CARIBBEAN FOOD CORPS SOCIETY

Annual Meeting
Georgetown, Guyana
1971

PUBLISHED WITH THE COOPERATION

OF THE

UNIVERSITY OF PUERTO RICO

MAYAGUEZ CAMPUS

1980

VOLUME IX

SOIL RESOURCES OF GUYANA

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INTRODUCTION

Guyana is located in the northern coast of South America between 1°10' and 8°32' north latitude, and between 56°31' and 61°20' degrees west longitude and has an area of about 83,000 square miles. Major physiographic divisions are the coastal plain, the interior alluvial plains, the gently sloping sandy plateaus and plains, the hilly or rolling uplands of crystalline rocks, and the mountains and high plateaus.

The nearly level coastal plain makes up about 9 percent of the country, and the nearly level interior flood plains about 8 percent. Sandy or gravelly, gently sloping plateaus and plains make up about 25 percent; hilly or rolling areas with loamy soils, some of them rocky, 34 percent; and mountains or high rocky plateaus, 17 percent. Not accounted for in this list is about 7 percent of the country, the parts not yet covered by aerial photographs when these calculations were made.

Average annual rainfall near the coast ranges from 74 to 115 inches (6). In much of the interior the annual average is within these same limits, but is reported to be only 55 inches at Orinduik on the Brazil border south of the Pakaraima Mountains, and more than 150 inches at Mahdia on the northeastern edge of the mountains. In most part of the country there are two rainy seasons, May through July, and November through January; and dry seasons in the other months. In the southwest, however, 60 to 80 percent of the annual rain falls in one rainy

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season from May through August; and at Mahdia there is no true dry season. The average annual temperature is near 80 degrees Farenheit. Actual temperature at Georgetown 1889-1955, ranged from an extreme low of 72 degrees to an extreme high of not quite 90 degrees.

Types of vegetation cover a wide range. Several types of herbaceous marshes and of swamp forests occupy the coastal plain and the interior lowlands. Part of the coastal plain in cultivated and part was formerly cultivated. Tropical rain forest covers much of the hilly and rolling areas. Evergreen seasonal forest, dry evergreen forest, and xeromorphic scrub vegetation cover much of the sandy gravelly, gently sloping plateaus and plains. Montane forest, seasonal forest and dry evergreen forest are in many of the mountain areas (9).

Tropical savannahs occupy parts of the gently sloping sandy soils in the northeast near the Berbice River, parts of the Interior lowlands and of the gently sloping sandy or gravelly soils of the southwest, and the southwestern edge of the Pakaraima Mountains. The types of vegetation were described in detail by Fanshawe (9), and much more briefly by Braun, Derting and Suggett (3).

The general map of soil associations was abstracted and generalised from the reconnaissance soil survey maps made in 1961-64 and especially from the one by Braun, Derting and Suggett (3). The approximate area of each soil association shown on the map is given in table 1. More detailed data on the acreage of 10 groups of soils in the two parts of the coastal plain are in tables 2 and 3. Table 2 was derived from semi-detailed soil surveys of about three fifths of the area covered, and from the reconnaissance soil survey of the remainder. Table 3 was derived from the reconnaissance soil survey. In these two tables the soils have been grouped into Land Capability Classes and Sub-classes.

Physical and chemical data for 10 extensive soils, representing 7 of the general soil associations are given in table 4. Six of these associations

contain most of the land likely to be significant in agriculture for some time, except the southwestern savannahs. Those savannahs, which are in associations 5, 8, and 12, are already used for extensive grazing and have further potential for production of livestock.

COASTAL PLAIN

The coastal plain and adjacent alluvial areas, shown as associations 1, 2, 3, and 4 on the map, make up 4,613,000 acres or 7,200 square miles, about 8.7 percent of the country. Nearly all the people of the country live in the eastern part of this coastal strip, most of them between the Essequibo and the Corentyne rivers, and nearly all farming is done there. Sugar is grown on 120,000 to 126,000 acres, nearly all in large, well managed estates. Rice is grown on about 279,000 acres, mostly in farms of 10 to 15 acres, although a few farms are larger. Approximately 400,000 acres more of the coastal plain are used for pasture.

