SUITABILITY EVALUATION OF SOME SOILS OF MBARACHARA – UBO IN OWERRI AREA OF IMO STATE, SOUTH EASTERN NIGERIA FOR CASSAVA AND MAIZE CULTIVATION.

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Abstract
Some soils of Mbarachara – Uboin OwerriArea, Imo State were evaluated for their suitability for cassava and maize cultivation. The area studied covered 200ha of land. Ten (10) representative profile pits were dug within the area based on topography, texture and colour after a reconnaissance survey. The profile pits were described following the FAO Soil characterization guideline and soils were randomly sampled at each genetic horizon. Soil samples were processed and analyzed in the laboratory using standard laboratory methods. Four soil types were identified by soil characterization and classification. They included TypicHapludults (USDA) and approximately correlated to HaplicAcrisol (FAO/UNESCO), TypicDystrudepts (USDA) (DystricCambisols (FAO/UNESCO)), TypicEpiaquepts (USDA) (GleyicCambisols (FAO/UNESCO)) and AericEpiaquepts (USDA) (GleyicCambisols (FAO/UNESCO)). The suitability evaluation of the soils for cassava and maize cultivation was made by comparing the suitability scores obtained from previous works with the results of the soil and site characterization. Results of the soil suitability evaluation showed that three soil types were moderately to highly suitable for maize cultivation with minor limitation of poor nutrient status (P and K) while the TypicEpiaquepts (USDA) was marginally to moderately suitable with major limitation of wetness and poor nutrient status (organic carbon, P and K). For cassava cultivation, three soils were again moderately suitable with major limitation of poor nutrient status (NPK) whereas the TypicEpiaquepts (USDA) was marginally to moderately suitable due to poor drainage and low nutrient status. However, the soils can be improved by application of NPK fertilizers, organic manure, lime as well as crop rotation and drainage.

Key words: suitability, evaluation, MbaraAcharaUbowalla, pedon, soil types, cultivation

Introduction

Soil suitability evaluation involves characterizing soils in a given area for specific landuse (Rossiter, 1996). Dent and Young, (1981), noted that specific landuse may be rain-fed agriculture, livestock production, forestry, etc. The success of soil suitability evaluation is based on the information obtained during soil survey as it helps in the development of land-use plans, evaluates and predict the effect of the landuse on the environment

According to FAO, (1976), the specific purpose of soil suitability evaluation is strongly related to the land qualities such as erosion resistance, water availability and flood hazard that are not measurable. However, they noted that these land qualities are derived from the land characteristics which are measurable such as: slope angle and length, rainfall, soil texture and structure, soil pH, cation exchange capacity (CEC), etc.

FAO (1983) observed that in many parts of the world, soils that are well suited for the production of food crops are already in short supply. They stated that this shortage coupled with the competing demand for land for different purposes has led to wide spread soil degradation. Hence, soil suitability evaluation provides the basis to balance the quest for increased food production, to meet the increasing human demand, and to protect the soil resources from further degradation. In line with that, Senjobi (2007) reported that the productivity of Nigerian soils is decreasing and lands have been utilized intensively for all purposes at the expense of its suitability and capability which resulted in land degradation and altering of the natural ecological conservatory balances in the landscape. Hence, he proposed that soil suitability evaluation is paramount for a sustainable landuse, since it provides an avenue for the use of lands based on their capabilities.

There is an increasing need for productive agriculture with a view to meeting the food need of the people and livestock. It therefore seems paramount to evaluate our soils especially in the face of the challenging climate change so as to ensure environmentally friendly agriculture while improving the production of our arable crops. Therefore, the objective of this study was to evaluate the suitability of the soils of Mbarachara – Ubo for cassava and maize cultivation.

Materials and methods

Study area

The study was conducted at Mbarachara – Ubo in UbowallaEmekukuOwerri North LGA, Imo State Southeasthern Nigeria. The site covered 200ha of land. It lies within latitude $5^0$15'N, and longitude $7^0$25'E. The altitude is about 100m above sea level (Lekwa*et al.*,1986)..

