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SUITABILITY ASSESSMENT OF UPLAND SOILS FOR CASSAVA CULTIVATION IN ABI ENVIRONS OF CROSS RIVER STATE, NIGERIA

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Abstract

The upland soils of Abi environs were evaluated for sustainable cassava production using both the parametric and non-parametric evaluation systems. Three profile pits were dug and denoted as soil unit 1, 2 and 3 and soil samples collected from identified horizons were analyzed for key physico-chemical properties; using standard routine laboratory procedures. The results obtained showed that bulk density was favourable for the cultivation of cassava (<1.8mg/kg). Particle size analysis revealed higher sand fraction with soil units showing sandy loam textures and soil unit 1, sandy clay loam. The soil units were moderately acidic (pH 5.0-6.0). Organic carbon, total nitrogen, available P, exchangeable Ca and Na and CEC were generally low in all the soil units; while base saturation was rather high in all the soil units. Suitability evaluation of the soils indicated that in term of physical land characteristics (the mean annual temperature and rainfall, drainage and soil depth) all the soil units were highly suitable (S1) for the production of cassava. In respect of soil texture soil units 2 and 3 were highly suitable (S1) while soil unit 1 was moderately suitable (S2). Apart from pH and base saturation, all the soil units were generally low in nutrient status (available P, total nitrogen, exchangeable K and CEC). Overall, the soils have thus been classified as currently not suitable (N1) due to the major constraint of fertility. To improve the fertility of the soils, adequate soil management practices such as liming, the use of organic manure and mulching are recommended.

Keywords: suitability, cassava cultivation, soil unit, non-parametric, parametric systems

1.0 Introduction

Soil suitability has to do with the evaluation of soils in a given area for specific land use type(s). In evaluating the suitability of any land/soil unit for crop production, the soil requirement for that crop must be known. In addition, evaluating soil suitability for cassava production the land units resulting from the overlay operation of the defined land qualities should be established (Morgklsawat et al, 2000). The physico-chemical properties of the soil control the availability of plant nutrients and water to a large extent and the success and failure of any species of a particular area is therefore controlled by some characteristics of the soil (Shahbarzi, 2008).Cassava (*Manihot Spp*) is described as a perennial crop which has the most active growth period in the year round. In order to increase the production of food and provision of security there is need to have knowledge about the interaction of soil, water, crop, and climate with a view of having land use planning to improve productivity (Kari, 2008). Therefore, for any soil to be suitable and for the use to be sustainable, it must address the values that are related to the degree of suitability. Poor knowledge of soil suitability for cassava cultivation has resulted to poor yield and harvest of this crop in the study area. For sustainable production of cassava, reliable soil of correct land-use systems and soil management practices as well as gaining a better understanding of the environment must be known (Aderonke & Gbadegesin, 2013). To optimize the production of cassava in the Abi environs, the soil must be evaluated in terms of its suitability for cultivation of cassava. Cassava grows well in porous, friable soils with some organic matter content and soil depth of 30-40cm with a pH of 6-7 and clay content of less than 18%. In Abi environs, little attention is given to the proper cultivation and soil requirement of this viable crop.

Abi Local Government is one of the local areas known for intensive cassava cultivation thus resulting in continuous cultivation and decline in crop yields under continuous cultivation has been documented in literature. For instance the works of Aderonke, *et al* (2013) on spatial variability in soil properties of continuously cultivated land Adeboye (1994) on the physico-chemical properties and evaluation of Kaduna Polytechnic Farm soils for arable cropping and Enwezor *et al* (1989) on Fertilizer use and management practices for crops in Nigeria. This has been attributed to lack of plant nutrients, acidification and inappropriate land use among other factors. Hence, the objective of the study is to evaluate the soils suitability for cassava production in the area.

2.0 Materials and methods

2.1 Study area

Abi Local Government Area is a riverine area, which lies between latitude 6^0 00' and 5 45' N and longitude 8°00 and 08 75'E. It shares boundaries with Yakurr Local Government Area in the east and Abia State at the west, Biase Local Government Area at the south and Ebonyi State at the North (figure1). The study area covers a land mass of 285.17sqkm (Cross-River State Ministry of Lands and Survey, 2012).