Association 1, wet clay soils, contains the soils near the coast that consist of marine sediments and are commonly called "frontland". They are nearly level, and except on the sandy or loamy ridges they are naturally wet and must be drained before they can be cultivated. Most of the soils are in capability class I, subject to few limitations.

Native vegetation in most places was water-tolerant forest; in some places it was herbaceous or grass- like marsh plants. The soils mapped were classified in 19 soil series. Most of them are Aquic Haplorthents in the new classification, or Low Humic Gley soils in the classification of 1938. Analytical data for Corentyne clay, a soft, gleyed, somewhat salina soil, are given in table 4. The two deepest horizons of this soil listed in table 4 contained 1400 and 1500 parts per million, respectively, of soluble salts.

Most of the soils in Association 1 make good farm land if they can be drained and protected from floods. The cost of drainage and of sea defense is high everywhere, and has been described as prohibitive in some places where the strip of good soil to be protected is narrow. Sugar cane and rice are commonly irrigated. Yields of rice could be improved on many farms by good management practices which include water control and use of fertilizer.

About 173,000 acres, mostly on margins of the peat swamps, contain toxic sulphides that are oxidized to acid sulphates if the land is drained. The limitations of these toxic soils need to be considered in any plan for development.

Association 2 consists of wet or moderately we silty soils or clay soils in the coastal plain and adjacent alluvial plains along the rivers. These have been called "riverain" soils. They lie in large areas back of the marine frontlands between the Berbice and the Corentyne Rivers, and also on natural levees along the lower courses of the large rivers. They are nearly level; they lie slightly higher than the "frontlands", and can be drained more easily. They are dominantly in capability subclass. If, fairly easy to drain and cultivate but low in fertility. The soils mapped were classified in 17 series. The most extensive soils are Typic Ochraquults; they are mostly Low Humic Gley and some Humic Gley Soils.

Soils of Association 2 occur on natural levees along the rivers and were used for many of the early plantations. Nearly all of those plantations were later abandoned, probably in part because the systems of farming did not maintain soil fertility. Although chemical properties of the soils are somewhat variable, most of the soils have lower base-exchange capacity and a much lower content of extractable bases than the wet clay soils of Association 1. Analytical data for one profile of De Velde silt loam are given in table 4. With proper drainage, fertilizer, and good management the soils can be made productive for a wide variety of crops.

Association 3 consists of peat or much soils in swamps and marshes. The areas of organic soils lie aback of the frontland clays. They are low and difficult to drain; and are in capability subclass IIIm, severely limited for farming. Native vegetation is mostly swamp forest, but in some places is fresh-water marsh. The peat is locally called "pegasse". Drained peat or muck soils, as a rule, have a low content of plant nutrients; a few contain soluble salts. In many places toxic sulphates, aluminium, or both, are present in the peat or muck or in the underlying clays. Fire often lowers the land surface, and leaves toxic amounts of aluminium. Many crops can be grown if the management is intensive enough although some require large amounts of lime and fertilizer. Flood-fallowing with salt water helps make some of the toxic soils suitable for crops. Because of their limitations and the difficulties of management, the peat and muck soils have low capability for large-scale developments of farm land. Some successful farms have been established. Many of the peat swamps are needed and are already used for water conservancies, to provide water for irrigation and for domestic and industrial uses.

Association 4, dominated by gently sloping silty soils, is a transition between the coastal plain and the gently sloping sandy plateau and plains. The association lies in several separate areas along the inner margin of the coastal plain in the northeastern section. Slopes, as a rule, range from nearly level to 2 or 3 percent, but in some places are as much as 5 percent. The dominant capability subclass is IIf, moderately limited by low fertility. Soil materials are dominantly silty water-laid terraces of the Coropina geological formation, which is described as of late Pleistocene age. Native vegetation is partly savannah of coarse grasses and some shrubs, and partly evergreen tropical forest. The soils were classified in II series. The most extensive soils, which are slightly or gently sloping, are Oxic Ochraquults and Ochric Plinthaquults. In terms of

great soil groups, they are Ground-Water Laterites and Low Humic Gley soils, and intergrades between these and other great groups. The moderately well drained soils are Plinithic Normudults; and are also classified as Red-Yellow-Podzolic soils, some grading toward Ground-Water Laterites. The savannahs in this section are used for grazing; very little of the forest has been cleared. Crops probably can be grown if they are fertilized heavily and managed well; the nearly level soils will need surface drains to remove water, and some of them might even then be too wet in the rainy seasons.