The area lies within the tropical rainforest zone of Nigeria. The climate is characterized by wet and dry seasons. The rainy season is bimodal with peaks in June and September and a short period of dry spell in August. The rainy season starts in March through October while the dry season begin in November and terminating in February. The mean annual rainfall is about 2500mm. The area has a mean annual temperature of about 28^0C. The relative humidity is 75% but sometimes rises higher during the rainy season, when it gets to about 90% (Lekwa and Whiteside,1986).

The study area is lowland with near level to gently undulating topography. The parent material is predominantly coastal plain sand. The clay mineralogy of the Coastal Plain Sand is dominated by kaolinite which is a 1:1 silicate clay mineral (Lekwa*et al.*,1986). The site was characterized by secondary vegetation of the tropical rainforest. The plant species commonly found in the area comprisedgrasses and some tree crops such aslocal pear (*Dacryodesedulis*), African breadfruit (*Treculia Africana*), African oil bean (*Pentaclethramacrophyllum*) and Oil palm (*Eleaisguinensis*). Cassava (*Manihotesculentus*), maize (*Zea mays*), yam (*Dioscoreaspp*) and vegetables (*Telferiaoccidentalis, Solanumgilo*) were common crops cultivated in the area.

Field work

After a reconnaissance survey, ten (10) representative profile pits were dug within the land area based on differences in topography, soil texture and colour. Thedimensions of the pits were 2 x 1.5 x 2 meters (ie. Length x width x depth). They were described following the FAO Soil characterization guidelines. Each profile pit described was georeferenced using a handheld Global Positioning System (GPS) of model GERMIN ETREX - 10. Representative soil samples were collected from each profile pit at the identifiable genetic horizon, with sampling starting from the base of the pit to the top. The soil samples were air-dried and passed through a 2mm sieve for laboratory analysis.

Laboratory analysis

The samples were analyzed in accordance with standard laboratory procedures. Parameters determined were particle size distribution (Gee and Or, 2002); Soil pH (Mcleans, 1982); Organic carbon (OC) (Nelson and Sommers, 1982); total Nitrogen (TN) (micro Kjeldahl (Bremner, 1996), Available phosphorus was determined using Bray 2 method (Oslen and Sommers, 1984). Exchangeable cations were extracted using ammonium acetate (NH_4OAC) method (Tel and Hagarty, 1984). Exchangeable calcium and magnesium were determined by titration while exchangeable sodium and potassium were determined using flame photometer. Cation Exchange Capacity (CEC) was byRhoades (1982) method. Percentage base saturation was deduced as the ratio of the total exchangeable bases to CEC. Electrical Conductivitywas read off using Conductivity Bridge; Hydraulic conductivity Stolte, (1997). Bulk density was by the method of Grossman and Reinsch (2002).

SOIL CLASSIFICATION

From the results of the laboratory analysis and soil morphological properties, pedons were classified according to USDA Soil Taxonomy of Soil Survey Staff (2010) and approximately correlated with FAO/UNESCO (FAO, 1990).

SOIL SUITABILITY EVALUATION

This was done using the simple limitation method of Sys *et al* (1991). The parameters used were rainfall, mean annual temperature, slope, wetness, drainage, texture, soil depth, and soil fertility (cation exchange capacity, organic carbon and percentage base saturation). Each parameter was evaluated based on crops' requirement and matched with the soil suitability scores for the crops as provided by Sys *et al*(1991).

Soil Suitability Classification

This was done by assessing and grouping the soil types in order, class, subclass, and units as established by Dent and Young (1981).Tables 1 and 2 below show the factor ratings of land use requirements for maize and cassava cultivation, respectively.

