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CHARACTERISTICS AND CROPS SUITABILITY OF VERTISOLS IN THE COASTAL PLAIN OF THE PARISH OF CLARENDON, JAMAICA

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ABSTRACT

Three Vertisols are identified in the Coastal Plain of the Parish of Clarendon, Jamaica. They are Brysons, Monymusk and Rhymesbury series. The morphological, physical and chemical characteristics of these soils are described. Their suitability is assessed and classified for 30 selected crops with respect to four major kinds of land use and management level. This assessment and classification were done following Jamaica Physical Land Evaluation System. In addition, soil and climate related limitations are also discussed.

INTRODUCTION

The Coastal Plain of the Parish of Clarendon is the largest piece of level land in Jamaica. It comprises approximately 37,000 hectares (Sharif, 1989) of which Vertisols occupy about 40 percent. The Vertisols have agricultural potential, but their characteristics require special attention for crop production.

In the previous study (Finch, 1959), the characteristics of the soils were not described in enough detail to be classified as series. The land capability classification of the soils was not dealt with in relation to specific crop and management level. The classes merely indicate arable lands.

This study describes the morphological, physical and chemical characteristics of Vertisols in the coastal plain of the Parish of Clarendon. It also interprets them in terms of their suitability for selected crops under defined land use and management levels.

MATERIALS AND METHODS

Auger borings were done in order to determine the range of characteristics and the typical pedon sites. Pits were dug at the selected sites, described (FAO, 1977) and sampled. A total of 14 soil samples were collected from different layers of these soil pits at an average depth of 1.45 meters from the surface. The soil samples were then analyzed in the laboratory. Soil classification was done according to the USDA System (Soil Survey Staff, 1987).

Assessment of analytical results was made for pH (USDA, 1983) organic carbon and total nitrogen (Landon, 1984) and for available P and K (ICTA, 1940).

Crops suitability and their classes were evaluated following the Jamaica Physical Land Evaluation System (JAMPLES), developed by the Soil Survey Staff (RPPD, 1986). This evaluation represents 30 selected crops with respect to four major kinds of land use and management levels (MLU). The MLUs are:

A) Small scale (less than 2 hectares), rainfed, subsistance, mixed crop farming with low technology and management.
B) Medium scale (2 to 5 hectares), rainfed, subsistence and local market oriented, mixed crop farming with intermediate technology and management.
C) High-medium scale (5 to 25 hectares), irrigated, export oriented, single crop farming with modern high technology and management.
D) Large scale (more than 25 hectares), irrigated, export oriented, single crop farming with modern high technology and management.

RESULTS AND DISCUSSION

Soil Characteristics

i) Morphology and particle size: Most areas of these three soils are flat (0 to 2 percent slopes). Monymusk soils occur on convex slopes and show no sign of impeded drainage. Brysons and Rhymesbury soils occupy the concave slopes and consequently, they suffer from impeded drainage. This condition is evident by the presence of mottles in their profiles (Table 1).

The color hue in Brysons soils ranges from 2.5Y to 10YR,but in Monymusk soils it is 5YR throughout the profile. On the other hand, Rhymesbury soils have hue of 10YR over 5YR. This would indicate that Rhymesbury soils were deposited subsequently over Monymusk soils (Figure 1).

Other morphological characteristics such as structure, consistency, slickensides and horizon boundary of all these three soils are comparable (Table 1).

The particle size analysis (Table 1) shows that Brysons soils are heavier (56% clay in the control section) than Monymusk and Rhymesbury soils. The latter two soils do not differ from each other in clay content.

ii) Chemical characteristics: Data in Table 2 imply that Brysons soils are neutral to mildly alkaline, but Monymusk and Rhymesbury soils are mildly to strongly alkaline. This is also evident by the amount of $CaCO_3$ present.

