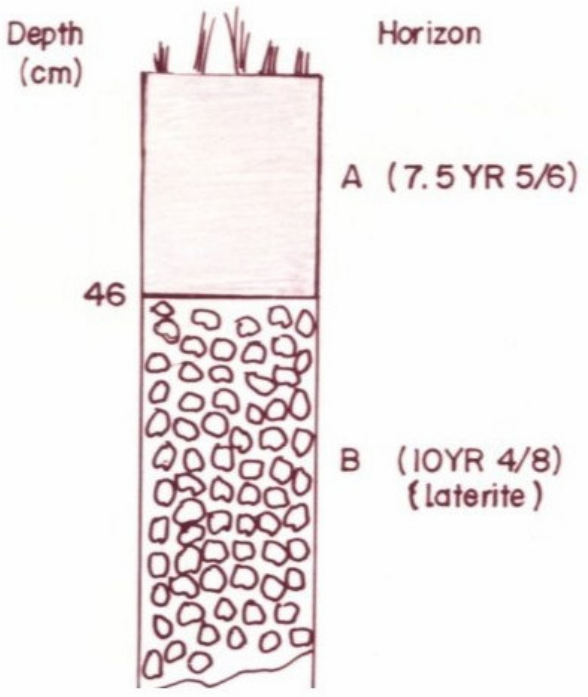

Fig A8. Soil Profile in Myainggalay unclass (2)

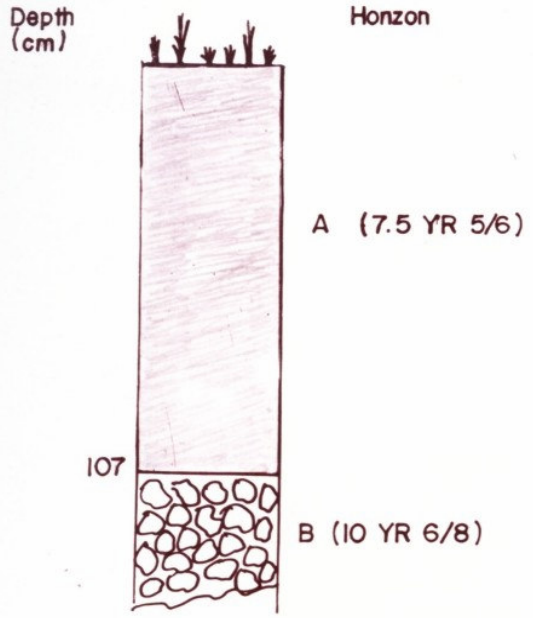

Fig A9. Soil Profile in Myainggalay unclass (3)

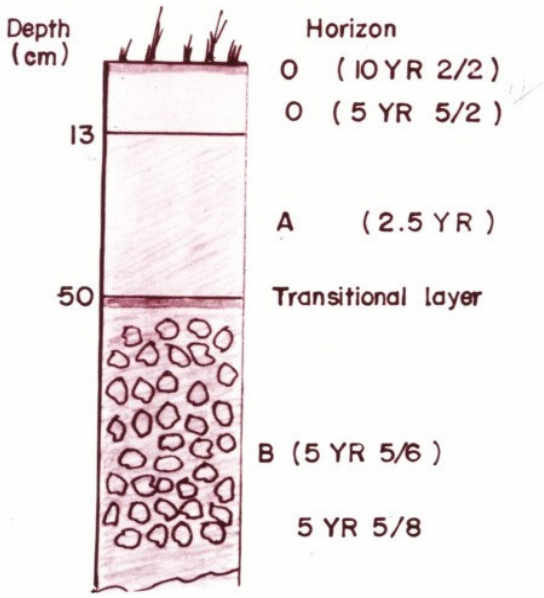

Fig A 10. Soil Profile in Theinzayat Reserve.

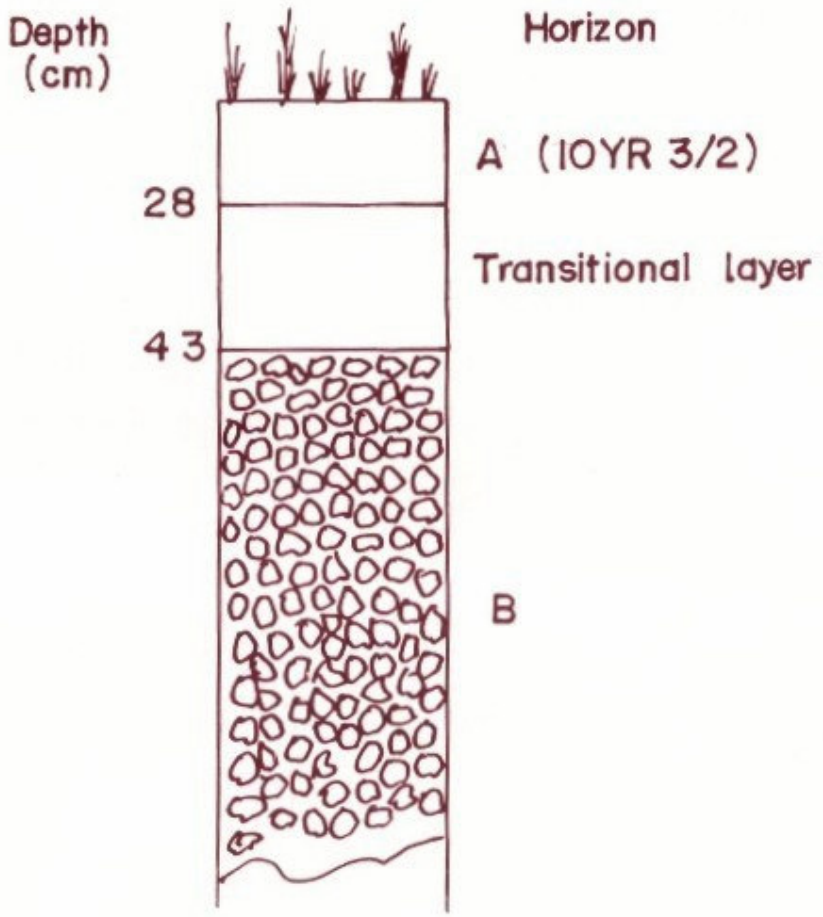

Fig A 11. Soil Profile in Konbilin Reserve.

3. Result and Discussion

Physical and chemical properties of laterites and its profile description were shown in table 2 and appendix I and II respectively. Laterite layer from various study areas were presented in figure 1-9.

A - Layer on study areas for laterites were generally 0-30 cm depth with the exceptational case of 60 cm. Laterite sub layer were observed at about 30-200 cm or more. In some cases, formation of laterites was found at the top layer just above the sandy soil without having surface of organic layer (Fig. 4).