Table 1. Factor rating of land use requirement for maize

Land Qualities Group	Land Characteristics	Unit	S1 95% 1	S2 85% 2	S3 60% 3	N1 40% 4
Climate (C)						
Water availability	Mean annual rainfall	mm	12500 - 1800	1800 - 1600	1600 - 500	< 500
Temperature Regime	Mean annual temperature	^{0}C	32 - 18	18 - 16	16 - 14	< 14
Wetness (W)						
Oxygen availability	Soil drainage		Well drained	Imperfectly drained	Poorly drained	Very poorly drained
Fertility (f)						
Nutrient availability	Organic matter 0 - 15 cm	%	2 - 1.2	1.2 - 0.8	0.8 - 0.4	< 0.4
	Available P	mg/kg	> 25	6.0 - 25.0	< 6	any
	pH		5.5 - 7.5	5.0 - 5.5 or 7.5 - 8	4.0 - 5.0 or 8.0 - 8.5	< 4.0 > 8.5
Nutrient retention	Apparent CEC	cmol/kg	24 - 16	16 - 3	> 3	< 3
	Base sat.	%	50 - 35	35 - 20	20 - 15	< 15
Soil Physical Character (S)						
Water retention capacity	Soil texture		SCL	LS,SL	C	S
Rooting condition	Soil depth	cm	> 75	> 50	> 20	< 20
Salinity (n)	EC	Ms/cm	0 - 4	4.0 - 6.0	6.0 - 8.0	> 8
Topography (t)	Slope	%	0 - 4	4.0 - 8.0	8.0 - 16.0	> 16

(**Source** : Sys *et al*, 1991)

Table 2. Factor rating of land use requirement for cassava

Land Qualities Group	**Land Characteristics**	**Unit**	**S1 95% 1**	**S2 85% 2**	**S3 60% 3**	**N1 40% 4**
Climate (C)						
Water availability	Mean annual rainfall	mm	1500 - 1100	100 - 900	900 - 500	< 500
Temperature Regime	Mean annual temperature	^{0}C	18 - 30	<16	<12	any
Wetness (W)						
Oxygen availability	Soil drainage		Well drained	Imperfectly drained	Poorly drained	Very poorly drained
Fertility (f)						
Nutrient availability	Total N	%	> 0.2	0.1 - 0.2	<0.1	any
	Available P	mg/kg	> 25	6 - 25	< 6	any
	Exch. K	cmol/kg	>6	3 - 6	<3	any
	pH		5.5 - 7.5	5.0 - 5.5 or 7.5 - 8	4 – 5 or 8.0 - 8.5	< 4.0 > 8.5
Nutrient retention	Apparent CEC	cmol/kg	24 - 16	16 - 3	> 3	< 3
	Base sat.	%	50 - 35	35 - 20	20 - 15	< 15
Soil Physical Characteristics (S)						
Water retention capacity	Soil texture		SCL	LS,SL	C	S
Rooting condition	Soil depth	cm	> 75	> 50	> 20	< 20
Salinity (n)	EC	Ms/cm	0 - 4	4.0 - 6.0	6.0 - 8.0	> 8
Topography (t)	Slope	%	0 - 4	4.0 - 8.0	8.0 - 16.0	> 16

(**Source** : Sys *et al*, 1991)

Results

Table 3.Taxonomic classification of pedons

Profile pits	Georeferences	Soil Classification	
		USDA Soil Taxonomy	FAO/UNESCO
AC 01 - AC 06	05^0 $49^{'}$ $0.464^{''}$N to 05^0 $49^{'}$ $0.630^{''}$ N 007^0 $13^{'}$ $0.771^{'}$E to 007^0 13' 0.838''E.	TypicHapludults	HaplicAcrisols
AC 07 and AC 09	05^0 49^{I} 0.370^{ll} N to 05^0 49^{I} 0.232^{ll} N 007^0 13^{l} 0.711^{ll} E to 007^0 13^{l} 0.814^{ll} E	TypicDystudepts	DystricCambisols
AC 08	05^0 49^{I} 0.370^{ll} N, 007^0 13^{l} 0.814^{ll} E.	TypicEpiaquept	GreyicCambisol
AC 10	05^0 49^{I} 0.445^{ll} N, 007^0 13^{l} 0.852^{ll} E.	AericEpiaquept	GreyicCambisol

Table 3 above shows the classification of pedons into four soil types which according to USDA soil taxonomy are TypicHapludult, TypicDystudepts, TypicEpiaquepts and AericEpiaquepts.

