SELECTED MACROMORPHOLOGICAL PROPERTIES OF SOILS IN PRELIMINARY ASSESSMENT OF A FARMLAND AT OKHEMUEN IN EKPOMA AREA OF EDO STATE, NIGERIA.

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ABSTRACT
Soils vary in time and space as can be established from morphological differences in a tract of land. The study aimed to investigate variations in selected macromorphological properties of soils in Okhemuen farmland proximal to Ekpoma town in Edo State, Nigeria. A free soil survey technique was used in locating soil sampling sites in a one hundred and twenty hectare(120 ha) farmland. Horizonation, horizon thickness, soil colour, soil texture, soil structure, soil consistence, soil drainage and abundance of roots were macromorphological properties of soils investigated. Preliminary assessment using these macromorphological properties show varying degree of suitability of evaluated arable and tree crops on the farmland. Identified constraints include sandiness, weak soil structural grade and topographic setting. The study recommends soil conditioning, soil fertility regeneration and soil conservation on the farmland.
Keywords: Evaluation, Farmland, Macromorphology, Soils. Edo State

INTRODUCTION

Soils vary in time and space. The variation in soils could be as a result of interaction between climate, lithological materials, local relief and organisms including man over time**.** Differences in slope forms (topography), climate, vegetation, human activities, land use history parent materials and age of soil development (Saldana, *et al.*,1998). Macromorphological properties such as depth of soil, horizon thickness, soil colour, soil texture, soil structure, soil consistence, soil drainage, root abundance, soil inclusions and soil boundary sometimes govern movement and retention of soil nutrients and go a long way to predict suitability of soils for any land use type. Pedologists at first sight based on field experience discuss these soils based on morphology.

Nutrient depletion in African soils have been topical of recent with Henao and Baanante (2001) asserting that average annual nutrient depletion in Nigeria is more than 60 kg of NPK per hectare requiring more than 80 kg of NPK per hectare to maintain Nigerian soils.

Experts use morphological properties like soil texture, soil structure, soil drainage, horizon thickness, soil colour, soil consistence, abundance of roots and several other properties to predict cation exchange capacity, water holding capacity, available water capacity and porosity of soils. These experts undertake such predictions with minimal differences.

Soil colour is one of the simplest and most easily determined morphological properties of soil (Ahmed, 2002), which can easily be identified in the field. It indicates several important soil characteristics including degree of oxidation and reduction, content of organic material, and leaching or accumulation of such chemical compounds as iron, which may greatly influence soil quality (Onweremadu and Oti, 2005). Buol *et al.* (1997) showed that some broad generalizations stating that black soils usually indicate the presence of organic matter; red colours indicate the presence of free iron oxides in well oxidized soil, while gray or bluish gray usually occur under reducing conditions of free iron.

Soil texture is an inherent property of soils that depends on relative proportion of clay, silt, and sand . Soil texture is perhaps the most fundamental and most permanent soil property, not readily subject to change by normal soil management practices in the field (Brady and Weil, 2002, Ndukwu, 2014). It determines water intake rates, water storage in the soil, the ease of tilling the soil, the amount of aeration and influences soil fertility (Gupta and Germida, 1988). Texture influences the response of crop to fertilization. Soil textural variability plays a significant role in crop performance, especially in dry conditions, where spatial variability of soil texture can show the moisture shortage effect on plant stand variability across the field. Generally, soil is not uniform and immense spatial soil texture variability can be noticed across fields. Changes in soil texture across a field affect moisture availability, which in turn affects the crop stand. In addition, changes in soil texture and soil moisture can influence soil temperature. Soil texture, soil drainage class, and tillage system can have an impact on soil temperature.

Particle density of most mineral soils ranges from 2.60 to 2.75 Mgm-3 since they are largely composed of quartz, feldspar, micas, and the colloidal silicates. For arable mineral surface soils (1 to 5% organic matter) its average value is 2.65 Mgm-3 (Brady and Weil, 2002).

Soil structure is physical property which can be altered in response to disturbance or soil management practices and can related to bulk density and porosity of soils. Ahmed (2000) indicated that bulk density increases with increasing soil depth. This could be as a result of lower content of organic matter, less aggregation and root penetration, and compaction caused by the weight of the overlying layers. Increases in bulk density usually indicate a poorer environment for root growth, as it causes reduced aeration, and undesirable changes in hydrologic function, such as reduced water infiltration (Brady & Weil, 2002). Researchers often need a bulk density value to use in models, characterize field conditions, or convert to volumetric measurements (Reinsch and Grossman, 1995). This condition can be altered by cultivation, trampling by animals, agricultural machinery, weather and raindrop impact (Arshad *et al.,* 1996). The low bulk density in the bottom slope position indicates low level of soil compactness and associated improvement in root penetration (Ogban and Babalola 2003), and hence favourable root activity (Ogban *et al*., 1998). In the case of the elevated landform, the high bulk density may be related to the hardening of the iron/quartz stone layer due to prolonged dry conditions which manifested in low moisture status. Boling *et al.* (2008) found that bulk density varied appreciably along some top sequences. Porosity is a critically important parameter of soil because it influences the movement of water and gases, which in turn determine the activity of roots and soil organisms (Kimmins, 1997). Brady and Weil (2002) pointed out that pores can be grouped by size into macro pores (>0.08 mm) characteristically allow ready movement of air and the drainage water; are large enough to accommodate plant roots and tiny animals and micro pores (<0.08 mm) are usually filled with water in field soils; even when not water filled, too small to permit much air movement; and water movement is slow and not available to plants and the study of spatial variability is very important for site specific management of this total porosity.

