Nigerian Journal of Soil Science 25 (2015) 125 – 134

Nigerian Journal of Soil Science

Journal homepage:www.soilsjournalnigeria.com

SUITABILITY ASSESSMENT OF SOILS SUPPORTING OILPALM PLANTATIONS IN THE COASTAL PLAINS SAND, IMO STATE, NIGERIA

Ukaegbu, E.P.[1], Osuaku, S.K.[1], and Okolo, C.C.[2]

[1]*Department of Agric. Science, Alvan Ikoku Federal College of Education, Owerri Imo State*

[2]*Department of Soil Science, University of Nigeria Nsukka, Enugu State*

E-mail: emekaprosper2@yahoo.com

ABSTRACT

Due to declining yield of Oilpalm, soils of the coastal plains sand of Imo State supporting oil palms were evaluated. A bulked sample was taken from each of ten sites studied, at 0 – 20cm and 20 – 40cm depths and analysed in the Laboratory. Soils textures were dominated by sandyloam at the surface, but sandy clayloam at the subsurface. Ranges of values of parameters at the topsoil were: pH(4.1 – 5.6), ECEC (5.7 – 8.7cmol/kg), BS (36 – 87%), OM (1 – 4.7g/kg), TN (0.01 – 0.14g/kg), Av. P (6 – 48mg/kg), Fe (0 – 233mg/kg), Cu (0 – 1.2mg/kg), Zn (0.3 – 14mg/kg), Mn (5.7 – 145.6mg/kg). Fertility Capability Classification (fcc) identified in the soils the condition modifiers – g (gley – in the valleys), e (low cec), h (strong acidity), and k (low content of k). But by suitability rating, the main limiting factors were – OM (N), TN (S3/N), K (S3/S2). Generally, the soils were moderately suitable (S2) for oilpalm cultivation. Slight drainage of sites on alluvium, moderate liming (particularly of alluvial soils), liberal application of nitrogenous fertilizer and moderate application of potassic fertilizer are recommended. The parametric method of assessment was more realistic than the non-parametric.

Keywords: Oilpalm, Coastal Plains Sand, Soil Properties, Suitability Assessment.

INTRODUCTION

Oilpalm (Elaeis guineensis) is an important economic tree which, according to Komolafe et al (1979), originated in tropical West Africa. Adeniji et al (1991) report it as a source of food (oil), palmwine, palmkernel cake for feeding livestock, and palmoil for making soap, pomade, magarine, candles etc. So, if well managed, the crop has the potential of positively contributing to the transformation of the country's (Nigeria) economy.

However, Nigerian Institute for Oilpalm Research (NIFOR) (1986) noted that the acid sand types of soils in Nigeria, which are the more important oilpalm growing soils, are deficient in nutrients. Similarly, Udom (2002) reported a drastic falling off in yield of oilpalm plantations in Nigeria and Cameroun, which he attributed to declining soil Fertility and improper manage- ment of plantations. His study included 'Ada- palm plantation' which is in the coastal plains sand of Imo State, the location of this study. The management of the soils is the more compounded by the use of plantation sites for arable cultivation. This challenge is captured by Ohaji-anya (2006) who reported poor resource use efficiency in Imo State resulting in poor yield of major food crops – yam, cassava, maize.

The foregoing therefore underscores the need for improved management of the soils supporting oilpalm plantations in the coastal plains sand of Imo State. By matching the requirements of landuse to land qualities (FAO, 1976), soil management is optimized and productivity enhanced. This then provides a good basis for advising farmers on appropriate management practices. The study thus assessed soils of ten sites in the location of study supporting oilpalm, to highlight their limiting qualities and management requirements.

MATERIALS AND METHODS

Location. Study location is within Lat. 5015|N and 5045|N, and Long. 7030|E and 6045|E. It is within the humid tropics. Mean annual temperature is 270 – 280C (800 – 820F) (Monanu, 1975a); total annual rainfall is 2250 – 2500mm (Monanu, 1975b), having three dry months in which total rainfall is less than 60mm (Inyang, 1975). The location is in the rainforest region dominated by oilpalms (Elaeis guineensis) and Hyparrhenia grass species (Igbozurike, 1975). However, Ukaegbu (2014) records the soils parent materials as alluvium (in the river valleys), subrecent alluvium (in delta), and coastal plains sand (in the upland), as indicated in table 1. Following the standards of USDA Soil Taxonomy (Soil Survey Staff, 2010) and FAO (1998) World reference base for soil resources, Ukaegbu (2014) further records the soils' classifications as indicated in table 1. Alluvial soils of the inland valleys (sites 1, 2, 3) are classified as Fluvaquentic Eutrudepts (USDA) and Gleyic – Fluvisol (FAO). Those of uplands (sites 4 to 9) are classified as Typic Paleudult (USDA), and Haplic Ferralsols (FAO). Soil of delta is classified as Typic Paleudult (USDA) and Haplic Ferralsol (FAO).

Sampling. Table 1 shows the description of sites sampled.

Samples were taken by Free Survey Technique from a quarter of an hectare within each plantation site, as some were less than half an hectare in area. A minimum of five samples (spread the entire area sampled) were taken from each of 0 – 20cm and 20 – 40cm depths and bulked, such that each site had a bulked sample for each depth sampled. Total of twenty (20) bulked samples were thus taken to the laboratory for analyses.