Either external movement and deposition of laterites or loss organic top through the surface erosion is probably responsible for the formation of those profile as mentioned above.

No significantly differences in physical and chemical properties of laterites were observed among Phugyi, Wanetchaung and Myainggalay area.

Physical and chemical properties of five lateritic soils were presented in table 3. Lateritic soils from five study areas were found to be slightly acid and acidic condition. Low organic matter content was found in Konbilin Reserve and Htilon Reserve while the other areas were found to be moderate to high organic matter in surface layer. Total Nitrogen was generally sufficient for plant growth in all areas except, Min Hla Reserve and Konbinlin area where it is rated as low level. Extractable phosphorus in lateritic soils in locations were found to be apparently very low for normal plant growth.

In the case of extractable calcium and Magnesium, relatively lowest level was observed in Thinzayat Htilion Reserve while the highest content was found in Min Hla Reserve.

Table 3. Some Physical and chemical Properties of Lateritic Soils.

Description	Depth (cm)	P^H	Organic Matter	Extrable Nutrients (mg/100g)						Electrical conductivity	Texture (%)		
				Total N	P	K	Ca	Mg	Na		Sand	Silt	Clay
				----------mg/100gm----------							----------%----------		
Theinzayat	0-10	5.3-5.7	9.9-13.5	90-300	Trace	1.5-2.4	Trace	Trace	1.9- 9.2	3.7-7.5	54-68	16-22	9-19
Kyaikhto	20-30	5.3-5.8	7.9-11.8	70-100	"		"	"	1.9- 6.7	5.0-6.8	55-63	10-24	3-13
Mon State	40-50	5.5-5.7	7.6-10.5	70-200	"	1.1-2.2	"	"	1.0- 6.9	3.7-6.2	55-66	18-22	5-14
	60-70	5.4-5.7	7.9-8.25	80-100	"	1.4-1.8	"	"	7.0-53.0	3.7-6.2	56-65	18-24	5-13
	80-90	5.5-5.8	6.3-9.3	60-100	"	1.8-2.1	"	"	-	3.7-5.0	53-68	20-24	6-15
Myainggalay	0-15	5.5-6.2	5.7-11.5	110-260	Trace	0.6-3.6	7.0-8.9	Trace-2	T-127	2.0-15.0	23-67	10-28	8-29
Hpa-an	20-30	5.5-5.8	5.0-9.8	100-200	"	0.6-2.6	3.0-7.2	Trace	T-118	2.0-12.0	24-66	11-38	6-35
Kayin State	40-50	5.5-6.0	4.1-9.2	50-160	"	0.6-2.6	6.0-6.2	"	T-135	2.0-23.0	22.66	14-44	12-33
	60-70	5.4-6.0	4.0-8.8	80-170	"	0.6-6.4	5.0-5.2	Trace-2	T-15	2.0-12.0	22-66	14-32	12-39
	80-90	5.5-6.1	4.0-8.7	60-223	"	0.6-2.4	6.0-5.0	Trace	T-16	2.0-6.0	21-64	26-42	12-41
Htilon	0-10	5.4-5.8	2.1-3.1	80-100	Trace	10.7-15.6	Trace	Trace	T-4	2.3-5.0	6-63	26-42	1-36
Hlaingbwe	20-30	5.4-5.7	1.5-2.1	50-60	"	10.2-18.5	"	"	T-40	2.0-25.0	43-71	20-30	7-11
Kayin State	40-50	5.5-6.5	1.5-2.1	40-40	"	8.8-12.4	"	"	1.3-6.8	1.6-2.3	42-58	22-26	10
	60-70	5.4-5.5	2.0-2.1	40-50	"	8.2-10.3	"	"	T	2.3-2.5	57	22	14
	80-90	5.4-5.5	1.7-2.4	30-50	"	7.1-8.9	"	"	T-7.6	1.2-2.1	38-72	16-28	10-20

Table 3. (Continued)

Min Hla	0-10	6.2-6.4	3.0-4.6	40-70	Trace-6	7.0-13.9	32-41	2.8-7.3	3.3-18.7	32-72	12-24	10-18
Min Hla Township	20-30	5.7-6.1	2.4-5.4	40-56	Trace	9.0-23.0	40-54	3.9-7.0	3.1-7.5	29-71	14-28	9-27
Bago Division	40-50	5.7-6.5	3.7-6.4	40-70	"	9.6-32.0	39-48	1.0-2.2	2.5-9.8	17-19	14-36	9-29
	60-70	5.4-6.1	2.0-6.2	30-50	Trace-6	9.0-20.0	34-51	2.2-10.0	1.6-10.0	18-72	12-44	12-24
	80-90	5.8-7.1	2.6-5.6	40-60	2-4	14.0-28.0	25-52	2.0-8.0	2.1-4.1	29-75	6-26	6-36
Konbilin	0-10	5.4-6.1	1.5-2.9	80-120	Trace	8.0-12.0	Trace	10.0-12.8	6.2-808	73-82	10-16	2-16
Thayarwady Township	20-30	5.3-5.8	1.2-2.2	100-150	"	10.0-15.0	"	8.2-10.8	6.2-10.0	68-79	8-16	6-16
Bago Division	40-50	5.5-5.9	2.3-	100-120	"	10.0-12.0	"	3.0-9.6	6.2-7.5	65-73	10-16	10-18
	60-70	5.3-5.8	1.0-	100-120	"	10.0-12.0	"	5.6-12.8	7.5-10.0	66-73	6-18	10-19
	80-90	5.4-5.8	1.0-4.0	120-130	"	12.0-13.0	"	3.5-7.0	6.2-7.5	64-74	6-12	13-21