Table 4 shows that a representative soil, one that is somewhat poorly or poorly drained, has a high content of silt and low content of extractable bases, nitrogen, and phosphorus.

Areas of Association 4 shown on the map include some places, between and around the peat swamps, in which the silty soils occur as low silty islands surrounded by wet clays, some of which contain toxic sulphates. The acreage of these silty soils actually available for farming is therefore somewhat less than the amount shown in table 2.

INTERIOR FLOOD PLAINS AND LOW LANDS

Association 5 consists of the soils on interior flood plains and other lowlands. The largest areas form a nearly continuous belt that includes part of the savannahs north of the Kanuku Mountains, lies on both sides of the Lower Rupununi River, and extends from the mouth of the Rupununi in a broad plain southeastward to the Corentyne River. Smaller areas are long the Burro-Burro River, along the upper parts of several large rivers, and in basins of the Pakaraima Plateau. Most of these soils are subject to flooding, some for three months or more each year, capability class III, severely limited for crops. These soils are nearly level of gently sloping. Vegetation is partly savannah

and partly luxuriant rain forest. Extensive soils are Aquic Haplorthents (Alluvial soils). Ochric Plinthaquults (Ground Water Laterite soils), and some Typic Thermoquods (Ground Water Podzols). Soils of other great groups are present.

The savannahs furnish grazing for several months each year after the floods-subside. Some farming might be done in places that are above the level of flood waters, but soil fertility is low. Some of the soils are extremely sandy or gravelly, and they are not suitable for any cultivation.

GENTLY SLOPING SANDY PLATEAUS AND PLAINS

Two associations in this group are dominated by sandy soils. The third association has in it a variety of soils that contain ironstone gravel or boulders.

Association 6 consists of deep, white sand. Geologically it corresponds to the Berbice Formation. Large areas lie just south of the coastal plain the northeastern section of the country, and scattered areas are elsewhere. Slopes are mostly gentle, but some on the sides of valleys are steeper than 15 percent. Vegetation is mostly dry evergreen forest or the xeromophic shrub type. Analysis of a representative soil showed 97 or 98 percent white quartz sand and no clay to a depth of 34 inches, and no extractable calcium, magnesium, or potassium. These soils are Typic Quartzipsamments, and members or the great soil group of Regosols. The white sand has little potential for cultivation, (capability class IV), although some crops could be grown in well-watered places if all the plant nutrients were supplied. Some sites have stands of greenheart, wallaba, and other commercial timber trees; and Caribbean pine is growing well in plantings near Bartica. The 6500 square miles of this association, and the areas of white sand in association 7, will furnish some wood products and can be used as extensive parks and wild life refuges, but are not suitable for farming.

Association 7, brown sandy soils, contains large areas of gently sloping sands, loamy sands, or sandy loams. Important areas lie between Ituni and Orealla, and large but discontinuos bodies extend southward from that vicinity nearly to the southern border of the country more than 250 miles away.

Soils were classified in 16 series. The deep, brown sands are classified as Ultic Quartipsamments (Regosols). The soils that contain some clay in the subsoil are Psammentic Udorthox (Red-Yellow-Latosols) or Oxic Normudults (Red-Yellow Podzolic soils). Native vegetation is partly savannah grasses with extremely low potential for grazing, but mostly evergreen seasonal forest and rain forest. In the savannah areas, trees grow along drainageways and in wet places, where the soils are dark coloured, seasonally wet Aquipsamments, Ochraquults, and Umbraquults (Low Humic Gley and Humic Gley soils). The well-drained brown soils that are not too sandy have good physical properties, good water holding capacities and if fertilized heavily will produce many annual crops and tree crops, and pastures of high carrying capacity, capability class II and III.