The climate of the study area is equatorial and it is made up of wet and dry seasons with an annual rainfall of about 2500mm, annual temperature of about 29°C and a relative humidity of about 60 percent.

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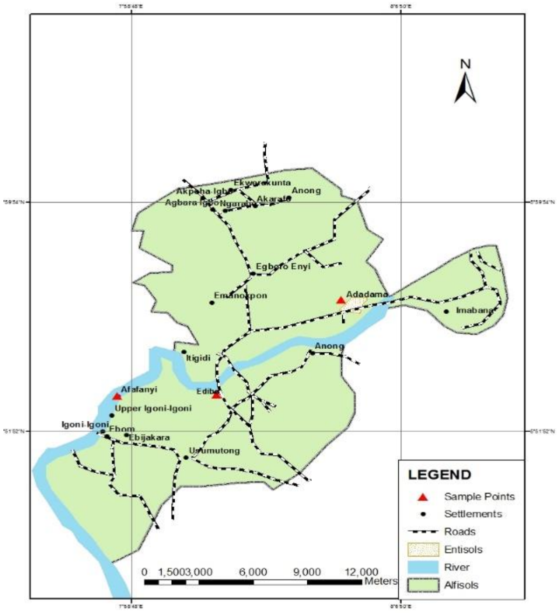

Figure 1: Abi Local Government Area showing the study locations
Source: GIS, University of Calabar

2.2 Methods of study

Three profile pits were dug for the study and designated as soil units 1, 2, 3 respectively.. Soil samples were collected from genetic horizons of the profile pits for physico-chemical analyses and suitability evaluation. The soil samples were subjected to the standard routine procedures described by Page, Miller and Keeney, (1983), Jou, (1983) and Klute ((1986). The suitability of the soils was evaluated.Non-parametric,the conventional method (FAO, 1976) was employed for the evaluation of the suitability of the soils. For the non-parametric evaluation, the soils were placed first in suitability classes by matching their characteristics with the established requirements for cassava cultivation respectively. The most limiting characteristics dictated overall suitability for each soil unit. The suitability of each factor for each soil unit was classified as highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N).

3.0 Result and Discussion

3.1 Physico-chemical properties of the soils

The results on physic- chemical properties are displayed on table 1. The mean value for bulk density in soil units 1showed 1.70g/cm^3 while that of soil unit 2 showed a mean value of 1.78g/cm^{3}whereas soil unit 3showed a mean of 1.70g/cm^3. This showed that bulk density is agronomically favourable for the cultivation of cassava since it is <1.8g/cm^3. Porosity was low (<50%) in all the soil units. Moisture content was higher in soil unit 1 (25.268%) than that of soil unit 2 (25.2%) and 3 (19.81%). The particle size analysis depicted that sand fraction was higher in soil unit 1 (74.20%) while that of soil unit 2 was 71.2%. Soil unit 3 was 72% respectively. The predominance of sand particle size fraction in the soil units implies that the soils are susceptible to erosion under heavy rains coupled with continuous cultivation that further loosen up soil aggregates (Antigha and Ibraham, 2006). However, results also revealed that more of these sand particles are concentrated in soil units 1 and3.In the other hand silt content was seen to be higher in soil unit3 than in other soil units (1 &2); whereas clay content, was higher in soil unit 2 than in the other soil units. This indicates that there was illuviation and perturbation in sub-soil of soil unit 2**(**Malgwi *et al*, 2000, & Raij, 2000). The textural classes of the soil units were sand clay loam, and sandy loam. The mean values of pH for the soil units were 5.1, 5.54, and 5.30. The soils were moderately acidic (5.00 – 6.00). The organic carbon content was higher in soil unit1 than in the other soil units. The organic carbon content was generally low in the soil units (Enwezor *et al*, 1989). The total nitrogen content was also too low for the cultivation of cassava in the study area (<0.10 mg/kg) (Udo et al, 2009). The available P was seen to be too low for cassava cultivation in the soil units (<10 mg/kg) (Uponi & Adeoye, 2000). The amounts of exchangeable bases varied over the soil units of the study area. The mean of exchangeable Ca and Na were below the critical limits for the production of cassava. Exchangeable Mg was within the critical limit for cassava cultivation (<0.5 cmol/Kg). The exchange acidity (EA) was high in the soil (>1.5 cmol/Kg) and this reflects the acidic content of the soils. The mean values of CEC were low across the soils units being <5 – 15cmol/kg. Though low it is good for cassava cultivation. Base saturation was high in all the soil units.Bulk density, porosity and pH were least variable (<15%) in all the soil units whereas moisture content, silt and clay were moderately variable in all the soil units except in soil unit 3 that showed least variability in moisture content. Organic carbon, TN, Exchangeable Mg, Na and EA were high variability in all the soil units except soil units 2 and 3 that showed moderate variability in exchangeable Na. Available P showed moderate variability in soil units 1 band 2 and least variability in soil unit 3 the same trend was observed in exchangeable Ca. Exchangeable K showed moderate variability in soil units 1 – 3. Exchange acidity showed high variability in soil units 2 and 3 and least variability in soil unit 1 whereas CEC and base saturation showed least variable except in soil units 1 and 3 while soil unit 2 showed moderate variability in CEC and base saturation. The least to high variation observed can be due to the biological materials from which the soils were formed (Omotoso and Akinnbola, (2007).