Table 1 Morphology, particle size and classification of typical pedons

depth (cm)	horizon	sand (percent)	silt (percent)	clay (percent)	texture	colour	mottles	structure	consistency	slickensides	boundary
Brysons soils: Entic Chromusterts, fine, mixed, isohyperthermic											
0-14	Ap	43	6	51	C	10YR 3/3	-	c/granular	very firm	-	cs
14-34	AC1	44	1	55	C	2.5Y 4/4, 5/6	-	c/sbk	firm	common	cs
34-75	AC2	41	1	58	C	10YR 6/8	-	c/sbk	firm	common	gs
75-108	C1g	41	5	54	C	10YR 5/8	FFP 10YR 7/2	c/sbk	firm	few	gs
108-145	C2g	45	1	54	C	10YR 5/8	CMP 10YR 7/1 + FMD 2.5YR 4/6	c/sbk	firm		
Monymusk soils[1] *: Typic Chromusterts, fine, montmorillonitic, isohyperthermic*											
0-32	Ap	46	14	40	SC	5YR 3/2	-	c/granular	ext. firm	common	gs
32-54	AC1	47	13	40	SC	5YR 3/3	-	vc/sbk	very firm	few	cw
54-91	AC2	47	13	40	SC	5YR 4/3	-	vc/sbk	very firm	few	cw
91-116	C1k	52	12	36	SC	5YR 3/3	-	vc/abk/sbk	very firm	few	cs
116-150	2C2	52	12	36	SC	5YR 3/3	-	vc/sbk			
Rhymesbury soils: Entic Chromusterts, fine, montmorillonitic, isohyperthermic											
0-22	Ap	43	17	40	C	10YR 3/2	-	m/sbk	firm	-	as
22-50	AC1	42	18	40	C	10YR 4/2	-	vc/abk/sbk	ext. firm	few	as
50-99	AC2	41	10	49	C	10YR 5/3	FFF 10YR 4/6	vc/abk/sbk	ext. firm	common	cw
99-127	C1	41	18	41	C	5YR 4/3	-	c/sbk	ext. firm	few	cs
127-140	C2	43	25	32	CL	7.5YR 3/4	-	vc/sbk	-	-	

[1] Previous name Agualta Clay, map code 104 (Finch, 1959).

Figure 1 Physiographic position of Monymusk and Rhymesbury soils

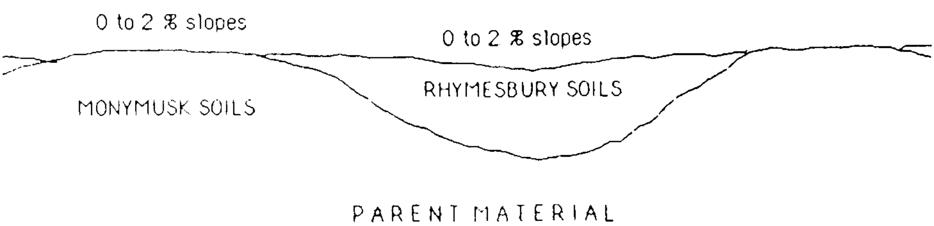

Table 2 Analytical results of typical pedons

depth (cm	pH	$CaCO_3$ %	O.C. %	Total N %	P_2O_5	K_2O	Ec	ESP	Exch. bases (meq/100g. soil)				CEC	BSP
					avil. in ppm				Ca^{2+}	Mg^{2+}	K^+	Na^+		
					Brysons soils									
0-14	7.2	2.2	1.7	0.18	34	54	0.1	1	19.8	2.5	0.13	0.20	24	93
14-34	7.5	<0.5	0.9	0.13	21	24	0.1	1	18.7	1.9	0.11	0.25	21	100
34-75	7.6	3.0	0.2	0.04	18	24	0.1	1	16.0	1.9	0.07	0.28	18	92
75-108	7.2	<0.5	0.1	0.04	15	45	0.1	2	14.4	1.7	0.06	0.37	18	92
108-145	5.3	<0.5	0.2	0.04	18	15	0.2	3	12.9	1.8	0.07	0.50	18	85
					Monymusk soils									
0-32	8.1	0.7	0.9	0.07	53	179	0.1	4	24.1*	13.0	0.54	1.52	39	100
32-54	8.3	1.6	0.6	0.06	41	122	0.1	8	22.4*	13.1	0.39	3.31	39	100
54-91	8.3	1.9	0.3	0.03	35	86	0.3	15	19.0*	13.1	0.33	5.57	38	100
91-116	8.8	3.2	0.2	0.01	86	68	0.4	22	14.7*	11.6	0.29	7.40	34	100
116-150	8.8	5.4	0.1	0.01	63	17	0.5	23	13.0*	12.3	0.30	7.61	33	100
					Rhymesbury soils									
0-22	7.7	2.2	1.8	0.08	84	369	0.1	1	30.5	10.9	0.99	0.44	44	98
22-50	8.1	2.3	1.1	0.03	103	109	0.1	4	29.3	10.7	0.37	1.65	42	100
50-99	8.5	2.9	0.4	0.02	22	127	0.2	8	26.9*	16.5	0.45	3.74	48	100
99-127	7.5	2.1	0.2	0.01	120	68	0.6	11	21.6*	16.7	0.34	4.96	44	100
127-140	7.5	2.6	0.2	0.01	400	63	0.5	12	17.5*	13.5	0.25	4.35	36	100

* derived values

Although organic carbon and nitrogen contents in these three soils are very low to low, Monymusk and Rhymesbury soils could be considered fertile, because such conditions can be corrected easily. Brysons soils which are also low in available P and K, present poor fertility status.