MATERIALS AND METHODS

3.1 Study Area

3.1.1.Location

The study was conducted at Okhemuen in Local Government Area(LGA) of Edo State ,Nigeria, located between Latitudes 6^0 30^l and 6^0 50^l N and Longitudes 6^0 00^l and 7^0 30^l E. Okhemuen is about 40 kilometres to Ambrose Alli University, Ekpoma in Edo State.

3.1.2. Geology and Geomorphology

The lithologic materials consist of a mixture of Shale and sand deposits. The geomorphology of the area consists of inland valleys, plains, river slopes and hills.

3.1.3. Climate

Okhemuen lies within the humid tropics with annual rainfall of about 1800mm and annual temperature range of 29 to 31^0C.The area has a bimodal rainfall pattern with peaks during July and September every year. However, there has been recent changes in climatic characteristics referred to as climate change. Relative humidity is generally high during wet seasons. The Southwest and Northeast Trade winds govern the rainfall and dryness characteristics of the region. Dry season tends to be sunny and dry with harmattan winds blowing across the area. Evapotranspiration is high, leading to wilting of most plants except some deep-rooted ones.

Vegetation

The vegetation is a typical rainforest belt with many plant species. Plants are arranged in storeys with sun-loving plants towering above sun-hating plants. It is mixed vegetation comprising trees, shrubs, herbaceous species, climbers and saprophytes. Built-up vegetations of varying economic crop types exist in the area. The vegetation has of recent witnessed pronounced deforestation as the area supplies fuelwood to towns proximal to it including Benin City, Ekpoma and the Local Government Headquarters.

Hydrology

The hydrology of the area is governed by local rivers and their tributaries. Volumes of the river increases during rainy season due to in-flow of runoff water after rains, sometimes causing overflows at the banks.

Socioeconomic

Smallscale agriculture is a major socioeconomic activity. Dominant crops include cassava, yam, maize,, cocoa, plantain, banana, pineapple, oil palms and a host of others. These crops are cultivated in a mixed cropping system to avoid crop failure. Bush fallowing is used for soil fertility regeneration although fallow length has been shortened due to less farmland. Land clearing is by slash-and-burn method. Other socioeconomic activities are sand mining, processing for oil palm products, cassava processing, lumbering, fishing, hunting and marketing of farm products.

3.2.Brief Description of Sampling Sites

Two sampling sites were used for the study viz Upland and River Slope. The Upland is located on Latitude $5^0 19^1$ 50.80692^{11}N and Longitude 6^0 $57^1 47.88194^{11}$ E; and characterized by plains of about 0 to 2% slope. The land unit has an elevation of 27 metres above mean sea level. Grasses dominate the vegetation. Old cassava mounds were found and soil were well-drained. There are minimal leaf litters, Faunal activities were also minimal. Inter-rill erosion activities are common Parent material is Coastal plain sands. On the other hand, the River Slope lies on an undulating slope of 6-7 % slope and is thickly forested. It is located on Latitude $5^0 29^1$ 55.30770^{11}N and Longitude 6^0 $59^1 52.67368^{11}$ E There is abundance of leaf litter and other plant debris. Also, there were abundance of rills at forest floor. Soils are subjected overland flow and rills are common.

3-3.Field Studies

A free survey was used in which choice of sites were based on topography. Soil profiles were sited on flat Upland and sloping River Slope. Each soil profile was dug, delineated, described and sampled according to FAO (2006) guidelines. Soil sampling from soil profiles was done based on horizon differentiation. Soil samples were collected from the deepest horizon upwards to avoid sample contamination. Soil Profiles were georeferenced using Handheld Global Positioning System (GPS) receiver (Garmin Ltd, Kansas USA). Munsell Colour Chart was used to obtain and record information on soil colour and this was done *in situ*.

Macro morphological properties were observed *in situ* and recorded using appropriate field tools.