3.2 Land Suitability evaluation for cassava cultivation

When climatic requirements for cassava (FAO, 1976; Sys, 1985, 1991) (Tables 2) were matched with land quality (mean annual rainfall and temperature) of the study area (Table 3),

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Table 1

Description of physico-Chemical properties of the soils for cassava and rice cultivation

					Particles size distribution							Exchangeable bases							
	Soil Depth	BD	Porosity	MC	sand %	silt %	clay %	pH	OC	TN	Avail P	Ca	Mg	Na	K	EA	CEC	BS %	Textural Class
Soil unit 1																			
Mean	200	1.7	35	25.26	74.2	8.8	16.8	5.1	2.34	0.05	1.5	2.36	1.28	0.06	0.08	2.27	6.06	62.70	
SD		0.13	2.25	3.94	6.25	2.03	3.24	0.22	1.13	0.03	0.40	0.32	0.12	0.02	0.01	0.24	0.56	0.67	SCL
Cv%		7	8	16	8	23	19	5	46	69	27	14	39	32	16	10	9	1	
Soil unit 2																			
Mean	200	1.78	3.2	25.2	71.2	8.2	20	5.54	1.40	0.04	2.23	2.08	0.94	0.06	0.10	2.24	5.59	60.55	
SD		0.17	4.9	9.54	7.73	3.51	6.07	0.08	0.53	0.03	0.41	0.47	0.47	0.01	0.03	0.79	0.95	9.81	SL
Cv%		11	15	38	11	42	30	2	38	70	18	22	50	17	28	35	17	16	
Soil unit 3																			
Mean	120	1.71	32	19.81	72	9	19.5	5.30	2.06	0.05	2.49	3.40	1.25	0.1	0.1	1.85	6.96	75.54	
SD		0.11	2.92	2.71	5.0	1.5	4.76	0.29	1.21	0.04	0.33	0.45	0.46	0.02	0.02	0.61	0.82	8.73	SL
Cv%		4	9	14	7	17	24	5	59	73	13	13	36	19	19	33	12	12	

