CARIBBEAN FOOD CROPS SOCIETY

PROCEEDINGS

ELEVENTH ANNUAL MEETING

SOILS OF BARBADOS

by

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GEOLOGY

The Caribbean island of Barbados is a coral island of about 430 sq. km. rising gently to a maximum height of just over 305m. The geology of the island has been studied in great detail by a number of workers and their findings have been summarized by WRIGHT (1959). The oldest rocks, Eocene sediments of great thickness, were laid down in a region of rapid and continuous subsidence. Subsequently, they were uplifted, strongly folded, thrust faulted, partially eroded and covered by a thick series of mud flows, the product of mud volcanoes. Further depression in the late Eocene was followed by deposition of radiolarian chalk and tuff of considerable thickness. Deformation certainly continued during the deposition of these materials because the lower members are somewhat folded and faulted. During the final phase of the building of the island, corralline limestone to a maximum thickness of about 120m accumulated, the lowest layer of which consists of coral reef debris and algal and foraminiferal limestone. Higher strata are made up of massive coral with interstitial reef debris and coral sand.

There appears to be some difference of opinion about the eventual emergence of the island. At first, geologists were of the opinion that uplift was gradual as this explained the terrance edges which are a conspicuous feature of the Barbados landscape. Later TRECHMANN (1940) concluded from fossil evidence that the entire coral cover was of uniform age and that the whole of the submarine platform was elevated by an oblique thrust from the west and south, thus producing an east and northeast rise to the land and cracking of the coral cap along the present escarpment of the currently eroded Scotland District. In contrast, recent radiochemical dating of coral in the lower terraces by BROECKER et al. (1968) indicates that the island has emerged at a constant rate over at least the past 125000 years. The surface of the seamount had one major irregularity in the form of a raised ridge (Christ Church Ridge) towards the southern end, and at one stage in the emergence this ridge would have formed a separate island. The valley (St. George's Valley) separating the two high areas was occupied by a shallow arm of the sea or inland lagoon on the floor of which detritus was deposited (VERNON and CARROLL, 1965).

The oldest rocks of Barbados, the Scotland formations, are very thick sediments deposited into a rapidly and continuously subsiding geosynclinal foredeep. They show the sedimentary structures characteristics of such turbidite deposits and large scale slumping and sliding features are common. The origin of these sediments appears to have been an emerging geanticlinal ridge of metamorphic and igneous rocks somewhere to the south of the present position of Barbados. The Scotland formations are strongly folded and the limbs of the folds are often overturned and thrusted.

In the Middle Eocene, when the volcanic eruptions began in the Lesser Antilles, these clastic sediments were covered by a thick, structureless deposit, the Joes River Formation. The chaotic texture and pebbly nature of this formation supports Senn's (1947) view that it formed from a thick series of flows from mud volcanoes, although it is also possible that this formation may represent large scale shear zones mobilized by the break-up of oil, gas and water reservoirs.

CLIMATE

The annual rainfall and land humidity of Barbados are shown in Fig. 2.

SOILS

The soils of Barbados can be conveniently divided into the limestone derived soils and soils of the Scotland District. A soil association map of Barbados is shown in Fig. 1.

LIMESTONE – DERIVED SOILS

Black Soil Association:

Site and soil characteristics. The soil pit is located at Friendship and the soil generally occurs from sea level to 60m and where the rainfall is less than 152cm. The soil is a black clay to the parent rock with a transition zone of only about 2.5 cm. Clay content increases with depth ranging from 66 to 82 percent and the profile has CEC values between 40 and 45 m. e./100gm of soil; $CaCO_3$ is present in small quantities throughout.

The clay consists of inter-layered montmorillonite, kaolinite and small quantities of amorphous minerals. (Table 2). The particle size distribution and chemical properties are shown in Table 1.

Soil Profile Description:-

Depth cm	*Description (moist)*
0-15	Black (N2/0) clay; strong changing to moderate subangular blocky structure with depth; friable to firm with depth; sticky when wet; roots plentiful; fragments of marl up to 1.5 cm diameter common; gradual smooth boundary.
15-30	Black (N 2/0) compact clay; moderate medium subangular blocky structure; firm; sticky and plastic when wet; roots common; gradual smooth boundary.