RESULTS AND DISCUSSION

Macromorphology

Results on macromorphological properties of soils are presented on Table 1, indicating that both soils are well-differentiated and deep exceeding 100 cm depth. It follows that given depth as a criterion, both soil groups can accommodate both shallow-rooted as well as deep- rooted crops. Upland soils were darker than river slope soils, suggesting higher organic matter content of soils. The afore-stated is consistent with a similar study by Onweremadu and Oti(2005) on tropical soils of southeastern Nigeria. Soils were redder towards the endopedons as a result of less interaction with vegetal materials. Again, Buol *et al.* (1997) showed that some broad generalizations stating that black soils usually indicate the presence of organic matter while red colours indicate the presence of free iron oxides in well oxidized soil, Soils of the river slope were sandier than soils of the upland, suggesting allocation of root tubers which thrive optimally in sandy soils for ease of tuberization. Grade of soil structure indicates greater weak structure in river slope soils compared to moderate grades recorded in upland land init. Crumb soil structural type appeared in surface horizons to a depth of 17 cm which can be attributed to greater aggregation of upland soils which showed granular soil structural type underlain by a crumb type at a depth of 10 to 21 cm. Roots were more in abundance in upland soils which could be attributed to a variety of plant species growing the land unit.

Table 1: Soil macromorphological properties of the studied sites

Horizon	Depth (cm)	Colour (Moist)	Texture	Structure			Consistence (Moist)	Roots	Drainage	Boundary
				Grade	Class	Type				
				Upland (1-2% slope)						
A	0 – 10	VDB (7.5YR 2.5/3)	SL	2	f	cr	friable	abt	Well drained	C,W
AB	10 – 17	DB (7.5YR 3/4)	L	2	m	cr	friable	ff/m	Well drained	C,S
Bt1	17 – 44	DRB (2.5YR 3/4)	SCL	2	m	sbk	Firm	ff/m	Well drained	G,S
Bt2	44- 70	DR (10 R 4/4)	SCL	2	M	sbk	Firm	r	Well drained	G,S
Bt3	70 – 157	DR (10R 3/4)	SCL	2	m	sbk	Firm	-	Well drained	-,-
				River slope (6-7 % slope)						
A	0 – 10	DB (7.5YR 3/3)	LS	1	F	gr	very friable	mf/m	Well drained	C,W
AB	10 – 21	DB (7.5YR 3/4)	SL	1	M	cr	friable	mf/m	Well drained	C,S
Bt1	21– 42	DRB (5YR 3/4)	SL	1	M	sbk	friable	mf/m	Well drained	G,S
Bt2	42 – 74	DRB (5YR 3/4)	SL	2	M	sbk	friable	ff/m	Well drained	G,S
Bt3	74 – 155	DR (2.5yr 3/6)	SL	2	M	sbk	firm	ff	Well drained	G,S
									Well drained	-,-

Colour: VDB= very dark brown, DB= dark brown, B=brown,RB=reddish brown, DRB= dark reddish brown,DR =dark red, R=red

Texture: SL= Sandy Loam, L= Loam, SCL=Sandy Clay Loam, SC=Sandy Clay.
Structure: 1=weak, 2= Moderate, F= fine, M=medium, gr=granular, Cr= Crumb, Sbk= Sub angular blocky.
Roots: abt = abundant, mf/m = many fine/medium, ff/m = few fine/medium, r = rare

Evaluation of possible crops based on macromorphology

Table 2 shows an allocation of crops to both land units. Cassava and cocoyam are considered suitable based on soil texture and soil structure but may not give optimum yield thus requiring somewhat little amendment of soils. Other suitable crops include Pineapple, Rubber Banana, Irvingia and Oil Palm. Rice have potentials of marginal performance in the area if soils are conditioned as appropriate. In river slope land units, with the exception of cassava, most crops as listed on Table 2 are marginally suitable. Predicted marginal suitability could be attributed to soil texture, granular soil structural type and topographical nature pf the farm being on an undulating slope of 6 to 7 % slope, implying that a minor earth moving may be expedient to improve the topographic setting for optimal performance of both arable and tree crops with more severity expected of the arable crops. Tree crops could do better once their roots penetrate deeper given the deep nature of soil profiles in that portion of the farmland

Table 2. Attributes and allocation of crops based on macromorphology of Soils

Property	Land unit	
	Upland (1-2%)	River slope (6-7%slope)
Depth(cm)	157	155
Texture	Sandy loam	Loamy sand
Colour at epipedon (moist)	Very Dark Brown	Dark Brown
Structure(Grade)	moderate	weak
Structure(Class)	Fine	fine
Structure(Type)	crumb	granular
Consistence	friable	very friable
Roots	abundant	many
Cassava	suitable	very suitable
Cocoa yam	very suitable	suitable
Pineapple	suitable	currently not suitable
Rubber	suitable	marginally suitable
Banana	suitable	marginally suitable
Irvingia	suitable	marginally suitable
Oil Palm	suitable	marginally suitable
Upland rice	marginally suitable	suitable

CONCLUSION

Preliminary assessment farmland for crop production is achievable using some macromorphological properties of soils particularly depth of or thickness of horizons, soil colour, soil texture, soil structure and root abundance. Soil conditioning is necessary to improve soil structure in the farmland while the farm needs soil fertility regeneration coupled with conservation practices particularly on river slope soils.

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