Key: SCL – sand clay loam, SL – sandy loam

Table 2
Established Land requirements for cassava

	Unit	S1 100 %	S2 85%	S3 60%	N1 40%
Climate condition					
Annual rainfall	mm	1500 - 1100	1100 - 900	900 - 500	< 500
Mean temperature	^{0}C	18 - 30	>16	> 12	any
Wetness (s)					
Drainage		well drained	moderately drained	poorly drained	very poorly
Fertility condition (f)					
Total Nitrogen	%	> 0.2	0.1 – 0.2	0.1	any
Available P	Mg/Kg	> 25	6 - 25	< 6	any
Exchangeable K	Cmol/kg	> 6	3 – 6	< 3	any
pH		1 – 7.3	7.4 – 7.8 or 1 – 6.0	7.9 – 8.4 or < 4.0	any
Nutrient Retention					
CEC	Cmol/kg	> 16	3 – 16	< 3	any
Base saturation	%	> 35	20 – 35	< 20	any
Soil physical characteristics (s)					
Texture		L, SL,	LS, SCL	SiC, S	C
Soil depth	Cm	>100	00 -75	75 - 50	>50

Key= L loam, SL= sandy loam, LS = Loamy sand, C= clay, SCL= sand clay loam, SiC= silt clay, S=sand,
Source = adapted from Sys et al, 1991

Table 3

Land qualities and characteristics of the upland soils at present for cassava cultivation

Parameters	Soil uni1	Soil unit 2	Soil unit 3
Climate condition(C)			
Annual mean rainfall	2500	2500	2500
Annual mean temperature	29^0C	29^0C	29^0C
Soil physical characteristics (s)			
Drainage	well drained	well drained	well drained
Soil Depth	200	200	120
Soil texture	sand clay loam	sandy loam	sandy loam
Fertility condition (F)			
pH	5.1	5.54	5.30
TN	0.05	0.04	0.05
Available P	1.5	2.23	2.49
CEC	6.06	5.59	6.96
Base saturation	62.70	60.55	75.54
Exchangeable K	0.08	0.10	0.1

Table 4
Suitability Assessment of the upland soils for cassava production

Parameter	Soil unit 1	Soil unit 2	Soil unit 3
Climate condition			
Annual rainfall	S1	S1	S1
Annual Mean temperature	S1	S1	S1
Wetness (s)			
Drainage	S1	S1	S1
Fertility condition (f)			
Total Nitrogen	N	N	N
Available P	N	N	N
Exchangeable K	N	N	N
pH	S1	S1	S1
CEC	S2	S2	S2
Base saturation	S1	S1	S1
Soil physical characteristics (s)			
Texture	S2	S1	S1
Soil depth	S1	S1	S1
Overall suitability	**N1 (f)**	**N1 (f)**	**N1 (f)**

Key: S1 = highly suitable, S2 = moderately suitable, S3 = marginally suitable, N = Not suitable, N1=currently not suitable; **Limitations:** f = fertility limitation all the soils were highly suitable (S1) for cassava cultivation (Tables 4). These results depicted that the study area is currently ideal in terms of climate for the cultivation of cassava. Soil physical characteristics considered for the cultivation of cassava were soil depth, texture and drainage. Soil depth was highly suitable (S1) for cassava cultivation across the soils units (tables 4).The soil texture was highly suitable in all soil units for cassava cultivation. (Sys, 1985, 1991)

For soil drainage (wetness), the results of matching the crop requirements with land characteristics showed that soils units (1 - 3) were highly suitable (S1) for cassava .For soil fertility characteristics (f) available P, total nitrogen and Exchangeable K were seen to be not suitable (N) for cassava cultivation in all soil units of the study areas when compared with the requirements of crop (FAO, 1976). Generally, pH was highly suitable (S1) across the soil units. Whereas cation exchangeable capacity (CEC) was seen to be moderately suitable (S2) for cassava cultivation in the study area base saturation was highly suitable (S1) in all the soil units for cassava cultivation (Table 4).From the results of the aggregate (overall) suitability, all the soils units of the study area were currently not suitable (N) for the cultivation cassava. The major land characteristic limiting of this crop was fertility status of the soil. These findings aligned with the findings of Eze (2014) on soil characterization and land suitability evaluation of farmland in Nsukka Local Government Area of Enugu State of Nigeria where the same trend was observed. However, if land use types of the three soil units are improved, taking into consideration those properties that are easily altered (Total nitrogen, available P and exchangeable K), they will be highly suitable for cassava production in the study area.