Depth cm	Description (moist)
30-60	Black (N2/0) compact clay; structureless; firm, very sticky and plastic when wet; clear smooth boundary.
60-75	Gritty coral intermixed with grey (2.5YR 5/1) clay; structureless; transition to hard grey coral mass with wavy surface.

St. George's Valley Association:

Site and soil characteristics. The Bulkeley pit is located at Bulkeley. The soil occurs from sea level to 30m in St. George's Valley where the rainfall is 140-152 cm. The Valley was once occupied by a shallow arm of the sea where the sediments were deposited on preformed coral. The soil is a uniform dark grey clay on the surface changing to mottled lighter grey at depth. The clay content increases with depth ranging from 71 to 93 percent and the CEC 35 to 37m. e./100gm soil. The clay consists of kaolinite and montmorillonite in about equal amounts with small quantities of sesquioxides; $CaCO_3$ occurs only in the surface layers. (Table 2). The particle size distribution and chemical properties are shown in Table 1.

Soil Profile Descriptions:-

Depth cm	Description (moist)
0-15	Dark brown (7.5YR 3/2) clay; strong to moderate medium subangular blocky structure; common gravel to pebble-size pieces of limestone; very common roots; moderate cracking on exposure; gradual smooth boundary.
15-30	Dark brown (7.5YR 3/2) compact clay; weak medium subangular blocky structure; sticky when wet; few roots; gradual smooth boundary.

Depth cm	Description (moist)
30-61	Brown (7.5YR 4/4) compact clay; very weak massive blocky structure; few diffuse brownish yellow (10YR 6/8) mottles; gradual smooth boundary.
61-122	Brown (7.5YR 5/2) very compact structureless clay with few fine brownish yellow (10YR 6/8) mottles; cracks intensely on exposure and desiccation; sticky and plastic when wet; gradual smooth boundary.
122+	Profile continues as brown (7.5YR 4/4) compact clay.

Grey Brown Association:

Site and soil characteristics. Soil pit is located at Edgecombe and the soil generally occurs at an elevation of between 60 and 120m with rainfall of 152 to 165cm/annum. It is a dark grey clay and generally shallow with CaC03 distributed throughout. The clay content ranges from 47 tò 59%, the soil having a CEC of 35 to 45 m.e./100gm. The clay minerology consists of a mixed assemblage of kaolinite, montmorillonite and small quantities of amorphous oxides (Table 2).

The particle size distribution and chemical properties are shown in Table 1.

St. Philip Plain Association:

Site and soil characteristics. The soil pit is located at River in the St. Philip's Plain and the soil occurs from sea level to 90m in rainfall less than 140cm/annum. The soil is derived from lagoonal deposits. It is a uniformly dark grey to black clay, the profile being a few meters deep. The clay content ranges from 74 to 89 percent and the CEC from 61 to 69m. e/100gm soil. The predominant clay mineral is montmorillonite with lesser amounts of kaolinite and amorphous oxides. (Table 2). Calcium carbonate is found throughout the profile.

The particle size distribution and chemical properties are shown in Table 1.

Yellow Brown Association:

Site and soil characteristics. The profile is located at Pool and the soil occurs at an elevation of between 120 to 210m with rainfall of 165 to 178cm/annum. The surface soil is uniform yellowish brown in colour and the sub-soil is mottled reddish yellow and grey. Aggregate stability is good in the top soil. Clay content ranges from 80 to 99 percent and there are small amounts of CaC03 throughout the profile. The CEC decreases with depth from 25 to 18m. e./100gm soil. The clay fraction consists mainly of kaolinite and small amounts of montmorillonite and amorphous minerals. (Table 2). Iron oxide is present as goethite.

The particle size distribution and chemical properties are shown in Table 1.

Soil Profile Description:-

Depth cm	*Description (moist)*
0-15	Dark reddish brown (5YR 3/4) clay; strong medium crumb structure on surface changing to weak to moderate fine subangular blocky structure; friable; slightly sticky when wet; sparse cobble to gravel-size marl; roots common; gradual smooth boundary.
15-30	Dark reddish brown (5YR 3/4) clay; weak medium subangular blocky structure; friable to firm; slightly sticky when wet; pieces of marl rare; roots common; gradual smooth boundary.
30-46	Same, gradual change to
46-107	Yellowish red (5YR 5/8) clay; weak coarse blocky structure; friable; sticky and plastic when wet. At

Depth	*Description (moist)*
	105cm profile ends abruptly with wavy surface hard blocky coral limestone.