Table. 4 **Comparison of Soil Properties among some Forest area.**

Description	Depth (cm)	p^H	Organic Matter (%)	Total N	Extractable Nutrients P	K	Ca	Mg	Na
				---------- mg / 100 g ----------					
East Bago Yoma	0-10	5.8-7.0	2.2-8.8	57.4-197-4	0.1-1.6	0.2-26.4	-	-	-
	40-50	5.1-6.9	2.3-7.4	37.1-113.4	0.1-2.1	0.3-16.6	-	-	-
	100-110	5.2-6.8	2.6-7.4	26.6-103.6	0.1- -2.6	0.3-24.0	-	-	-
Dry zone	0-10	7.4-8.2	2.6-3.9	50.0-60.0	0.07-1.14	4.4-10.5	67.5-110.3	12.2-47.7	1.6-27.3
	40-50	7.1-8.1	2.3-3.2	40.0	0.04-0.39	3.3-6.3	55.5-224.0	19.9-311.4	1.3-12.0
	100-110	7.6-8.1	2.3-3.5	20.0-40.0	0.08-0.80	2.2-6.8	80.10-213.4	2.2-80.3	1.6-33.3
Old Teak Plantation	0-10	5.4-6.3	4.1-5.9	74.7-260.5	T-2.11	2.4-7.7	2.6-53.7	12.3-36.1	3.0-2.1
	40-50	5.4-6.4	3.5-7.3	60.8-88.9	T-0.75	1.6-8.1	7.2-53.2	15.4-50.8	2.0-2.8
	100-110	5.6-6.5	2.7-7.3	31.6-88.8	T-0.94	1.6-6.7	5.0-74.8	14.7-59.7	4.0-6.5
Mangrove	0-10	5.5-6.8	5.8-14.2	136.8-240.5	T-2.7	17.5-930	57.0-111.0	130-343	77-400
	40-50	3.9-6.8	4.0-14.2	84.8-220.6	T-3.6	19.4-741	27.0-93.0	90-210	77-510
	50-60	3.8-6.7	4.1-11.3	87.1-210.2	T-3.5	19.9-720	21.0-113.0	90-239	77-440
Laterite	0-20	4.3-5.4	2.5-4.9	20-70	0.08-0.65	6.0-20.0	70-112.0	9-13	66-75
	30-60/200	4.2-5.3	1.2-3.2	20-110	0.02-0.80	10.0-20.0	30-92.0	6-11	659-130
Lateritic Soil	0-10	5.3-6.4	1.5-11.0	40-260	T-6	1.5-15.6	T-89	T-41	T-12.8
	40-50	5.5-6.9	1.5-11.0	34.8-254.0	Trace	1.1-32.0	T-81	T-48	T-9.6
	80-90	5.4-7.1	1.0-8.7	29.6-220.0	T-4	1.8-28.0	T-90	T-52	T-7.0

Table 4. (Continued)

Description	Electrical Conductivity um hos/ cm	Texture (%) Sand	Silt	Clay
		---------- % ----------		
East Bago Yoma	3.5-12.5	33.8-92.0	0.4-34.0	5.0-56.0
	1.8-4.0	29.4-99.6	0.4-30.0	5.0-46.8
	1.7-44.0	35.0-96.0	3.2-24.0	6.2-46.8
Dry Zone	3.1-19.6	63-70	6.8	17.6-29.2
	6.5-22.3	56.1-68.5	6.9-8	22.7-30.5
	18.0-20.5	58.6-66.2	7.3-10	20.2-28.5
Old Teak Plantation	3.4-18.6	46-79	11-35	22-46
	1.9-14.8	40-89	10-33	10-33
	1.6-32.4	28-72	9-42	9-30
Mangrove	2500-5400	10-19	32-58	17-50
	2600-12000	6-32	36-50	3-52
	2800-10900	3-30	36-53	3-51
Laterite	1.0-5.0	67-86	4-6	9-20
	1.0-3.0	40-70	6-14	8-30
Lateritic	3.7-18.1	6-82	10-28	2-29
Soil	2.5-12	17-79	10-38	5-23
	2.0-12	21-75	6-26	6-36

This highest extractable sodium was observed in Konbilin Reserve as compared to Myainggalay and Htilon reserve. However, the amount of extractable calcium, magnesium, can be rated as low level in all areas except in Konbilin Reserve. In general, level of soluble salts as presented as Electrical Conductivity (E. C) in all study areas were not high enough to retard the plant growth. They type of soil in those study areas were generally sandy loam, clayey loam and loamy sand. Detail analytical results of soil were presented in Appendix III and IV.

Physical and chemical properties of some forest soils from east Bago Yoma forest area, Dry zone forest area, Mangrove forest area and old teak plantation in

comparison with laterites and lateritic forest soils were shown in Table 3. Soil reaction (pH) in all forest soils were found to be slightly acid to acidic conduction expect in dry zone forest soils as compared to others. Laterites in the study areas and the dryzone were generally low in nitrogen content in comparison with other forest soils. Amount of nitrogen in some lateritic soil except in Min Hla reserve can be rated as high level for plant growth (Table 2). Amount of phosphorus, on the other hand, were lower than the minimum plant requirement of 6.67 mg P/ 100 gm in those soils which is presented in table 4. Apparently very low level of phosphorus was observed in lateritic forest soils.

On account of higher potassium which exceeded 2.5 mg K/100 gm in laterites, it is likely to be sufficient for normal plant growth. Extractable calcium, magnesium, sodium and soluable salt (EC) in laterites and latertitic forest soils were lower than those of previously investigated forest soils were lower level of such extractable based, viz: calcium, magnesium and sodium in laterites and lateritic forest areas are probably attributed to losses of base-cations through leaching by virtue of easily disintegration of surface layer under high rainfall and temperature (Soil survey staff manual, 1975).

Although various soil type (clayey loam, sandy loam, loam sand) same were observed in laterites and lateritic forest soils, no soil in all study areas was more than 30% in clay content. Bender (1984) stated that low cation exchange capacity (C. E. C) and fair to high amount of organic matter in laterities are due to the slightly acid condition and high weathering. Lateritic soil is found to be high fertility for garden land and medium for ya-land but, low productivily for forest land (Hla Aye, 1986) Hownever, lateritic soils are very suitable for oil palm plantation (Chlibber, 1934)

4. Conclusion

Laterites and laeritic forest soils in the study areas are found to be slightly acid to acidic conduction Fair amount of Organic matter and low cation such as calcium, magnesium, and lateritic are also found. It is apparent that, laterites and lateritic soils present low fertility and it is needful to carefully choose the species which are to be reforested. Thus, it is to be recommended that the site for reforestation be preferably of those soils where surface layer is thick enough for root proliferation at rhizospherial zone. And if the surface layer is not thick enough species which are adaptable to the area should be choosen for reforestation

This paper would be more informative Si/ A1 or Sio/ R_2O ratio of comparison among lateritic soils be included. It is necessary to make more investigation so as to get more information on lateritic forest soils in Myanmar.

Appendix I Morphology of laterite in Myanmar.