Analytical data for Kasarama loamy sand are given in table 4. Control of runoff and of erosion are essential, even though many of the slopes are less than 3 percent. Slopes are long, and erosion takes place if water runs downhill in any unprotected channel. The brown loamy soils of this association appear to have good potential for agricultural developments; but settlers must learn to live and overcome the limitations of poor, erodible soils and erratic rainfall. Plant nutrients must be supplied in fertilizer, and mulching and other practices must be followed to conserve the nutrients and hold moisture.

Association 8 is dominated by very sandy or very gravelly soils that are mostly gently or moderately sloping, but are strongly sloping or steep in some places. The largest areas are in the southern part of the country; smaller areas

adjoin the laterite-capped mountains and hills in the north-central part, and lie in scattered locations within the Pakaraima Mountains. The dominant soils are sandy or gravelly; skeletal Typic Haplorthents, Typic Udorthox, and Ochric Plinthaquults are present. Great soil groups are Regosols, laterite gravelly phases, Red and Yellow Latosols, and Ground-Water Laterite soils. Vegetation is part forest and part savannah. Savannah areas of the sandy or gravelly soils furnish grazing of poor yield and quality. The Red-Yellow Latosols and Ground-Water laterite soils, if not too steep, can be improved with fertilizer for the growing of crops or pastures. They are in capability class III, severely limited for crops. Some shifting cultivation is practiced, mostly on edges of the forest near the savannah.

HILLY OR ROLLING SOILS

Three associations of hilly or rolling soils make up about 34 percent of the country. Bedrock in these areas is mostly igneous ormetamorphic rocks, consisting of granitic rocks, ridges and mountains of dark coloured basic rocks, and a considerable area of weathered phyllite, schist, mudstone, or other fine-grained, foliated rocks. Slopes are mostly hilly or rolling, with some steep hills and mountains. Elevations range from sea level to 1,000 feet, with a few higher ridges. Crusts, boulders, and gravel of ironstone are prominent wherever the original rock contained much iron, but generally not in the areas of acidic rocks. The original rocks have been deeply weathered, and the soils are acid and low in plant nutrients. In many places the rocks or the soil materials derived from them apparently were covered with the sands and some interbedded clays of the White Sands Formation, and then were re-exposed in a later cycle or geological erosion.

Areas of white sand remain on many of the tablelands between streams, especially in a strip 40 or 50 miles wide, west of the Essequibo River and north of the Potaro River.

Association 9 contains hilly or rolling loamy soils and clay soil, on deeply weathered, mostly light coloured, acidic rocks; many granites and gneisses, and some fine-grained, foliated rocks. Dominant soils probably are Typic or Oxic Normudults, also classified as Red-Yellow Podzolic soils and Red-Yellow Latosols. Most of the soils are very low in plant nutrients. Dominant capability classes are II, severely limited, depending on the slope. Some contain a small amount of calcium, but all are acid and require fertilizer, lime, and careful management if crops are grown. Analytical data for two soils are given in table 4. Slopes range from gentle to very steep. The soils are erodible, and control of runoff and erosion are essential wherever land is cleared for cultivation. This association is the dominant one in the northwestern section, north of the Pakaraima Mountains. It probably contains at least 3,000,000 acres of soils that have gentle or moderate slopes and can be cultivated with proper management. Slopes too steep for cultivated crops or even for tree crops are mingled with the favourable soils, and careful planning of any proposed farm land, therefore, is essential.

In association 10 are hilly, reddish clay soils that contain ironstone boulders or gravel. These soils generally are on ridges or mountains of dark-coloured, basic rocks. They are scattered throughout the northwestern and central parts of the country, and in the Pakaraima Mountain section. A small but significant area is located along the northern boundary of the Kanuky Mountains in the southwest. Native vegetation is mostly tropical forest. Dominant soils are Oxic or possibly Typic Rhodudults; in terms of great soil groups, Reddish-Brown Lateritic soils. Soil texture, of the material finer than gravel, is generally clay. The amount of laterite gravel ranges from little or none to 75% or more of the soil mass. Soils that contain more than 70% laterite gravel are classified as Regosols, laterite gravelly phases, and probably as a clayey skeletal family of Typic Haplorthents. Stones and boulders of hard laterite or of dark-coloured igneous

rocks, or both, are common in many of the areas. Steep and rocky soils are common. The moderate slopes that are not too rocky are in capability class II moderately limited, or Class III severely limited or class IV very severely limited for crops.