St. John Valley Association:

Site and Soil characteristics. The soil pit is located at Redland and the soil occurs at an elevation of between 210 and 330m with greater than 178cm of rainfall/annum. The surface soil is uniform brick red to chocolate brown friable clay, having stable crumb structure. The subsoil is mottled red and grey to white with weak structure development The clay content increases with depth ranging between 80-90 percent in the profile The CEC decreases with depth from 24 to 15m. e./100gm soil. Small amounts of CaCO3 occur in the surface. The clay fraction consists mainly of kaolinite with small quantities of montmorillonite and amorphous minerals. (Table 2). Fe2O3 is present as goethite.

The particle size distribution and chemical properties are shown in Table 1.

Soil Profile Description:-

Depth cm	*Description (moist)*
0-15	Dark reddish-brown (5YR 3/4) clay; fine to medium moderate subangular blocky structure; friable common gravel-size pieces of marl; sugar cane roots common; gradual smooth boundary.
15-30	Same, gradual smooth boundary.
30-46	Light grey (5YR 7/1) compact clay with diffuse faint reddish yellow (5YR 5/8) mottles; firm; weak to moderate fine subangular blocky structure; very few roots; gradual smooth boundary.

Depth cm	Description (moist)
46-61	Light grey (5YR 7/1) compact clay with common distinct red (10YR 4/8) and few faint reddish yellow (YR 6/8) mottles; weak thin to medium platy structure; firm; slightly sticky when wet; no roots seen; discontinuous clay coatings present.
61-122	Same, with common faint reddish-yellow (5YR 6/8) mottles ending abruptly on hard limestone with wavy surface.

Red Sand Association:

Site and soil characteristics. The soil pit is located at Lancester. The distribution of these soils is confined to a narrow strip, along the Leeward coast on parent material, consisting of beach sand of calcareous and silicious origins. The derived soils are clearly delimited from soils over coral by their very sandy texture. The red sands may overlie coral at a depth of a few meters but polysols are common. The texture becomes lighter with depth and the tilth is usually very fine after recent cultivation. Angular blocky structure is common; the soil cakes on the surface and is very hard when dry.

Free CaCO3 is generally absent; CEC varies between 10 to 15m. e./100 gm soil; exchangeable K is low but available and may be high. The clay mineralogy consists of kaolinite and montmorillonite with some mica. (Table 2).

The particle size distribution and chemical properties are shown in Table 1.