Description	Depth (cm)	Texture (%)					Structure	Consistance Plasticity	Boundary	Others
		Matrix	MoHles	Sand	Slid	Clay				
Taikgyi Township	0-20	A 10 YR 3/2	-	86	4	9	loamy sand weak	Loose & non-sticky	Diffuse & Smooth	
Phugyi	30-60	A 10 YR 4/6	-	66	16	15	sandy loam weak	Loose & non-sticky	Diffuse & Smooth	
(1)	60-80	B 10 YR 3/4	-	70	14	17	sandy loam moderate	hard & sticky	Diffuse & Smooth	Laterite
	80-200	B 2.5 YR 5/8	-	72	8	21	sandy clay loam moderate	hard & sticky	Diffuse & Smooth	"
Phugyi	0.28	A 10 YR 3/4	-	69	6	21	sandy clay loam weak	friable & non-sticky	Diffuse & Smooth	
(2)	28-200	B 10 YR 5/8	-	78	6	13	sandy loam moderate	hard & non-sticky	Diffuse & Smooth	Laterite
Phugyi	0-40	O 7.5 YR 4/4	-	69	6	21	sandy clay loam weak	friable & non-sticky	Diffuse & Smooth	
(3)	10-40	A 2.5 YR 3/6	-	82	6	10	loamy sand moderate	"	Diffuse & Smooth	
	40-200	B 10 YR 4/3	-	64	14	18	sand loam moderate	hard & sticky	Diffuse & Smooth	laterite
Phugyi	0-60	B 2.5 YR 4/6	-	66	14	18	sand loam moderate	friable & non-sticky	Diffuse & Smooth	laterite
(4)	60-120	B 2.5 YR 4/8	-	66	14	18	sand loam moderate	"	Diffuse & Smooth	"
	120-240	B 5 YR 8/1	-	73	8	15	sand loam moderate	friable & non-sticky	Diffuse & Smooth	white colour
Hmawbi Township Wanetchaung	0-15	A 2.5 YR 4/4	-	81	10	8	Loamy sand weak	friable & non-sticky	Diffuse & Smooth	
	20-80	A 2.5 YR 4/8	-	76	10	15	sand loam weak	friable & sticky	Diffuse & Smooth	laterite
	80-200	B 2.5 YR 4/6	-	77	10	15	sand loam moderate	hard & stick	Diffuse & Smooth	laterite

Appendix I (Continued)

Wanetchaung	0-10	A	5YR 3/3	-	64	8	23	sandy clay Loam	weak	friable & nonstickly	Diffuse & smooth	laterite
(2)	10-86	A	A 2.5YR 4/5	-	68	8	20	"	moderate	hard & stickly	"	
	80-177	B	2.5YR 4/6	-	56	14	27	"	"	hard & stickly	"	"
Wanetchaung	0-10	A	10YR 5/6	-	72	10	15	sandy loam	weak	friable & nonstickly	"	
(3)	10-80	B	7.5 YR 5/4	-	62	14	20	sandy clay loam	moderate	hard & stickly	"	laterite
Myainggalay (1)	0-30	A	7.5 YR 5/4	-	52	28	14	sandy loam	weak	friable & nonstickly	"	
Hpa-an Township	30-60	A	7.5 YR 5/6	-	76	18	12	"	"	"	"	
Kayin State	60-200	B	10YR 4/8	-	73	16	10	sandy loam	moderate	hard & stickly	"	lateriate
Myainggalay	0-40	A	7.5YR 5/6	-	48	26	22	sandy clay loam	moderate	friable & nonstickly	"	
(2)	40-200	B	10YR 4/8	-	62	12	20	sandy clay loam	strong	hard & stickly	"	lateriate
Myainggalay	0-50	A	7.5 YR 5/6	-	52	20	22	clay loam	moderate	friable & nonstickly	"	
(3)	50-100	A	7.5 YR 5/6	-	38	30	26	clay loam	moderate	"	"	
	100-∝	B	10YR 6/8	-	68	16	12	sandy clay loam	strong	hard & stickly	"	lateriate

Appendix II. Soil chemical data from lateriate areas in Myanmar

Description	Depth (cm)	P^{H-}	Organic Matter (%)	Total	Extractable Nutrients					Electrical Conductivity
										um hos/cm
				N	P	K	Ca	Mg	Na	
				----------mg/100gm----------						
Taikgyi Township	0-30	5.4	4.5	79.4	0.56	5.6	112.0	13.0	71.0	1.0
Phugyi (1)	30-6	5.5	1.9	49.4	0.08	21.5	43.0	6.0	77.0	2.8
	60-80	5.0	2.8	49.4	0.08	15.4	33.0	6.0	64.0	2.8
	80-200	4.4	1.4	41.8	0.04	9.4	31.0	6.0	74.0	2.5
Phugyi	0-20	4.8	3.1	-	0.82	19.4	38	9.0	66.0	5.0
(2)	28-200	4.9	3.5	22.8	0.08	20.2	24	10.0	59.0	3.0
Phugyi	0-40	4.3	3.4	26.6	0.52	12.8	62	9.0	75.0	2.8
(3)	10-40	5.2	1.2	41.8	0.30	20.2	94	10.0	67.0	5.5
	40-200	4.8	1.4	91.2	0.02	22.2	57	9.0	74.0	3.5
Phugyi	0-60	4.3	1.6	72.2	0.08	11.3	92	4.0	80.0	3.0
(4)	60-120	4.3	2.5	26.6	0.04	10.0	87	5.0	67.0	3.5
	120-240	3.9	6.3	205.2	0.21	29.0	61	11.0	74.0	5.0
Hmawbi Township	0-115	4.9	3.8	91.2	0.55	10.9	46	9.0	69.0	3.0
Wanetchaung (1)	20-80	4.6	2.4	121.6	0.50	16.2	53	11.0	106.0	2.5
	80-200	4.6	2.5	418.0	0.55	11.6	49	11.0	116.0	2.5
Wanetchaung (2)	0-10	4.2	2.5	136.8	0.46	13.5	61	4.0	135.0	3.5
	10-86	4.4	0.9	83.6	0.30	12.9	48	4.0	129.0	3.0
	86-177	4.4	0.9	83.6	0.30	12.9	48	4.0	129.0	3.0
Wanetchaung (3)	-	4.3	1.3	106.4	0.34	11.1	50	6.0	111.0	2.5
	-	4.5	1.6	110.2	0.42	11.0	72	10.0	110.0	2.5
Myaingalay	0-30	5.0	4.3	302.6	-	15.0	13	4.0	0.5	2.0
Hpa-an (1)	30-60	5.4	3.5	57.8	0.06	15.0	16	T	1.6	1.5
Township	60-200	5.3	3.0	34.0	0.02	23.0	33	2.0	1.9	1.0
Myaingalay	0-40	4.7	4.9	221.0	0.02	12.0	35	T	1.7	2.0
(2)	40-200	5.3	3.0	64.6	-	10.0	75	T	2.0	1.0
Myaingalay	0-50	4.8	3.9	183.6	-	13.0	19	T	1.5	1.0
(3)	50-100	5.0	3.3	119.4	-	9.0	22	T	0.7	1.0
	100-∝	5.0	3.2	30.6	0.04	23.0	24	T	2.9	1.5