4.0 Conclusion

The suitability evaluation results showed that land characteristics such as annual mean rainfall, annual mean temperature, and the soil texture were highly suitable for the production of cassava. However, the fertility characteristics such as total nitrogen, available phosphorus, exchangeable K and CEC were generally low; hence the soils have been classified as currently not suitable (N1) for cassava cultivation. The soils have a major limitation of fertility and so rated as (N1f). Therefore, to obtain maximum or optimum cassava output in the area adequate soil management practices including liming, use of manure, mulching and appropriate application of fertilizer should be adopted.

Reference

Aderonke, D. O. & Gbadegesin, G. A. (2013). Spatial variability in soil properties of continuously cultivated land. African Journal of Agricultural Research, 8(5): 475-483.

Adeboye, M. K. A. (1994). The physico-chemical properties and evaluation of Kaduna Polytechnic Farm soils for arable cropping. Spectrum, 1: 36-42.

Cross River State Ministry of lands and Survey, (2012). Population and land Survey in Cross River State

Antigha, N.R; and Ibrahim A (2006) Relationship between infiltration rate and hydraulic conductivity of soils ObufamEsuk Oro in Calabar area southeast Nigeria Proceedings of the 31st Annual conference of soil Science Society of Nigeria. Ahmadu Bello University, Zaria, Nigeria. November 13-17th 218-224

Enwezor,W.O, Udo, E.J; Chude, V.O, Ayotade, K.A and Adepetu, A.A (1989) Fertilizer use and management practices for crops in Nigeria.

Eze, N.C (2014): Soil characterization and land suitability evaluation of Nsuka farmland in Nsukka local government area of Enugu state, Nigeria, a dissertation submitted in partial fulfillment of the requirements for the award of the degree of master of Science (M.Sc.) soil science (soil survey, classification and land use management)

FAO,(1976): A framework to Land evaluation. FAO soils Bulletin:32: FAO, Rome

Juo, A, S.R (1983): Phosphorus absorption characteristics of some bench – mark soils of West Africa Soc. Sci 107:214 -220

Klute, A. (1986): Methods of soil analysis part 1 physical mineralogical properties (2nd edition) American Society of Agronomy, Inc Wisconsin pp 1188.

Kari, F.I (2008): Determinant of sustainability of cassava production in Nigeria: Delta Region of Nigeria, Journal of Economics and sustainable Development Vol 5 No14

Malgwi, W. B., Ojanuga, A. G., Chude, V. O., Kparmwang, T, and Raji, B. A, (2000). Morphological and Physical Properties of some soils of Samaru, Zaria. Nigerian Journal of Soil Research, 1: 58-64.

Omotoso, S.O & Akinbola, G.E (2007): Variability of soil properties at the transition zone between two parent materials in southwest Nigeria. International Journal of soil Science 2:218-223

Mongkolsawat, C; Thairangoon, P and Kuptawutiana, P. (2000). A physical evaluation of land suitability for rice: A methodological study using GIS. Proceedings of 18th Asian conference on remote sensing, Malaysia.

A.I, Miller R. H and Keeney, D.R. (1982:.Methods of soil Analysis part 2 – chemical and microbological properties 2nd edition, American Society of Agronomy; Wisconsin pp 1159

Raji, B.A, Malgwi, W.B, Falaki A. M and Kparmwang T (2000) Characterization and classification of soils in Jangargari alluvial complex in the semi-arid region of Nigeria, Proceedings of the 27th Annual conference of the SSSN pp 52-59.

Sys C. (1991). Land evaluation and crop production and calculations, Agric publication,No.7. General Admin for Development Corporation, Brosels: 247.

Uponi J.I and Adeoye, G.O (2000): Keys to soil taxonomy, United States Department of Agriculture (USDA 9thed) 263-385

Udo E.J, Ibia, T.O and Ogunwele, J.A, (2009): Manual of soil, plant and water analysis. Sibin Books Limited.