TABLE 1

PARTICLE – SIZE AND CHEMICAL ANALYSES

Particle-size analyses					Chemical analyses										
Depth	CsSand 2-0.2 mm	F.Sand 0.2-0.05mm	Silt 0.05 0.002mm	Clay 0.002mm	pH	$CaCO_3$	CEC	TEB	Ca	Mg	K	Na	C	N	C/N
cm	%	%	%	%		%	St. John's Ass'n		me/100g				%	%	
0-15	3	7	10	79	7.3	1.3	23.8	29.7	30.5	3.3	0.28	1.24	2.1	0.21	10.0
15-30	3	7	8	83	7.9	1.6	20.8	26.0	23.7	3.7	0.15	1.08	1.7	0.16	10.6
30-60	1	10	8	83	7.7	0.3	14.5	13.3	16.5	0.7	0.15	0.57	–	–	–
60-90	1	4	8	90	7.7	Tr	16.7	18.0	19.3	3.0	0.09	0.35	–	–	–
90-150	1	4	6	91	7.1	Tr	17.3	18.4	19.5	2.9	0.09	0.46	–	–	–
							Yellow Brown Ass'n								
0-15	3	10	12	79	7.6	0.9	24.9	26.8	27.6	3.7	0.15	0.81	2.5	0.23	10.9
15-30	2	7	12	81	8.0	2.8	22.9	24.9	23.5	5.3	0.17	1.49	1.9	0.18	10.6
30-60	0	2	6	96	8.0	0.5	19.1	18.5	20.0	2.5	0.16	0.76	–	–	–
60-90	0	1	2	99	7.5	0.3	20.0	18.1	19.1	2.0	0.12	0.84	–	–	–
							Grey Brown Ass'n								
0-15	10	4	31	55	8.0	20.5	34.9	nd	nd	6.9	0.11	0.78	1.6	0.17	9.1
15-30	13	2	26	59	8.1	22.4	36.0	nd	nd	6.9	0.10	0.86	1.2	0.15	7.9
30-45	10	4	39	47	8.0	18.6	45.0	nd	nd	6.0	0.12	0.95	1.1	0.14	7.8
							Black Soil								
0-15	12	18	5	66	7.0	0	44.2	47.5	45.0	2.3	0.17	1.22	1.5	0.10	15.0
15-30	10	18	7	71	7.1	0.3	41.2	40.8	38.3	1.2	0.11	1.40	1.2	0.08	15.0
30-60	10	15	7	74	7.0	0.4	39.4	41.0	37.4	2.1	0.11	1.70	–	–	–
60-75	7	10	5	82	7.4	0.8	43.3	45.6	40.1	2.8	0.12	2.01	–	–	–
							St. George's Valley								
0-15	5	10	12	73	7.7	7.5	36.2	39.3	42.8	4.7	0.14	3.86	1.3	0.12	10.8
15-30	6	10	12	75	8.1	8.8	34.6	39.5	46.3	5.2	0.12	3.62	1.3	0.11	11.8
30-60	6	12	12	71	7.9	8.0	35.6	36.6	45.7	4.9	0.12	3.69	–	–	–
60-90	1	3	8	93	7.8	0.9	36.9	38.1	38.4	4.3	0.12	3.34	–	–	–
90-120	0	4	7	90	7.5	0	36.8	38.5	38.3	4.5	0.13	3.43	–	–	–
							St. Philip Plain								
0-15	6	9	8	80	7.6	9.5	69.0	69.8	70.6	9.5	0.60	4.10	1.3	0.11	11.8
15-30	8	9	11	74	7.7	12.3	67.1	68.4	69.1	10.8	0.65	4.00	1.5	0.13	11.5
30-75	3	6	9	84	7.7	4.4	66.8	70.2	67.7	11.3	0.66	4.39	–	–	–
75-90	10	4	9	79	8.0	4.2	68.2	69.4	69.4	13.3	0.72	6.24	–	–	–
90-120	2	5	6	89	7.8	1.4	61.2	71.5	70.3	10.9	0.60	5.77	–	–	–

TABLE 2

CLAY MINERALOGY OF SURFACE HORISONS (0-15 cm)
(VALUES EXPRESSION ON OVEN-DRY BASIS)

Soil Association	Amorphous SiO_2	Amorphous Al_2O_3	Kaolinite	Montmorillonite	Fe_2O_3*
	%	%	%	%	%
St. John's Valley	9.8	4.1	58	20	7.51
Yellow Brown	9.9	5.8	43	30	11.09
Yellow Brown – R+	6.8	5.5	45	34	7.88
Grey Brown	12	4.8	37	42	4.01
Black Soil	15	5.8	29	48	2.26
Black Soil – R+	13	3.6	26	51	6.44
St. George's Valley	4.2	2.8	42	48	3.25
St. Philip Plain	18	3.0	25	52	1.55

*Extractable by citrate-dithionite.

Soil Profile Description:

Depth cm	Description
0-12	Dark brown (10YR 3/3, moist); fine sandy loam; weak fine to medium subangular blocky structure, breaking to granular; loose to friable, very slightly plastic, almost non-sticky consistence; gradual, slightly wavy boundary to:
12-67	Dark brown (7.5YR 4/4, moist), passing to red-brown (5YR 4/4, moist); fine sandy loam passing to loamy fine sand; virtually structureless at 15 inches; firm non-sticky, almost non-plastic consistence; diffuse, smooth boundary to:
17-87	Red (2.5YR 4/8, moist); fine sand; structureless; firm non-sticky, non-plastic consistence; abrupt, wavy boundary to:
At 87	Hard, blocky coral.