Appendix III. Morphology of lateritic in Myanmar.

iv

Description	Depth (cm)	Horizon	Color (moist)		Texture (%)				Sturcture	Consistance plasticity	Boundary	Others
I.Theinzayat Kyaik Hto Township	1. 0-10	0	5 YR 3/3	-	60	20	13	Sandy Loam	Weak	Loose & nonstickly	Diffuse & Smooth	root were found in A.
	20-30	A	10YR 2.5/2	-	63	20	13	"	"	"	"	
Mon State	40-50	A	10YR 3/4	-	55	20	15	"	"	"	"	
	60-70	A	7.5YR 3/5	-	63	20	13	"	"	"	"	
	80-90	A	5YR 3/2	-	69	20	7	"	"	"	"	
	2. 0-10	O	10YR 2/2	-	62	16	11	"	"	"	"	root were found in A.
	20-30	O	10YR 3/6		55	24	13	"	"	"	"	
	40-50	A	10YR 2/2		67	18	5	"	"	"	"	
	60-70	A	10YR 3/4		57	24	11	"	"	"	"	
	80-90	A	10YR 3/4		57	24	15	"	"	"	"	
	3. 0-10	O	10YR 3/3		54	20	13	"	"	"	"	
	20-30	A	7.5YR 4/4		60	18	7	"	"	"	"	
	40-50	A	7.5YR 4/2		57	22	11	"	"	"	"	
	60-70	A	7.5YR 4/4		66	18	15	"	"	"	"	
	80-90	B	7.5YR 3/4		54	20	15	"	"	"	"	
	4. 0-10	O	10YR 3/3		55	22	19	"	"	"	"	
	20-30	A	10YR 3/2		69	10	3	"	"	"	"	
	40-50	A	10YR 3/4		56	22	11	"	"	"	"	
	60-70	A	7.5YR 5/4		59	20	11	"	"	"	"	
	80-90	B	7.5YR 3/2		61	22	9	"	"	"	"	
	5. 0-10	O	7.5YR 4/4		60	20	9	"	"	"	"	laterite rock
	20-30	A	7.5YR 4/4		58	22	9	"	"	"	"	
	40-50	A	5YR 3/4		63	20	9	"	"	"	"	
	60-70	A	5YR 3/3		59	24	13	"	"	"	"	
	80-90	B	5YR 3/4		68	22	9	"	"	"	"	

Appendix III(continued) v

II.MyainggLy Hpa-an TownShip Kayin	1.	0-10	O 10 YR 2/2	50	18	17	Sandy Loam	weak	loose & non-sticky
		20-30	A 10 YR 2/2	67	18	7	"	"	"
		40-50	A 5 YR 3/3	69	10	13	"	"	"
		60-70	B 10 YR 3/4	50	16	21	sandy clay loam	Moderate	friable & sticky
		80-90	B 10 YR 3/3	64	16	15	sandy loam	weak	loose & non-sticky
	2.	0-10	O 10YR 2/2	55	18	14	"	"	"
		20-30	A 5 YR2.5/1	65	20	66	"	"	"
		40-50	A 7.5 YR 3/2	68	16	12	"	"	"
		60-70	A 10 YR 3/2	66	16	12	"	"	"
		80-90	B 10 YR 3/3	61	18	14	"	"	"
	3.	0-10	O 10 YR 3/2	67	16	19	"	"	"
		20-30	A 10 YR 3/3	51	20	12	"	"	"
		40-50	A 5 YR 4/4	51	10	20	"	"	"
		60-70	A 5 YR 4/4	53	16	20	"	"	"
		80-90	B 5 YR 3/3	59	18	18	"	"	"
	4.	0-10	O 5 YR 3/3	51	14	16	"	"	"
		20-30	A 10 YR 2/2	56	18	10	"	"	"
		40-50	A 10 YR 3/2	57	14	14	"	"	"
		60-70	B 7.5 YR 3/2	59	14	14	"	"	"
		80-90	B 7.5 YR 3/6	49	14	22	Sandy clay loam	Moderate	friable & sticky
	5.	0-10	O 10 YR 2/2	61	12	8	loam	"	"
		20-30	A 10 YR 3/2	56	14	12	sandy loam	"	loose & non-sticky
		40-50	A 5 YR 4/4	52	16	15	"	"	"
		60-70	A 10 YR 3/2	57	16	16	"	"	"
		80-90	B 10 YR 3/6	55	14	20	"	"	"
	6.	0-10	O 10 YR 3/2	40	28	11	"	"	"
		20-30	A 10 YR 3/2	42	30	13	"	"	"
		40-50	A 10 YR 3/4	33	30	23	loam	"	"
		60-70	A 10 YR 5/6	29	32	29	clay loam	moderate	friable & sticky
		80-90	B 5 YR 5/8	23	32	39	"	"	"

Appendix III (continued)

	7.	0-10	O 7.5 YR 5/8	24	26	29	"	"	"
		20-30	A 5YR 6/8	28	24	35	"	"	"
		40-50	A 5 YR 6/6	29	26	33	"	"	"
		60-70	B 5 YR 6/8	27	24	39	"	"	"
		80-90	B 5 YR 6/8	22	26	41	clay	weak	Loose & non-sticky
	8.	0-10	O 7.5 YR 4/4	45	22	16	sandy loam	"	"
		20-30	A 5 YR 4/4	40	28	20	"	"	"
		40-50	A 5 YR 3/3	35	28	22	sandy clay loam	moderate	friable & stick
		60-70	A 5 YR 4/6	40	28	22	"	"	"
		80-90	B 5 YR 3/4	36	28	30	clay loam	"	"
	9.	0-10	O 10 YR3/2	54	24	10	sandy loam	weak	loose & non-sticky
		20-30	A 10 YR 4/4	53	26	10	"	"	"
		40-50	A 5 YR 3/4	48	24	16	"	"	"
		60-70	A 5 YR 3/4	50	24	18	"	"	"
		80-90	B 5 YR 3/4	50	26	12	"	"	"
	10.	0-10	O 7.5 YR 4/2	26	28	14	"	"	"
		20-30	A 7.5 YR 3/2	24	38	18	loam	"	"
		40-50	A 7.5YR 4/2	22	38	18	"	"	"
		60-70	A 7.5YR 4/4	22	44	13	"	"	"
		80-90	B 7.5YR 4/4	-	-	-	-	-	-
III.Hlaing Bwe		0-10	O 5 YR 3/2	-	-	-	sandy loam	weak	Loose & non-sticky
		20-30	A 10 YR 4/3				"	"	"
		40-50	A 5 YR 4/2	58	26	10	"	"	"
		60-70	B 10 YR 4/4				"	"	"
		100-110	B 10 YR 4/6				"	"	"
		0-10	O 10 YR 3/2				"	"	"
		20-30	A 10 YR 4/3	58	20	7	"	"	"
		40-50	A 5 YR 3/4				"	"	"
		60-70	B 7.5 YR 3/2				"	"	"
		100-110	B 10 YR 6/2	72	16	10	"	"	"
		0-10	O 10 YR 3/2	64	26	11	"	"	"
		20-30	A 10 YR 4/4				"	"	"
		40-50	A 10 YR 4/3				"	"	"
		60-70	B 10 YR 2/2						
		100-110	B 10 YR 5/6	48	28	16			