Most of the soils have been highly leached, and when analysed contain few or no more plant nutrients than the soils of association 9. In some parts of the Pakaraima Mountains and near the Kanuku Mountains, however, these soils contain a significant amount of exchangeable calcium and are less acid than the usual soils of the uplands. These few soils of relatively high base status are the most fertile soils of the Interior, but they are steep and rocky, and they are located far from present markets or sources of fertilizer. The more extensive, more acid, low-base soils of this association produce good fruits of many kinds, but they are too steep and rocky to permit much cultivation except by hand methods. Fertilizer, lime and management to control erosion are needed to maintain production of crops with acceptable yields and quality.

Association II consists of steep or shallow soils of low fertility. They make up a large part of the southeastern tip of the country. Soils are chiefly steep, shallow, or gravelly Red-Yellow Latosols, probably Inceptic or Lithic Udorthox, and Lithosols on granite, gneiss, or schist. These soils belong to Land Capability Class III severely limited, Class IV very severely limited. Vegetation is high forest, with undergrowth thick on the fine-textured soils and more sparse on the gravelly or the shallow soils. These soils have not been cultivated, they are infertile, and have little capability for farming.

SHALLOW OR ROCKY SOILS OF MOUNTAINS

Association 12 consists of steep, shallow, or rocky soils of the mountains and high plateaus; mostly land capability class IV. The main areas are the

Pakaraima Mountains and Plateau in the West-central part of the country, the Kanuku Mountains in the southwest and small mountains in the southern and central parts. Major soils are Lithosols, probably Lithic Dystrochrepts. The most extensive kind of bedrock in the Pakaraima Plateau is thick, white sandstone of the Roraima formation. The Kanuku Mountains are mostly granite and gneiss, with some intrusive basic rocks. Vegetation on these soils is variable, and probably depends greatly on the supply of moisture. Rain forest (in Fanshawe's terminology), and savannah are some of the main types. The areas have low potential for farming, but might yield timber and other wood products. when transportation becomes available. The savannahs are suitable for extensive grazing.

The best soils of the coastal plain are limited by the need for expensive drainage. All soils of the country, and especially those of the Interior, must have fertilizer.if crops are to be grown on the same land for several years, most of them must have lime, also. Irrigation is needed for some crops, but the amount of water is limited and the cost of irrigation is high. As a result, many farmers must produce the crops that can be grown with natural rainfall. This demands careful timing of work, expert water conservation on all the sloping soils, and the risk that some crops will fail. These climatic hazards are not unique to this country, but are faced in one way or another by farmers in every part of the world.

Further development of farming is possible and is practically certain to take place in soil association 1, 2, 4, 7, 9 and 10. Developments in the other six soil associations will of necessity be restricted to those situations in which high inputs are practicable to overcome the natural limitations and minimize the risk of failure. Association 6 is unsuited for commercial farming. A few successful farms are operated on the peat or muck soils of association 3, by persons who can afford the level of management that is required and the risk that

must be taken. Land settlements and co-operative development projects are expected on associations 5, 8, 11 and 12 with the completion of the proposed hinterland road connecting the Coastlands to Brazil.

Savannahs of associations 5, 8, and 11 furnish significant grazing, and can be maintained and improved through range management that encourages the good forage plants. Forested areas of these associations should not be considered for farming developments, but might furnish timber when transportation becomes available.

Great possibilities exist for increased production of crops and livestock in the coastal plain. Tables 1 and 2 suggest that as many as 1,000,000 acres of good or fairly good soil might be available for farming. These soils need drainage and flood control, and water might not be available to irrigate all the acreage. Cost of development, even for main drains and minimum flood control, will be substantial. The technology of producing crops on the nearly level, naturally wet or somewhat wet soils is fairly well understood by many people, but enormous improvements are still needed in use of fertilizers, in cultural practices, and in choice of high quality seed or planting stock for many of the lesser crops.