SCOTLAND DISTRICT

The soils of the Scotland District are quite unlike those of the coral regions of Barbados. Most of the soils are immature because of rejuvenation by accelerated erosion. Landslips result from spring water which lubricates slip planes between pervious and underlying impervious strata. The slip planes are often deep, and trees, crops, houses, bridges and roads are frequently destroyed. Landslips have been prevented by using subterranean pipes to drain spring water away from unstable areas (MARTIN–KAYE and BADCOCK, 1962; and CUMBERBATCH, 1966a). Further erosion is prevented by land moving (reshaping) operations to reduce slope gradients, fill ravines and prepare rough terrain for mechanical cultivation.

Slumping results from the toe erosion of swift flowing streams which undercut steep V-shaped slopes. Small earth dams have been used successfully to prevent slumping.

The areas with high concentrations of oil and sodium salts have remained uncultivated and even bare of natural vegetation for years. In addition, the bulldozers spread contaminated soil during land reshaping, and some potentially good agricultural land has been ruined. The oil and salt are widely distributed in the clay and sand strata.

Overstocking has denuded slopes, leading to sheet erosion and gullying, and exposure of infertile subsoil.

The problems have resulted in the loss of valuable land and this must be stopped. KON (1964) calculated that 70 percent of the Scotland District was threatened by erosion, and that 11 percent of the area had already reached a very severe stage of degradation. The present writer estimates that only 60 percent of the 15000 acres comprising the Scotland District is effectively cultivated today. The population density in Barbados is among the highest in the world (ANON., 1965), and reclamation even though expensive, is essential.

The Soil Conservation Board is reforming and draining steep, eroded land in the Scotland District. Ripping by heavy tractors, however, brings oil-impregnated and salt-rich subsoil to the surface and it is difficult to retain any topsoil on these strongly eroded slopes. The raw subsoils exposed by the reforming operations may be almost sterile because of low nutrient levels, poor structure or high levels of free lime. Considerable efforts and special techniques are required for restoring fertility. These reformed soils are not further described, but, with the limitations already mentioned, may be regarded as generally similar to normal soils from the same parent material developing on a stable site.

The following are the main mapping units:

(1) Soils from the Joes River Muds. Soils developing from Joes River Muds are uniformly dark coloured sandy clays of mixed mineralogy. Their drainage is imperfect and they typically cover steep eroded slopes.

The Joes River muds range from dark grey sandy and argillaceous silts, to silty and sandy clays including angular and subangular pebbles, fragments and boulders of dark brown to black tar sand and other sandstones. There are also smaller, rounded clay pebbles, fragments of clay, ironstone and fibrous calcite. The formation is impregnated with oil.

The soil has pH values of slightly over 7 with CEC of 20 to 30 m. r. e./100 gm, Ca being the major exchangeable cation. The clay mineralogy consists of montmorillonite, illite and kaolinite in 2: 2; 1 ratio.

Soil Profile Description:

Depth cm	*Description*
0-15	Very dark grey-brown (2.5Y 3/2, moist); sandy clay loam; weak to moderate fine to medium subangular blocky structure; friable, slightly plastic, slightly sticky consistence; gradual, slightly wavy boundary to:
15-45	Dark grey-brown (2.5Y 4/2 moist), mottled with olive brown; sandy clay; moderate medium subangular blocky structure; firm, slightly plastic, slightly sticky consistence; diffuse, slightly wavy boundary to:
45-102	Dark grey brown (2.5Y 4/2, moist), with varying colours due to weathering rock fragments, stony sandy clay; structureless; very firm, slightly sticky, slightly plastic consistence.

(2) Scotland Sandstones

Upper Scotland Formation.

The Scotland Sands are very soft, friable sandstones. They consist of a vari-coloured banded and laminated sandstone and siltstone sequence with a grey silty claystone. There are occasional beds and lenses of calcareous sandstone and sandy limestone. One member is largely composed of poorly sorted grits and conglomerates.

Soils developed from the base deficient weakly coherent sandstone are acid and light textured. The profile is shallow and poorly structured. Texture is very variable due to the graded nature of the beds and the very rapid alteration of strata with very different grain sizes. There is probably as much variation within beds as between them.

Where contaminated with coral calluvium the pH values are above 7.0, otherwise the soils are slightly acid; CEC is of the order of 10 to 15m. e./100 gm soil with Ca being the dominant exchangeable cation. The clay mineralogy consists of 50 percent montmorillonite, 30 percent illite and 20 percent kaolinite.