Appendix III (continued)

	0-10	O 10 YR 2/1	55	30	1	"	"	"
	20-30	A 10 YR 4/4				"	"	"
	40-50	A 10 YR 4/6				"	"	"
	60-70	B 10 YR 2/2				"	"	"
	100-110	B 10 YR 4/3				"	"	"
	0-10	O 10 YR 4/6	57	30	11	"	"	"
	20-30	A 10 YR 4/3	71	24	7	"	"	"
	40-50	A 10YR 4/4				"	"	"
	60-70	B 10 YR 2/2				"	"	"
	100-110	B 10 YR 5/6				"	"	"
IV. Min Hla	0-10	O 5 YR 2.5/1	73	12	12	sandy loam	weak	loose & non-sticky
	20-30	A 5YR 3/4	72	14	9	"	"	"
	40-50	A 7.5 YR 3/2	-	-	-	"	"	"
	60-70	B 10 YR 4/6	-	-	-	sandy clay loam	"	":
	80-90	B 7.5 YR 5/8	-	-	-	sandy loam	"	"
	0-10	O 5 YR 2.5/1	-	-	-	"	"	"
	20-30	A 10YR 5/4	58	18	21	sandy clay loam	moderate	friable & sticky
	40-50	A 7.5 YR 5/6				"	weak	loose & non-sticky
	60-70	B 10 YR 4/3	-	-	-	"	"	"
	80-90	B 5 YR 4/6	-	-	-	clay loam	moderate	friable & sticky
	0-10	O 5 YR 2.5/1	-	-	-	sandy loam	weak	loose & non-sticky
	20-30	A 5YR 5/4	53	22	21	sandy clay loam	moderate	friable & sticky
	40-50	A 7.5 YR 4/4				"	weak	loose & non-sticky
	60-70	B 7.5 YR 5/6	-	-	-	"	"	"
	80-90	B 5 YR 5/6	-	-	-	clay loam	moderate	loose & non-sticky
	0-10	O 5 YR 3/1	72	18	10	sandy loam	weak	loose & non-sticky
	20-30	A 10YR 5/4	49	24	17	"	"	"
	40-50	A 7.5 YR 4/4	42	24	21	sandy clay loam	"	"
	60-70	B 7.5 YR 5/6	-	-	-	sandy loam	"	"
	80-90	B 5 YR 5/6	30	32	28	clay loam	moderate	friable & sticky
	0-10	O 5 YR 2.5/1	65	16	13	sandy loam	weak	loose & non-sticky
	20-30	A 5 YR 6/8	29	28	27	sandy clay loam	"	"
	40-50	A 5 YR 3/4	79	14	9	"	"	"
	60-70	B 7.5 YR 4/2	51	26	12	sandy loam	"	"
	80-90	B 5 YR 2.5/1	76	6	6	loamy sand	"	"

Appendix III (continued)

V. Konbilin									
Tayawady 1. Township	0-10	O 10 YR 4/3	79	10	6	loamy sandy	weak	loose & non-sticky	Diffuse smooth
	20-30	A 2.5 YR 5/6	70	16	8	sandy loam	weak	"	"
	40-50	A 2.5 YR 5/4	72	10	14	sandy loam	moderate	firable & non-sticky	"
	60-70	A 10 YR 4/6	73	18	10	"	"	"	"
	80-90	B 10 YR 4/6	68	10	18	"	"	"	"
2.	0-10	O 10 YR 3/2	80	12	2	sandy loam	weak	firable & non-sticky	Diffuse smooth
	20-30	A 10 YR 4/4	68	10	16	"	"	"	"
	40-50	A 10 YR 5/6	66	12	18	"	moderate	"	"
	60-70	A 10 YR 5/6	72	10	16	"	"	hard sticky	"
	80-90	B 25 Y 4/4	70	8	19	"	"	"	"
3.	0-10	O 10 YR 3/2	78	14	2	loamy sand	weak	loose & non-sticky	"
	20-30	A 2.5 YR 4/4	69	8	6	"	"	"	"
	40-50	A 2.5 YR 6/6	74	16	10	"	moderate	firable & non-sticky	"
	60-70	A 10 YR 4/6	69	8	14	"	"	hard sticky	"
	80-80	B 5 YR 5/4	74	6	14	"	"	"	"
4.	0-10	O 10 YR 4/3	83	10	6	sandy loam	weak	loose & non-sticky	Diffuse & smooth
	20-30	A 2.5 YR 4/4	73	10	8	loamy sand	"	"	"
	40-50	A 2.5 YR 5/4	72	10	12	sand loam	moderate	firable & non-sticky	"
	60-70	A 10 YR 4/6	87	10	20	"	"	hard sticky	"
	80-90	B 10 YR 4/3	65	12	22	sandy clay loam	"	"	"
5.	0-10	O 10 YR 5/6	74	16	6	loamy sand	weak	loose & non-sticky	"
	20-30	A 2.5 YR 4/4	79	8	10	"	"	"	"
	40-50	A 10 YR 4/6	66	14	18	sand loam	moderate	firable & non-sticky	"
	60-70	A 10 YR 4/6	71	6	18	"	"	hard sticky	"
	80-90	B 10 YR 4/3	71	12	16	"	"	"	"

Appendix IV. Soil chemical data from lateritic areas in Myanmar.