Table 4. Mean Values of the Chemical Properties of Soils

Soil types	Horizons	pH (H_2O)	OC (g/kg)	N (g/kg)	Avail. P (mg/kg)	TEA (cmol/kg)	Exch. Cations (cmol/kg)				CEC (cmol/kg)	BS (%)
							Ca	Mg	K	Na		
Typic	Surface	5.45	0.99	0.27	10.93	1.79	1.81	1.43	0.29	0.20	9.60	39.38
Hapludult	subsurface	5.08	0.40	0.08	7.44	1.19	2.16	1.64	0.46	0.17	11.27	40.74
Typic	Surface	5.53	1.19	0.05	6.63	1.68	1.68	1.00	0.14	0.33	8.68	31.31
Dystrudepts	subsurface	5.17	0.58	0.02	7.31	1.01	1.63	1.04	0.16	0.09	9.19	31.89
Typic	Surface	5.70	0.38	0.03	10.83	0.83	1.65	1.23	0.13	0.06	8.10	37.90
Epiaquepts	Subsurface	5.20	0.26	0.01	9.13	0.50	2.09	1.35	0.10	0.14	9.85	37.36
Aeric	Subsurface	5.65	1.40	0.06	8.20	0.78	4.00	1.80	0.08	0.07	14.80	40.20
Epiaquepts	Subsurface	5.40	0.79	0.02	4.72	0.60	2.50	1.87	0.04	0.08	10.03	44.77

Table 4 above shows the mean values of chemical properties of the soils.

Pedon AC 01 – 06 (TypicHapludults)

Mean pH values of 5.45 at the surface horizon and 5.08 at the subsurface horizons indicated strong acidity. At the surface horizons, OC was 0.99g/kg while at the subsurface horizons, it was 0.40g/kg. Total nitrogen content was 0.27g/kg at the surface horizons and 0.08g/kg at the subsurface horizons. Available P was moderate with values of 10.93mg/kg at the surface horizons and 7.44mg/kg at the subsurface horizons.

Total exchangeable acidity of the pedons at the surface horizons was 1.79cmol/kg while at the subsurface horizons, it was 1.19cmol/kg. Apart from exchangeable Na that decreased with depth, the exchangeable cations increased with depth. The values ranged from very low to moderate (0.17 - 2.16cmol/kg). The soils were low in cation exchange capacity (CEC) as values ranged from 9.60cmol/kg at surface horizons to 11.27cmol/kg at the subsurface horizons. At the surface horizons, value of percentage base saturation was 39.38% while the subsurface horizons recorded 40.74%.

Pedons AC 07 and 09 (TypicDystudepts)

The pH indicated strongly acidic ranging from 5.53 at the surface horizons to 5.17 at the subsurface horizons. Organic carbon (OC) of the soil decreased with depth. It was very low at the surface and subsurface horizons with mean values of 1.22g/kg and 0.32g/kg respectively. Total nitrogen content of the soil was very low and decreased with depth. At the surface horizon, it was 0.045g/kg and 0.015g/kg at the subsurface horizons. Available P at the surface horizons was low (6.63mg/kg) while at the subsurface horizons, it was moderate (7.31mg/kg).

Total exchangeable acidity of the pedons decreased with depth with mean values of 1.68cmol/kg and 1.01cmol/kg at the surface and subsurface horizons, respectively. Exchangeable Ca was low with mean values of 1.68cmol/kg and 1.63cmol/kg at the surface and subsurface horizons respectively. Exchangeable Mg was moderate with mean values of 1.00cmol/kg and 1.04cmol/kg at surface and subsurface horizons, respectively. Exchangeable K was low with mean values of 0.14cmol/kg and 0.16cmol/kg for surface and subsurface horizons respectively. Exchangeable Na ranged from very low (0.09cmol/kg) at the surface to moderate (0.33cmol/kg) at the subsurface horizons. The soil was low in CEC with mean values of 8.68cmol/kg and 9.19cmol/kg at the surface and subsurface horizons, respectively. Percentage base saturation of the soil was low and ranged from 31.31% to 31.89% at the surface and subsurface horizons, respectively.