The Ca/Mg ratio (0 to 50 cm) of Monymusk and Rhymesbury soils is 2 and 3, respectively. Compared to this, the ratio in Brysons soils is very high (8 to 10). The approximate optimum range of Ca/Mg ratio for most crops is 3 to 4 (Landon, 1984). K/Mg ratio in all soils is less than 0.1 which is assumed to be too low. The recommended level of this ratio for crops is 0.6 to 1.5 (Doll and Lucas, 1973).

The ESP (0 to 100 cm) is not at harmful levels for crops in the Brysons and Rhymesbury soils, but in Monymusk soils it reaches a detrimental level 50 cm below the surface. At ESP level of 10 to 20 the growth of sensitive crops such as beans and sugarcane are affected (Landon, 1984).

Some areas of Monymusk and Rhymesbury soils are saline (RPPD, 1988), while small areas are interrupted by gullies.

These areas are considered as saline and gullied phases (Sharif, 1989), respectively, and are not included in this study.

Crops suitability

In this study four suitability classes are considered:

Highly suitable (S1)
Moderately suitable (S2)
Marginally suitable (S3)
Not suitable (N)

Apart from these classes another class "Not Logical (NL)" is also used when a projected crop is not appropriate within the context of this study.

The results of JAMPLES on suitability are considered on the assumption of sustained use and do not include the socio-economic evaluation. The results are presented in Table 3 and 4.

Table 3 shows that Brysons and Rhymesbury soils are moderately suitable for most crops at the highest level of management (MLU D). The major limiting factors in these soils are unavailability of oxygen to the root zone and unfavorable rooting conditions. In Monymusk soils (with a better drainage condition) crops can be grown at higher levels of management (MLU C and D). However, sodium toxicity limits the suitability for most of these crops at the marginal level.

Other crops which differ from these trends can be given with specific suitability and limitations:

All these three soils are found highly suitable for improved pasture. Cauliflower and Irish potato are not suitable on any of these soils because of the limitation of temperature (Table 4). Sugarcane is moderately suitable at MLU C and as the level of inputs increases, i.e., at MLU D, it shows high suitability. In Brysons and Rhymesbury soils rice is highly suitable, but due to the limitation of soil reaction it is moderately suitable in Monymusk soils. Unavailability of oxygen in the root zone and unfavorable rooting condition are the principal factors which make coffee not suitable in Brysons and Rhymesbury soils. The same limitations also preclude the suitability of forestry on any of the three soils.

It appears from this study that on Brysons and Rhymesbury soils most of the selected crops could be produced at moderate levels when irrigation, modern high technology and management are applied. On Monymusk soils these crops could be grown with supplementary irrigation, high technology and management at the marginal level. However, some of these crops (coconut, pumpkin, sugarcane, tomato and watermelon) could have positive responses on the same if the level of inputs is increased.

Table 3 Suitability of soils series for selected crops produced under 4 MLU (A, B, C and D)