Soil Profile Description:

Depth cm	*Description*
0-10	Brown (10YR 5/3, moist); fine sandy loam, weak to moderate fine angular blocky structure; friable, very slightly sticky, non-plastic consistence; gradual, smooth boundary to:
10-45	Brown (10YR 5/3, moist); fine sandy loam; moderate to strong medium and coarse angular blocky structure; firm non-plastic, non-sticky consistence; clear, slightly wavy boundary to:
At 45	An intimate mixture of horizon II material with powdery fragments of weathering white sandstone.

(3) Scotland Clays

Lower Scotland Beds.

The Scotland Clays consist mostly of evenly bedded and regularly laminated silty and shaley claystones ranging in colour from dark grey to olive brown. Nodules and thin beds of clay ironstone are relatively common. There are streaks and thin beds of fine sandstone and siltstone and a few thicker and coarser sandstones. Ferruginous limestone occur in lenses.

Soils formed from Scotland Clays are greyish silty clays of mixed mineralogy. They are poorly drained and easily eroded. Colours tend to vary widely in the sub-soil wherever weathering parent material begins to appear. The subsoil may contain many black and reddish-brown concretions. Textures may occasionally be fine sandy instead of silty. The structural grade is usually weaker and finer after recent cultivation. pH values are slightly above 7 with small quantities of $CaCO_3$ being present in some profiles. CEC is around 40 m.e./100gm; exchangeable Ca and K are usually high. The mineralogy consists of montmorillonite, illite and kaolinite in about equal amounts.

Soil Profile Description:

Depth cm	*Description*
0-10	Brown (10YR 5/3, moist); silty clay; moderate medium angular blocky structure; friable, slightly sticky, slightly plastic consistence; gradual, slightly wavy boundary to:
10-32	Almost concolorous grey-brown (2.5Y 5/2, moist); silty clay, moderate to strong medium and coarse angular blocky structure; firm to friable, slightly sticky, plastic consistence; gradual, slightly wavy boundary to:
32-55	Grey brown (2.5Y 5/3, moist), mottled with light olive brown; silty clay loam; poor prismatic structure – almost structureless; firm, sticky, plastic consistence; gradual, slightly wavy boundary to:
55-120	Olive grey (5Y 5/2, moist), intermottled with light olive brown and brown in a mosaic pattern; silty clay

Depth	Description
	loam; structureless; very firm plastic, slightly sticky consistence.

(4) Soils from the Oceanic Formation

The Oceanic Formation includes a great diversity of geological materials. A distinction could be made, however, between soils developed over calcareous globerigina marls and siliceous radiolarian earth. Four sub-groups can be recognised as follows:—

(a) The grey-brown sub-group: grey, medium textured soils with a high $CaCO_3$ content derived from the oceanic marls; soil neutral to weakly alkaline in reaction.

(b) The brown sub-group: moderately weathered and leached slightly calcareous silty clay soils over-lying Oceanic marl.

(c) The red-brown sub-group: More strongly leached clay soils resembling the Red-Brown Association of the coral derived soils. Their parent materials are clay beds within the Oceanic Formation, presumably of volcanic formation. The sub-group is confined to relatively flat areas immediately above or below the Scotland District escarpment.

(d) The Bissex Hill sub-group: Light textured yellowish soils from the sandy Bissex Hill marl. The soils of the Oceanic Formation have very variable clay mineralogy.

(5) Alluvial Soils

The alluvial soils of the Scotland District can be classified on the basis of the materials from which they are derived as follows:—

Mapping Unit	171	From Joes River Mud
Mapping Unit	172	From Scotland Sandstones

Mapping Unit	173	Finer-grained variant of Unit 172
,, ,,	174	From Lower Scotland Formation
,, ,,	175	Gleyed variant of Unit 174.

Unit 171 derived from Joes River Muds is variable in texture and uniformly dark in colour. It has better structure and moisture retention than the other sandy alluvial soils. The soil is deep and virtually stone-free.

Unit 172 is a relatively coarse – textured sandy alluvial soil. A profile description of this Unit is as follows:–

Depth cm	*Description*
0-12	Brown(10YR 4/3); loamy fine sand; weak to moderate fine medium angular blocky structure; friable, non-plastic, non-sticky consistence; gradual, smooth boundary to:
12-55	Yellowish-brown (10YR 5/4, moist); predominantly fine sand; single grain structure; compact, non-plastic, non-sticky consistence; clear, slightly wavy boundary to:
55-110	Brown (10YR 5/3, moist): medium and coarse sand; single grain structure; loose, non-plastic, non-sticky consistence.