Pedon AC 08 (TypicEpiaquepts)

The pH of the soil decreased with depth and ranged from moderately acidic (5.70) to strongly acidic (5.20) at the surface and subsurface horizons respectively. Organic carbon (OC) was low with mean values ranging from 0.38g/kg to 0.26g/kg for surface and subsurface horizons respectively. Total nitrogen content was very low in all the horizons and decreased with depth. At the surface horizon, the mean value was 0.025g/kg while at the subsurface horizons, the value was 0.01g/kg. The available P was moderate at all horizons. At the surface horizons, the mean value was 10.83mg/kg while at the subsurface horizons; it was 9.13mg/kg.

Total exchangeable acidity of the soil decreased with depth. At the surface horizon, the mean value was 0.83cmol/kg while at the subsurface horizons, it was 0.50cmol/kg. Exchangeable Ca ranged from very low to low with mean values of 1.65cmol/kg and 2.10cmol/kg at the surface and subsurface horizons respectively. The soil was moderate in exchangeable Mg with mean values of 1.23cmol/kg and 1.35cmol/kg at the surface and subsurface horizons, respectively. Exchangeable K and Na were very low at all horizons. For exchangeable k, the mean values were 0.13cmol/kg and 0.10cmol/kg at the surface and subsurface horizons, respectively whereas exchangeable Na was 0.06cmol/kg and 0.14cmol/kg at the surface and subsurface horizons, respectively. The soil was low in CEC and base saturation at all depths. The mean value of the CEC at the surface horizons was 8.10cmol/kg while at the subsurface horizons, it was 9.85cmol/kg. The mean values of percentage base saturation at the surface and subsurface horizons were 37.90% and 37.36% respectively.

Pedon pit AC 10 (Aericepiaquepts)

Soil pH ranged from moderate acidity (5.65) on the surface horizons to strong acidity (5.40) at the subsurface horizons. Organic carbon (OC) decreased with depth and ranged from moderate (1.40g/kg) to low (0.79g/kg) at the surface and subsurface horizons respectively. Total nitrogen content also decreased with depth and ranged from low (0.06g/kg) to very low (0.02g/kg) at the surface and subsurface horizons respectively. Available P ranged from low to moderate. At the surface horizons, it was moderate (8.20cmol/kg) while at the subsurface horizons, it was low (4.72mg/kg).

Total exchangeable acidity decreased with depth with mean values ranging from 0.78cmol/kg at the surface horizons to 0.60cmol/kg at the subsurface horizons. Exchangeable Ca ranged from low (4.0cmol/kg) to very low (2.50cmol/kg) at the surface and subsurface horizons, respectively. Exchangeable Mg was moderate at all horizons and ranged from 1.80cmol/kg to 1.87cmol/kg at surface and subsurface horizons, respectively. Exchangeable K was very low at all horizons with mean values of 0.08cmol/kg and 0.04cmol/kg at the surface and subsurface horizons. Similarly, exchangeable Na was very low at all horizons with mean values of 0.07cmol/kg and 0.08cmol/kg at the surface and subsurface horizons, respectively. CEC ranged from moderate (14.80cmol/kg) at the surface horizons to low (10.03cmol/kg) at the subsurface horizons. Percentage base saturation was low at all horizons with mean values of 35.50% and 37.03% at the surface and subsurface horizons, respectively.