Crops	Brysons soil [1]				Monymusk soil [2]				Rhymesbury soil [3]			
	MLU											
	A	B	C	D	A	B	C	D	A	B	C	D
Banana	N	N	N	S2	N	N	S3	S3	N	N	N	S3
Cabbage	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Cassava	N	N	NL	NL	S3	S3	NL	NL	N	N	NL	NL
Cauliflower	N	N	N	N	N	N	N	N	N	N	N	N
Citrus	N	N	N	S3	N	N	S3	S3	N	N	N	S3
Cocoa	N	N	N	NL	N	N	S3	NL	N	N	N	NL
Coconut	N	N	N	S3	N	N	S3	S2	N	N	N	S3
Coffee (arabica)	N	N	N	NL	N	N	S3	NL	N	N	N	NL
Coffee (robusta)	N	N	N	NL	N	N	S3	NL	N	N	N	NL
Common bean	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Cucumber	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Forestry	N	N	NL	NL	N	N	NL	NL	N	N	NL	NL
Groundnut	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Improved pasture	NL	N	S1	S1	NL	N	S1	S1	NL	N	S1	S1
Irish potato	N	N	N	N	N	N	N	N	N	N	N	N
Maize	N	N	N	S2	N	N	S2	S2	N	N	N	S2
Mango	N	N	N	S3	S3	S3	S3	S3	N	N	N	S3
Onion	N	N	N	S2	S3	S3	S3	S3	N	N	N	S2
Pineapple	N	N	NL	NL	N	N	NL	NL	N	N	NL	NL
Pumpkin	N	N	N	S2	S3	S3	S3	S2	N	N	N	S2
Rice	N	N	S1	S1	N	N	S2	S2	N	N	S1	S1
Soyabean	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Sugarcane	N	N	S2	S1	N	N	S2	S1	N	N	S2	S1
Sweet pepper	N	N	S3	S2	N	N	S3	S3	N	N	N	S2
Sweet potato	N	N	S3	S2	N	N	S3	S3	N	N	S3	S2
Tobacco	N	N	N	S2	N	N	S3	S3	N	N	N	S2
Tomato	N	N	N	S2	N	N	S3	S2	N	N	N	S2
Unimproved pasture	S2	NL	NL	NL	S3	NL	NL	NL	S2	NL	NL	NL
Watermelon	N	N	N	S2	S3	S3	S3	S2	N	N	N	S2
Yam	N	N	NL	NL	N	N	NL	NL	N	N	NL	NL

[1] Based on climate and Rainfall data at Monymusk and May Pen respectively. R75=893 mm/year, PET=1,543 mm/ year, R75/PET= 0.58.

[2]&[3] Based on climate and rainfall data at Monymusk and New Yarmouth respectively. R75=773 mm/year, PET=1,577 mm/year, R75/PET=0.49.

Table 4 Soil and climate related limitations

Crops	Brysons soils											Monymusk soils											Rhymesbury soils										
	Land qualities and limitations																																
	LT	HT	OX	RC	NR	NA	SR	CC	AL	SA	SO	LT	HT	OX	RC	NR	NA	SR	CC	AL	SA	SO	LT	HT	OX	RC	NR	NA	SR	CC	AL	SA	SO
Banana	0	0	2	2	0	2	0	1	0	0	0	0	0	1	1	0	1	1	1	0	0	1	0	0	2	2	0	1	1	1	0	0	0
Cabbage	1	1	2	2	0	2	0	0	0	0	0	1	1	1	1	0	1	1	0	0	0	1	1	1	2	2	0	1	1	0	0	0	0
Cassava	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	0	0	0	0	0
Cauliflower	2	2	2	2	0	2	0	0	0	0	0	2	2	1	1	0	2	2	0	0	0	1	2	2	2	2	0	1	1	0	0	0	0
Citrus	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Cocoa	0	0	2	2	0	2	1	1	0	0	0	0	0	1	1	0	2	2	1	0	0	1	0	0	2	2	0	1	1	1	0	0	0
Coconut	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	2	2	0	1	0	0	0	0	0
Coffee (arabica)	1	1	2	2	0	2	2	1	0	0	0	1	1	1	1	0	2	2	1	0	0	1	1	1	2	2	0	2	2	1	0	0	0
Coffee (robusta)	0	0	2	2	0	2	2	1	0	0	0	0	0	1	1	0	2	2	1	0	0	1	0	0	2	2	0	2	2	1	0	0	0
Common bean	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Cucumber	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Forestry	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	2	2	0	1	1	0	0	0	0
Groundnut	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Improved pasture	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Irish potato	2	2	2	2	0	2	1	0	0	0	0	2	2	1	1	0	2	2	0	0	0	1	2	2	2	2	0	1	1	0	0	0	0
Maize	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Mango	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	0	0	0	0	0
Onion	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Pineapple	0	0	2	2	0	1	1	1	0	0	0	0	0	1	1	0	2	2	1	0	0	1	0	0	2	2	0	1	1	1	0	0	0
Pumpkin	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Rice	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Soyabean	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Sugarcane	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0
Sweet peper	0	0	2	2	0	2	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
SweetpPotato	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Tobacco	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0
Tomato	0	0	2	2	0	2	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	2	2	0	1	1	0	0	0	0
Unimproved pasture	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Water melon	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	2	2	0	1	1	0	0	0	0
Yam	0	0	2	2	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	2	2	0	1	1	0	0	0	0

LT- temperature for lowest altitude, HT- temperature for highest altitude, OX- oxygen availability, PC- rooting condition, NR- nutrient retention, NA- nutrient availability, SR- soil reaction, CC- $CaCO_3$ toxicity, AL- Al toxicity, SA- salinity, SO- sodicity.

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