Description	Depth (cm)	pH	Organic Matter	Extractable Nutrients						Electrical Conductivity
				Total						um hos / cm
				N	P	K	Ca	Mg	Na	
I. Theinzayat Kyaik Hto Township	1. 0-10	5.5	11.96	190.0	Trace	1.5	Trace	Trace	3.6	7.50
	20-30	5.5	8.75	100.8	"	1.2	"	"	34	5.00
	40-50	5.5	10.50	100.1	"	1.1	"	"	3.5	5.00
	60-70	5.5	8.70	83.2	"	1.5	"	"	4.1	5.00
	80-70	5.8	7.89	101.9	"	2.1	"	"	4.3	5.00
	2. 0-10	5.3	9.95	204.3	"	2.0	"	"	3.2	6.25
	20-30	5.3	11.80	138.3	"	2.2	"	"	4.8	6.87
	40-50	5.6	9.84	139.3	"	2.1	"	"	4.3	6.25
	60-70	5.6	9.70	85.2	"	1.4	"	"	4.1	5.00
	80-90	5.5	6.25	115.9	"	1.9	"	"	2.9	5.00
	3. 0-10	5.4	8.73	164.0	"	2.4	"	"	4.2	6.25
	20-30	5.5	7.93	70.4	"	2.1	"	"	6.3	5.00
	40-50	5.4	7.65	164.8	"	2.0	"	"	6.9	5.00
	60-70	5.4	7.97	109.2	"	1.8	"	"	5.3	6.25
	80-90	5.6	9.34	88.2	"	1.8	"	"	7.5	5.00
	4. 0-10	5.7	10.56	87.6	"	2.3	"	"	7.2	3.75
	20-30	5.8	10.29		"	2.0	"	"	6.7	5.0
	40-50	5.8	8.86	73.8	"	2.0	"	"	6.9	3.75
	60-70	5.7	9.56	79.3	"	1.8	"	"	7.2	3.75
	80-90	5.7	7.21	63.1	"	1.8	"	"	6.5	3.75
	5. 0-10	5.7	13.52	273.7	"	2.2	"	"	1.9	5.0
	20-30	5.7	9.58	124.0	"	2.0	"	"	1.9	6.25
	40-50	5.7	7.59	92.8	"	1.8	"	"	1.9	5.0
	60-70	5.7	8.25	83.7	"	1.8	"	"	0.7	3.75
	80-90	5.7	8.27	79.5	"	2.0	"	"	2.5	3.75

Appendix IV (continued)

II. Myainggalay Hpa-an Township Karan state	1. 0-10	5.6	10.2	238.6	Trace	2.5	Trace	Trace	1.4	6.25
	20-30	5.6	9.36	163.2	0.39	2.2	"	"	Trace	5.00
	40-50	5.6	8.34	110.7	0.38	2.2	"	"	"	3.75
	60-70	5.4	6.75	135.2	0.47	2.6	"	"	"	12.50
	80-90	5.9	7.52	82.6	0.38	2.2	"	"	"	3.75
	2. 0-10	5.5	8.94	239.7	2.83	2.7	"	"	"	6.25
	20-30	5.5	9.87	201.7	0.52	2.6	"	"	"	6.25
	40-50	5.6	8.96	160.1	0.38	2.4	"	"	"	5.0
	60-70	5.6	8.09	107.6	0.40	2.1	"	"	"	3.75
	80-90	5.9	8.71	102.9	0.48	2.4	"	"	"	3.75
	3. 0-10	6.0	6.91	252.4	0.46	1.2	8.9	"	5.8	2.50
	20-30	5.8	5.05	199.1	Trace	1.0	7.2	"	6.8	8.75
	40-50	5.8	4.57	159.1	"	0.9	6.2	4.0	5.9	6.25
	60-70	6.0	5.00	147.6	"	0.8	5.2	"	6.4	2.50
	80-90	6.1	4.56	135.7	"	0.9	5.6	"	7.3	2.50
	4. 0-10	5.8	5.77	159.1	"	0.8	3.9	"	4.7	5.00
	20-30	5.8	5.27	123.7	"	0.8	1.0	"	4.9	2.50
	40-50	6.0	5.31	118.5	"	0.6	8.0	"	4.8	1.62
	60-70	5.9	5.32	113.8	"	0.6	5.0	"	5.1	1.62
	80-90	6.0	4.95	112.8	"	0.6	12.0	"	5.1	1.50
	5. 0-10	6.2	6.27	206.9	"	1.2	64.0	"	10.6	8.75
	20-30	5.7	7.61	182.5	"	0.8	53.0	"	1.4	5.0
	40-50	5.8	7.66	159.1	"	0.8	23.0	"	4.6	3.75
	60-70	5.8	6.79	133.1	"	0.8	9.0	"	7.4	2.5
	80-90	5.8	7.52	222.5	"	0.6	8.0	"	8.0	2.5
	6. 0-10	5.7	9.17	99.8	"	1.4	7.0	"	12.1	8.12
	20-30	5.6	9.05	175.7	"	0.7	3.0	"	11.3	3.75
	40-50	5.6	9.24	128.4	"	0.6	14.0	"	10.9	2.5
	60-70	5.7	8.23	170.5	"	0.6	13.0	"	15.0	2.5
	80-90	5.7	8.06	93.6	"	0.6	12.0	"	16.1	2.5
	7. 0-10	5.6	6.92	182.5	"	0.6	27.0	"	12.7	6.25
	20-30	5.5	5.42	123.2	"	0.6	22.0	"	11.8	5.0
	40-50	5.5	4.29	51.5	"	0.6	6.0	"	13.5	5.0
	60-70	5.6	4.28	76.4	"	0.6	5.0	"	9.0	3.75
	80-90	5.6		62.9	"	0.6	6.0	"	10.6	3.75

Appendix IV (continued)