Table 5. Physico-morphological properties of soil

soil types	horizons	Depth(cm)	texture	Color (moist)	mottle	E.C (mS/m)	B.D (g/cm^3)	Ksat (cm/min)
TypicHapludults	surface	0 - 35	LS - SL	Dark brown (10YR3/3) - Dark Yellowish brown(10YR4/4)	-	0.092	1.27	1.84
	subsurface	35 - 190	SCL - SC	Strong brown (7.5YR 4/6) - Red (2.5YR4/8)	-	0.076	1.45	1.11
TypicDystrudepts	surface	0 - 42	LS - SL	Dark brown (10YR3/3) - Brown (10YR 5/3)	-	0.066	1.24	2.66
	subsurface	42 - 180	SL	Yellowish brown (10YR 5/6) - Reddish yellow (2.5YR 4/6)	-	0.046	1.28	2.66
TypicEpiaquepts	surface	0 -45	LS - SL	Strong brown(10 YR 3/3) - Light brownish grey (10YR 6/2)	CR (2.5YR4/6)	0.025	1.40	0.79
	subsurface	45 - 122	SL	Dark brown (10YR 4/3) - Light grey (10YR 7/2)	CPR (2.5YR4/6)	0.034	1.46	1.20
AericEpiaquepts	subsurface	0 - 40	SL	Strong brown(10 YR 3/3)	-	0.045	1.12	1.18
	subsurface	40 - 190	SCL - SC	Reddish grey (5YR 5/2) - Pinkish grey (5YR 7/2)	-	0.05	1.27	2.64

LS – loamy sand, SL – sandy loam, SCL – sandy clay loam, SC – sandy clay, CR – common red, CPR – common prominent red

Physico-morphological properties of soils are shown in Table 5 above.

Pedons AC 01 – 06 (TypicHapludults)

The textural class ranged from loamy sand to sandy loam and sandy clay loam to sandy clay at the surface and subsurface horizons, respectively. The colour obtained at moist condition ranged from dark brown (10YR3/3) to dark yellowish brown (10YR4/4) at the surface horizons and Strong brown (7.5YR 4/6) to Red (2.5YR4/8) at the subsurface horizons. The soils were well drained and well aerated as indicated by the absence of mottled surfaces.

Electrical conductivity was low at all horizons and decreased with depth with mean values of 0.092mS/m and 0.076mS/m at the surface and subsurface horizons, respectively. Hence, Bulk density increased with depth with mean values of 1.27g/cm^3 and 1.45g/cm^3 at surface and subsurface horizons, respectively. Water conductivity of the soils was higher at the surface than the subsurface horizons as indicated by the mean values of the hydraulic conductivity which ranged from 1.84cm/min and 1.11cm/min at the surface and subsurface horizons, respectively.

Pedons AC 07 and 09(TypicDysrudepts)

The textural class ranged from loamy sand to sandy loam at the surface horizons and sandy loam at all depths of subsurface horizons. The colour obtained at moist condition ranged from dark brown (10YR3/3) to Brown (10YR 5/3) at the surface horizons and Yellowish brown (10YR 5/6) to Reddish yellow (2.5YR 4/6) at the subsurface horizons. The soils were well drained and well aerated as indicated by the absence of mottled surfaces.

Electrical conductivity was low at all horizons and decreased with depth with mean values of 0.066mS/m and 0.046mS/m at the surface and subsurface horizons, respectively. Hence, the soil was free from salinity problems. Bulk density increased with depth with mean values of 1.24g/cm^3 and 1.28g/cm^3 at surface and subsurface horizons respectively. Hydraulic conductivity of the soil was similar at the surface and subsurface horizons with mean value of 2.66cm/min.

Pedon AC 08 (TypicEpiaquepts)

The textural class ranged from loamy sand to sandy loam at the surface horizons and sandy loam at all depths of subsurface horizons. The colour obtained at moist condition ranged from strong brown (10YR3/3) to light brownish grey (10YR 6/2) at the surface horizons and dark brown (10YR 4/3) to light grey (10YR 7/2) at the subsurface horizons. The soil was poorly drained as indicated by the presence of mottled surfaces which ranged from common red (2.5YR4/6) at the surface horizons to common prominent red (2.5YR4/6) at subsurface horizons.

Electrical conductivity was low at all horizons and increased with depth with mean values of 0.025mS/m and 0.034mS/m at the surface and subsurface horizons respectively. Bulk density increased with depth with mean values of 1.40g/cm^3 and 1.46g/cm^3 at surface and subsurface horizons respectively. hydraulic conductivity of the soil was observed to increase with depth having values ranging from 0.79cm/min to 1.20cm/min at the surface and subsurface horizons, respectively.