The Mabaruma - Wauna - Yarakita - Kaituma area offers exciting prospects for production of crops, but also impressive problems in soil management. Water transportation is already available to carry produce to Georgetown and also to bring fertilizer or other supplies from Trinidad. Soils, although far from ideal, appear to be capable of producing many crops and pasture plants. Citrus fruits are already being produced on some of the hills of soil association 10 at Hosororo and Mabaruma.

Farming is likely to increase south of Ituni now that the Atkinson-Mckenzie road is connected with the existing company road to put that section within reach

of the coast. The better soils of association 7 east of the Mckenzie-Ituni road will produce many crops, but fertilizer must be used. Supplemental irrigation is desirable and might be essential for some crops. Diversified farming, with annual crops, fruit trees, and livestock therefore is required, at least within communities and preferably on individual farms. Soils too steep or otherwise not suitable for crops, fruit trees, or pasture should not be cleared. Strict control of erosion is needed, along with cover crops, green-manure crops, and mulches to shade the soil and conserve both nutrients and moisture.

The savannahs of association 7 can be prepared for the first crop more easily than the forested soils, but they lack the initial supply of plant nutrients that is obtained when the logs and branches are burned or allowed to decay.

The possibilities for expansion of agriculture in Guyana are enormous; but the technology is intricate, and the level of management must be high. The early developers, whether they are Government agencies, cooperatives, or individuals, must be openminded, flexible, willing to take risks, and willing to profit by their early mistakes. Above all, they must be willing to invest in the technical guidance that is needed.

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Table 1: Approximate area of general soil associations

Map Symbol	Name	Area square miles	Percent
	SOILS OF THE COASTAL PLAIN		
1	Clay soils, wet	1,910	2.3
2	Silty or clay soils, moderately wet	1,670	2.0
3	Peat or muck (Pegasse)	3,220	3.9
4	Silty soils, gently sloping	410	0.1
	SOILS OF THE INTERIOR FLOOD PLAINS AND LOWLANDS		
5	Interior lowlands, mostly subject to flooding	6,600	8.0
	SANDY SOILS, GENTLY SLOPING		
6	White sand	6,500	7.9
7	Brown sandy soils, gently sloping	6,850	8.3
8	Very sandy or gravelly soils, some with clay subsoil	7,425	9.0
	HILLY OR ROLLING SOILS		
9	Hilly or rolling loamy soils	13,115	16.0
10	Hilly, reddish clay soils with ironstone	4,490	5.5
11	Steep sandy or gravelly soils	10,685	13.0
	SHALLOW OR ROCKY SOILS OF MOUNTAINS		
12	Steep, shallow or rocky soils of mountains	13,825	16.8
	Total area mapped	76,700	92.8
	unmapped area (no aerial photographs)	5,955	7.2
	Total area	82,655	100.0

Table 2: General Soil groups of the Northeastern Coastal Plain

	Acres
Class I land: Few limitations if drained	
Im: Clay soils of moderate fertility (frontland)	575,000
If: Silty and clay soils of moderate fertility (riverain soils, large areas)	794,000
Class II Land: Moderate limitations if drained	
IIs: Saline soils, frontland and riverain	75,000
IIm: Clay soils, low fertility (riverain)	110,000
IIw: Silty and clay soils of moderate fertility, (riverain soils, strips along rivers)	127,000
IIf: Silty gently sloping soils	260,000
IIf: Frontland clay, low fertility	57,000
Class III land: Severe limitations if drained	
IIIm: Mostly deep pegasse (peat or muck)	338,000
IIIt: Clay containing toxic sulphates	173,000
Class IV land: Tidal flats and distributed areas	21,000
Total	2,530,000

Table 3: General soil groups of the Northwestern Coastal Plain

Class I and Class II land: Few or moderate limitations	
I - IIm: Clay soils of moderate fertility (frontland) Area 1	323,000
IIw: Silty soils of moderate fertility, along rivers Area 2	38,400
Class III land: Severe limitations if drained	
IIIm: Deep pegasse (peat or muck) Area 3	1,721,600
Total	2,083,000