	8. 0-10	5.6	10.87	261.8	1.62	3.6	Trace	2.0	1.6	15.0
	20-30	5.5	5.04	102.9	Trace	2.4	"	Trace	1.3	6.25
	40-50	5.5	6.37	98.0	"	2.6	"	"	0.9	23.75
	60-70	5.8	7.57	86.8	"	9.4	"	2.0	1.0	5.0
	80-90	5.5	4.03	63.9	"	1.7	"	"	1.4	5.0
	9. 0-10	5.7	11.5	255.8	"	2.4	"	"	1.3	2.37
	20-30	5.6	7.77	138.3	"	2.0	"	"	1.4	12.5
	40-50	5.7	4.17	61.8	"	1.6	"	"	2.2	5.0
	60-70	5.6	4.03	75.9	"	1.9	"	"	Trace	5.0
	80-90	5.8	6.74	104.5	1.70	2.3	"	"	"	6.25
	10.0-10	5.5	7.86	219.4	1.16	2.8	"	"	0.6	10.00
	20-30	5.6	8.33	151.8	Trace	2.2	"	"	Trace	3.75
	40-50	5.8	7.31	121.6	"	2.2	"	"	3.3	3.75
	60-70	5.8	8.89	109.7	"	2.2	"	"	Trace	3.75
	80-90	5.6	8.63	125.3	"	2.1	"	"	"	5.00
III. Htilon Reserve	0-10	5.8	3.13	95.1	Trace	11.9	Trace	Trace	Trace	5.0
Hlaing Bwe	20-30	5.4	2.14	62.6	"	-	-	-	-	2.5
Township	40-50	6.5	1.5	45.7	"	10.1	Trace	Trace	6.8	1.87
Kayin state	60-70	5.5	2.21	41.6	"	10.3	"	"	"	2.62
	100-110	5.4	-	-	"	-	-	-	"	2.37
	0-10	5.5	2.13	87.8	Trace	11.9	Trace	Trace	4.4	3.5
	20-30	5.4	1.74	55.1	"	10.4	"	"	3.7	2.5
	40-50	5.5	1.87	43.6	"	8.8	"	"	2.6	1.62
	60-70	5.4	-	46.2	"	8.2	"	"	Trace	2.62
	100-110	5.5	1.93	78.0	"	7.1	"	"	"	1.25
	0-10	5.6	2.24	78.5	"	15.6	"	"	4.1	3.25
	20-30	5.4	1.58	53.0	"	10.2	"	"	Trace	25.0
	40-50	5.5	1.67	40.5	"	10.8	"	"	1.3	2.37
	60-70	5.4	-	-	"	8.5	"	"	Trace	2.5
	100-110	5.5	2.24	46.2	"	8.9	"	"	"	1.25
	0-10	5.6	2.93	100.3	"	10.7	"	"	3.1	2.62
	20-30	5.4	1.5	54.6	"	18.5	"	"	Trace	2.0
	40-50	5.5	2.12	46.2	"	12.4	"	"	6.1	1.75

Appendix IV (continued)

xii

Htilon	60-10	5.5	-	-	Trace	12.4	Trace	Trace	-	2.50
Resverse	100-110	5.5	1.97	45.2	"	8.6	"	"	Trace	1.25
Hlaing Bwe Township	0-10	5.4	3.05	81.1	"	12.3	"	2.0	4.1	2.37
Kayin State	20-30	5.7	1.76	56.6	"	10.2	"	"	2.6	2.37
	40-50	5.5	2.19	41.0	"	-	"	"	-	1.75
	60-70	5.4	-	-	"	-	-	-	-	2.37
	100-110	5.5	1.75	46.8	"	7.6	Trace	"	Trace	2.00
IV. Konbilin	0-10	5.4	2.38	62.9	0.5	-	-	-	-	7.5
	20-30	5.7	2.19	52.0		1.20	20.0	Trace	10.4	8.75
	40-50	5.9	2.32	37.4		1.10	18.0	"	9.6	6.25
	60-70	5.5	11.95	40.5		1.20	18.0	"	11.8	10.0
	80-90	5.8	4.05	37.4		1.30	6.0	"	5.1	7.5
	0-10	5.7	1.56	53.0		0.80	6.0	"	10.0	6.25
	20-30	5.7	2.52	41.6		1.20	16.0	"	8.2	10.0
	40-50	5.8	13.9	34.8		1.20	27.0	"	9.2	7.5
	60-70	5.8	1.07	35.8		1.00	34.0	"	12.8	7.5
	80-90	5.4	1.62	41.6		1.20	8.0	"	4.9	7.5
	0-10	6.1	2.19	60.8		0.80	10.0	"	11.7	8.75
	20-30	5.3	1.54	44.2		1.50	17.0	"	8.9	10.0
	40-50	5.5	15.3	44.7		1.20	22.0	"	4.3	7.5
	60-70	5.4	1.29	39.5		1.10	54.0	"	5.7	7.5
	80-90	5.4	1.08	29.6		1.20	11.0	"	4.8	7.5
	0-10	6.0	2.0	56.1		1.20	21.0	"	12.8	7.5
	20-30	5.6	1.32	40.5		1.00	7.0	"	10.8	7.5
	40-50	5.6	10.0	44.9		1.00	5.0	"	3.0	7.5
	60-70	5.3	1.75	53.0		1.10	48.0	"	6.2	7.5
	80-90	5.8	2.58	49.9		1.20	16.0	"	7.0	6.25

Appendix IV (continued)

V. Min Hla	0-10	6.4	4.62	40.0	0.62	7.4	85.0	38.0	3.2	4.25
Bago	20-30	6.1	4.62	44.2	Trace	6.2	89.0	41.0	6.9	6.87
Division	40-50	5.8	6.47	47.3	"	11.7	44.0	48.0	8.3	3.12
	60-70	5.4	6.28	43.9	"	15.8	72.0	41.0	7.6	2.62
	80-90	5.8	5.66	52.7	0.34	15.2	54.0	34.0	2.1	4.12
	0-10	6.2	4.35	68.1	"	13.9	73.0	41.0	2.8	6.5
	20-30	5.8	2.42	47.3	"	10.4	77.0	41.0	5.2	3.56
	40-50	5.6	4.63	48.8	"	15.4	49.0	46.0	12.8	5.5
	60-70	6.1	2.00	31.7	"	9.2	74.0	34.0	2.6	10.0
	80-90	6.3	3.46	51.8	0.24	21.0	48.0	44.0	5.5	4.12
	0-10	6.3	-	-	Trace	-	-	-	-	3.37
	20-30	5.7	2.66	56.1	"	8.7	86.0	40.0	5.4	3.12
	40-50	6.5	3.72	69.4	"	31.6	68.0	42.0	3.3	9.87
	60-70	6.0	5.11	43.1	Trace	30.4	78.0	39.0	2.7	1.62
	80-90	6.8	4.42	62.4	0.31	19.0	87.0	52.0	8.4	2.75
	0-10	6.2	3.70	46.8	Trace	8.8	82.0	34.0	7.3	18.75
	20-30	5.8	3.66	53.0	Trace	23.2	83.0	40.0	3.9	4.87
	40-50	6.5	3.72	69.4	"	31.6	68.0	42.0	3.3	9.87
	60-70	5.7	5.26	39.4	0.24	20.2	90.0	51.0	10.0	2.25
	80-90	6.9	2.67	63.1	0.30	28.3	72.0	36.0	7.4	2.12
	0-10	6.3	3.00	70.0	0.06	9.1	87.0	32.0	4.9	8.25
	20-30	5.9	5.40	40.0	Trace	16.1	50.0	54.0	4.0	7.5
	40-50	5.7	5.74	37.9	"	20.4	77.0	41.0	21.8	5.12
	60-70	5.8	5.07	44.5	0.26	14.7	57.0	40.0	2.2	2.37
	80-90	7.0	2.62	39.2	0.38	14.3	76.0	25.0	3.0	2.12

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