Pedon AC 10 (AericEpiaquepts)

The textural class was sandy loam at the surface horizons and ranged from sandy clay loam to sandy clay at the subsurface horizons. The colour obtained at moist condition was strong brown (10YR3/3) at the surface horizons and ranged from reddish grey (5YR 5/2) to pinkish grey (5YR 7/2) at the subsurface horizons. The soil was imperfectly drained but with an appreciable level of aeration that averted mottling.

Electrical conductivity was low at all horizons and increased with depth with mean values of 0.045mS/m and 0.050mS/m at the surface and subsurface horizons, respectively. Bulk density increased with depth with mean values of 1.12g/cm^3 and 1.27g/cm^3 at surface and subsurface horizons, respectively. Hydraulic conductivity of the soil was observed to increase with depth having values ranging from 1.18cm/min to 2.64cm/min at the surface and subsurface horizons, respectively.

SUITABILITY EVALUATION OF SOILS

Soils were evaluated on their suitability for maize and cassava as shown in tables 6 and 7, respectively. Table 6 shows that soils were moderately to highly suitable for maize cultivation except TypicEpiaquept (pedon AC 08) which was marginally to moderately suitable. The minor limitation of the soils was low nutrient status (NPK). TypicEpiaquept (pedon AC 08) however, had problem of drainage (wetness) in addition to low nutrient status,

Table 6. Suitability Scores of Soil Units for Maize Cultivation

Land Qualities	Land characteristics	Pedons 01	02	03	04	05	06	07	08	09	10
climate(C)											
water availability	mean annual rainfall	95	95	95	95	95	95	95	95	95	95
temperature regime	mean annual temperature	95	95	95	95	95	95	95	95	95	95
Wetness (w)											
Oxygen availability	Soil drainage	95	95	95	95	95	95	95	60	95	85
Fertility (f)											
Nutrient availability	Organic matter	95	60	95	85	95	95	95	60	95	95
	Avail. P	85	85	85	85	85	85	85	85	85	85
	pH	85	95	85	85	85	85	95	95	85	95
Nutrient retention	CEC	85	85	85	85	85	85	85	85	85	85
	Base sat.	85	85	85	95	85	95	85	85	85	85
Soil physical properties (s)											
Water retention capacity	Soil texture	85	85	85	85	85	85	85	85	85	85
Rooting condition	Soil depth	95	95	95	95	95	95	95	95	95	95
Salinity (n)	E.C	95	95	95	95	95	95	95	95	95	95
Topography (t)	Slope	95	95	95	95	95	95	95	95	95	95
Aggregate Suitability		S_2-S_1	S_2-S_1	S_2-S_1	S_2-S_1	S_2-S_1	S_2-S_1	S_2-S_1	S_3-S_2	S_2-S_1	S_2-S_1

E.C – Electrical conductivity, S_1 – Highly suitable, S_2 - Moderately suitable, S_3 – marginally Suitable

Table 7. Suitability scores of soil units (pedons) for cassava cultivation

Land qualities	Land characteristics	Pedons 01	02	03	04	05	06	07	08	09	10
climate(C)											
water availability	mean annual rainfall	95	95	95	95	95	95	95	95	95	95
temperature regime	mean annual temperature	95	95	95	95	95	95	95	95	95	95
Wetness (w)											
Oxygen availability	Soil drainage	95	95	95	95	95	95	95	60	95	85
Fertility (f)											
Nutrient availability	Total Nitrogen	60	40	95	40	40	40	40	40	40	40
	Avail. P	85	85	85	85	85	85	85	85	85	85
	Exch. K	40	40	40	40	40	40	40	40	40	40
	pH	85	85	85	85	85	85	85	85	85	85
Nutrient retention	CEC	85	85	85	85	85	85	85	85	85	85
	Base sat.	95	85	85	95	85	95	85	85	85	95
Soil physical properties (s)											
Water retention Capacity	Soil texture	85	85	85	85	85	85	85	85	85	85
Rooting condition	Soil depth	95	95	95	95	95	95	95	95	95	95
Salinity (n)	E.C	95	95	95	95	95	95	95	95	95	95
Topography (t)	Slope	95	95	95	95	95	95	95	95	95	95
Aggregate Suitability		S_2	S_2	S_2	S_2	S_2	S_2	S_2	S_3-S_2	S_2	S_2