Unit 173 is derived from Lower Scotland Formation. Drainage is free but not excessive and it has better surface structure and moisture supplying capacity than Unit 172.

Unit 174 is sandy although predominantly derived from the fine textured Lower Scotland Formation. The top-soil is commonly a fine sandy loam or silty loam with weak blocky structure. The sub-surface horizons are poor or loose and subsoil packing may occur. Traces of gleying may appear at about 60 cm depth.

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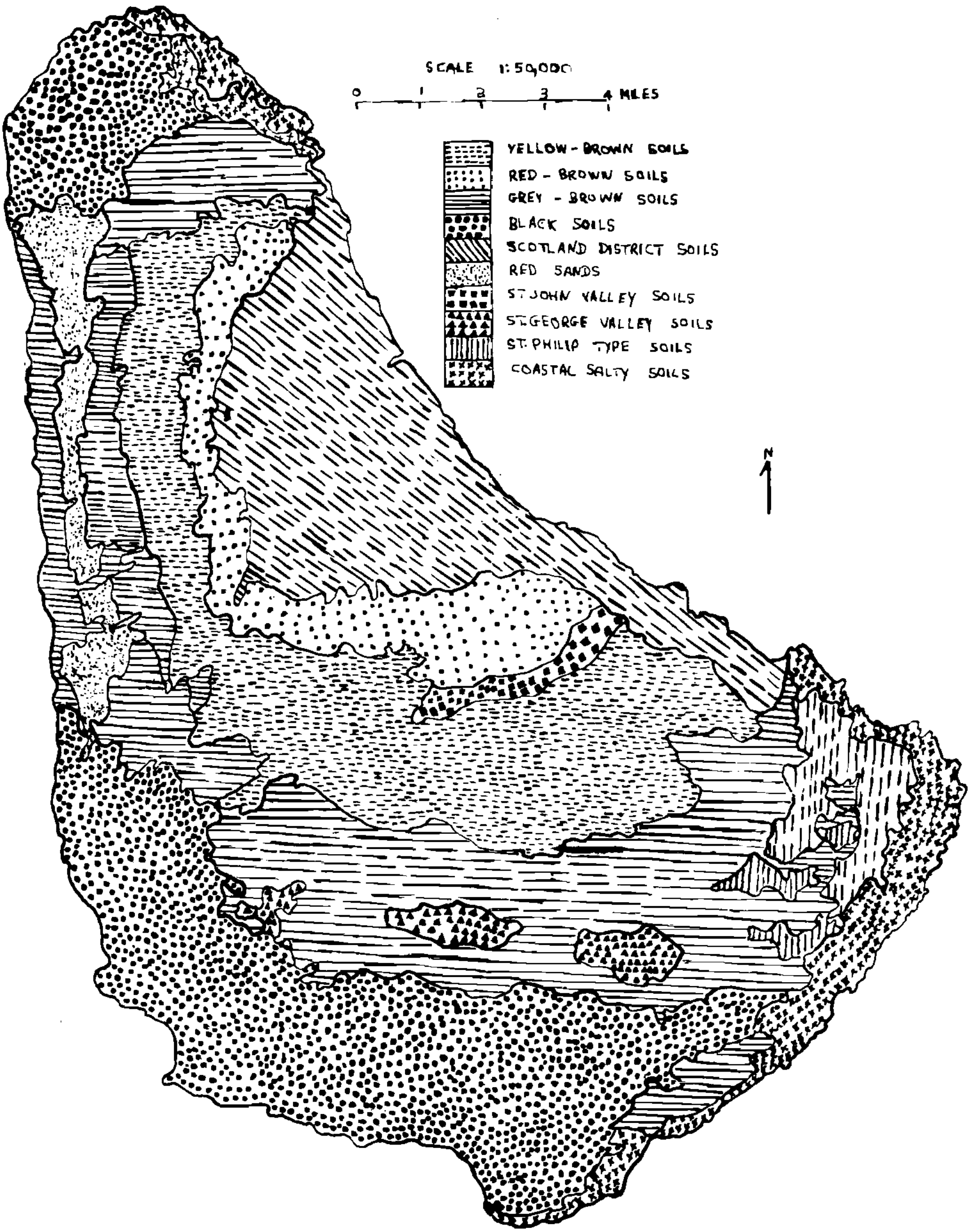
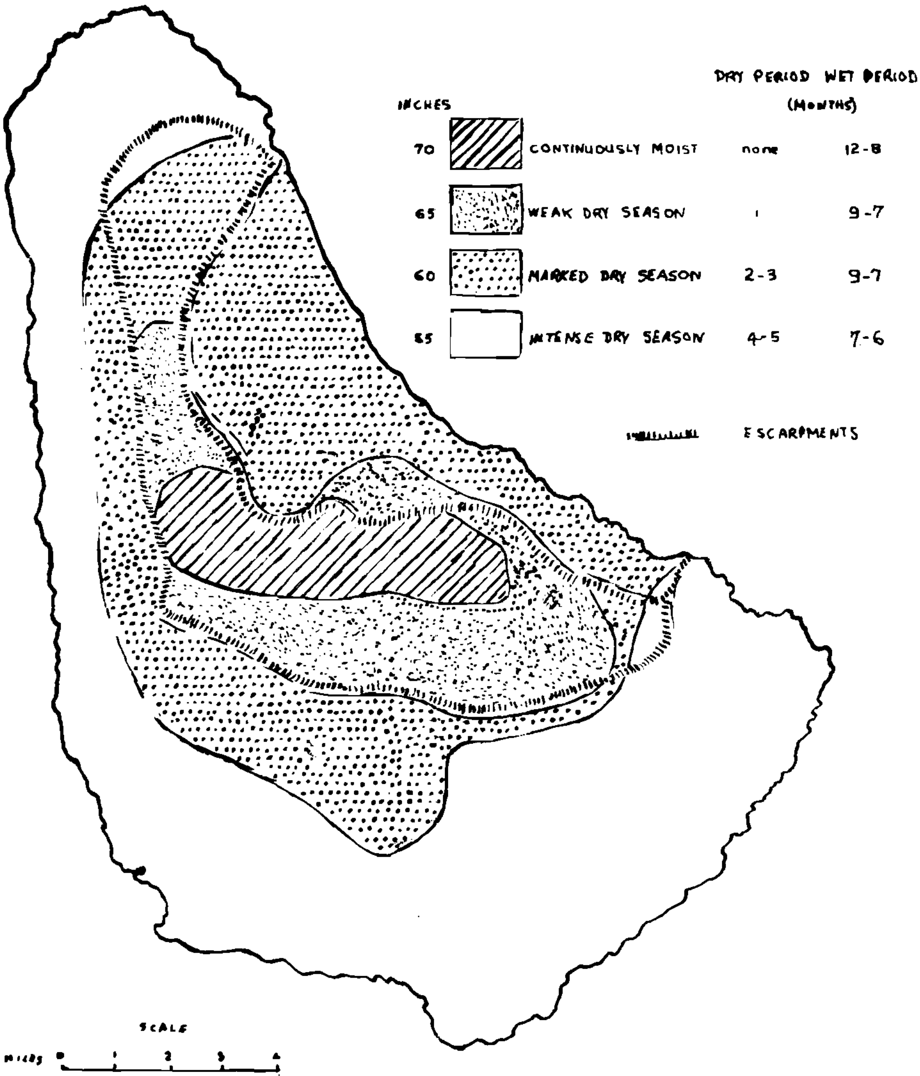

SCALE 1:50,000
0 1 2 3 4 MILES
YELLOW-BROWN SOILS
RED-BROWN SOILS
GREY-BROWN SOILS
BLACK SOILS
SCOTLAND DISTRICT SOILS
RED SANDS
ST JOHN VALLEY SOILS
ST GEORGE VALLEY SOILS
ST. PHILIP TYPE SOILS
COASTAL SALTY SOILS
N


DRY PERIOD WET PERIOD
(MONTHS)
INCHES
70 CONTINUOUSLY MOIST none 12-8
65 WEAK DRY SEASON 1 9-7
60 MARKED DRY SEASON 2-3 9-7
55 INTENSE DRY SEASON 4-5 7-6
ESCARPMENTS
SCALE
MILES 0 1 2 3 4