E.C – Electrical conductivity, S_2 - Moderately suitable,

Table 7 above shows that all the soil types were moderately suitable for cassava cultivation except TypicEpiaquept (pedon AC 08) and AericEpiaquept (pedon AC 10) which were marginally to moderately suitable. The major limitation of the soils was low nutrient status (NPK). TypicEpiaquept and AericEpiaquept had problem of drainage (wetness) in addition to low nutrient status.

Discussion

The infertility problem associated with the soils limited their potentials for optimum production of maize and cassava. NPK being primary nutrient elements necessary for plant growth, root growth and development, fruits and seeds production as well as translocation of plants assimilates were deficient in the soils and this resulted in the marginalization of the soils for maize and cassava cultivation. This confirms the findings of Baligar (2005) who reported that nutrient deficiency limited the productive use of soils for raising arable crops. Earlier, IITA (1999) reported that nutrient deficiency in arable lands is a common limitation to the productive use of soils for arable crops production.

The sandy texture of the soils promoted their infertility tendency through increased leaching of nitrogen and basic cations which also resulted in low soil pH.These observations affirmed the report of Mbagwu (1992) who stated that sandy soils were limited in crop production due to their low water and nutrient holding capacities and thus, lead to loss of soil fertility. Arora and Juo(1982) reported that in the absence of extraneous input of organic materials and mineral fertilizers, such soils can give a marginal or moderate yield of maize and cassava. With low to moderately acidic nature of the soils studied, nutrient availability and uptake will be limited against the crops. Hence, the acidic nature of the soils limited their optimum potential for maize and cassava production (Van Rueler and Jassen,1996).

The very low organic carbon content of pedon AC 08 (TypicEpiaquepts) limited its potential in promoting optimum performance of maize crop in particular. This agreed with Olayinka (1990) who stated that low organic carbon limited plant growth, reduced plant dry matter yield as well as limited the plants' uptake of N, P, K, Ca and Mg. However, the infertility problem of the soils can easily be improved by the use of mineral fertilizers and manure. TypicEpiaquepts (pedon AC 08), was poorly drained with a marked evidence of mottles. This therefore increased the limitation of this soil for cassava and maize cultivation. Poorly drained soils limit root growth and development due to poor aeration and roots toxicity resulting from an increase in the solubility and availability of Al^{3+} and Mn^{2+}. Hence, the soil was marginally to moderately suitable for maize and cassava cultivation (Sys *et al*., 1991).

The imperfectly drained nature of AericEpiaquepts (pedon AC 10) may not constitute a major limitation to the use of the soil for the crops except at extreme conditions of rain and flooding (Sys *et al*., 1991). Hence, all the soil types were moderately to highly suitable for maize and moderately suitable for cassava cultivation except TypicEpiaquepts (pedon AC 08) which was marginally to moderately suitable for the crops due to its dual limitations of infertility and wetness.

CONCLUSION AND RECOMMENDATION

Well drained deep soils formed on Coastal Plain Sand are moderately suitable for cassava cultivation and are moderately to highly suitable for maize cultivation and could easily be improved by good agronomic / soil management practices such as application of organic and inorganic fertilizers, crop rotation, mulching etc. However, poorly drained soils formed on the same parent material are marginally to moderately suitable for cassava and maize cultivation due to poor essential nutrient elements status as well as drainage problems.

As a result of the poor nutrient status associated with the soils, the application of soil amendments such as NPK fertilizers, organic manure (poultry droppings, pig waste, etc) and liming is recommended. More so, the practice of crop rotation and intercropping with leguminous crops as well as agroforestry systems could be suitable. In addition to these, water loving and short duration crops such as vegetable crops (*Abelmoschusesculentus, Telfairaoccidentalis, Solanumgilo, Lycopersiconesculentus* etc.) are recommended for TypicEpiaquepts and AericEpiaquepts considering their drainage problems.

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