Table 1: Descriptions of sites sampled

					Soil Classification		
S/N	Site	L.G.A.	Physiography	Parent Material	USDA	FAO	Landuse
1.	By Okpala/Owerrinta bridge	Ngor-Okpala	Imo river valley	Alluvium	Fluvaquentic Eutrudepts	Gleyic-Fluvisol	Wildpalm
2.	Nri-Amuzu	Aboh-Mbaise	Imo river valley	Alluvium	Fluvaquentic Eutrudepts	Gleyic-Fluvisol	Plantation
3.	Emekuku	Owerri North	Okatankwo river valley	Alluvium	Fluvaquentic Eutrudepts	Gleyic-Fluvisol	Plantation
4.	Nguru	Aboh-Mbaise	Upland plain	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Plantation
5.	Umuokrika-Ekwerazu	Ahiazu-Mbaise	Upland plain	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Plantation
6.	Umuahia-Ohekelem	Ngor-Okpala	Upland plain	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Haplic-Ferralsols
7.	Emekuku	Owerri-North	Gentle slope	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Plantation
8.	Ngugo	Ikeduru	Upland plain	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Plantation
9.	Ohaji	Ohaji/Egbema (Adapalm)	Upland plain	Coastal plains sand	Typic paleudult	Haplic-Ferralsols	Plantation
10.	Oguta	Oguta	Deltaic plain	Subrecent alluvium	Typic paleudult	Haplic-Ferralsols	Plantation

Laboratory Analyses: Samples were air-dried and sieved with a sieve of 2mm mesh size. The fine-earth fraction was analysed using standard procedures. Particle size analysis was by Bouyoucos (1951) hydrometer method, using sodium hexametaphosphate as dispersant. Soil pH was determined using a glass electrode pH meter in a soil-to-water ratio of 1:2.5. Organic carbon was by the Walkley and Black (1934) method. Organic matter was then got by multiplying the value of organic carbon with 1.724. Total nitrogen was determined by Macro-Kjeldahl method of Black (1965). Available phosphorus was determined by Bray and Kurtz (1945) No 11 Method. Exchangeable bases were extracted with neutral normal ammonium acetate solution; Ca++ and Mg+= in the extract were determined by EDTA titration, while K+ and Na+ were determined by flame photometry. Exchangeable acidity was determined by the method of Mclean (1965). Total Exchangeable Bases (TEB) was obtained by summation of the exchangeable bases (Na, K, Ca, Mg). Effective Cation Exchange Capacity (ECEC) was calculated as the summation of total exchangeable bases and exchange acidity. Base saturation was got by expressing TEB as a percentage of ECEC. Micronutrients were extracted with IMHCL solution and their extractable contents determined using Atomic Absorption Spectrometry (Buick Scientific Atomic Absorption/Emission Spectrometer 205).

Evaluation Procedure: Soil parameters were rated using critical values recorded in literature. On the other hand, productivity/suitability rating indices of parameters and soils were expressed as percentage of their optimal rates using an adaptation of the scheme by Jasbir et al (1988) given as:

$$\text{Suitability (Productivity) Rating Index} = \frac{\text{Actual rating}}{\text{Optimal rating}} \times 100$$

This scheme is based on the fact that output from good quality land under optimal conditions should be the standard for determining the suitability of other types of land. The scheme brings parameters to same term. Maximum value of 'moderate rating', which otherwise is minimum for 'high rating', is taken as optimal for the parameters considered. These are: O.M. – 3%/30g/kg (Landon, 1991); pH – 6.5 (Adeniji et al., 1991); TN – 0.15% (Chude, et al. 2011); Av. P – 25mg/kg (Enwezor et al, 1989); Exch. K – 0.25cmol/kg (Chude et al., 2011); Base saturation was taken as normally expressed; Exch. Mg – 0.5cmol/kg (Landon, 1991).

Soil texture was rated on the bases of silt and clay percentages, taking their average rating for that of texture. 50% and 30% were taken as respective optimal values of silt and clay (Savalia et al., 2009) in Loam, considered optimal for the growth of oilpalm.

The average rating of all parameters considered represents that of the site.

To determine the suitability class of parameters and of course soils, the suitability rating index values are referred to the rating scale of Dent and Young (1981) given below:

Table 2: Soil Suitability Rating Scale

Suitability Rating Index	Suitability Class
>80%	Highly suitable (S_1)
40 – 80%	Moderately suitable (S_2)
20 – 40%	Marginally suitable (S_3)
<20%	Not suitable (N)

NB: Describing these as supplementary definitions of suitability classes employed for assessment in terms of individual land qualities, Dent and Young (1981) define the classes in terms of expected crop yields as percentage of yields under optimal conditions, in the absence of inputs specific to the land quality considered, on one hand; while on the other, defined in terms of inputs specific to the land quality considered, necessary to achieve yields of >80% of those under optimal conditions.

Fertility Capability Classification (FCC): Results of laboratory analyses of the samples taken with the auger, along with the morphological properties of soil units as recorded by Ukaegbu (2014) were used to determine Fertility Capability Classification. The conversion data used in evaluating the soils are as outlined by Sanchez et al (1982). The system consists of three categorical levels, 'type' (texture of plough layer or top 20cm), 'substrata type' (texture of subsoils), and 'modifiers' (soil properties or conditions which act as constraints to crop performance). FCC units were determined by combining class designations from the three categorical levels.

RESULTS AND DISCUSSION

A survey of the location of study showed most oilpalm plantations to be on the upland of the coastal plains sand. This is reflected in table 1 as seven of the sites studied were on the well drained upland. Only sites 1, 2, 3 were in the valleys, poorly drained some parts of the year during the heavy rains. The Fertility Capability Classification (FCC) of soils (table 5) recorded the condition modifier 'g' in the sites, indicating gleying. This quality alone makes the sites unsuitable for oilpalm cultivation due to the defective oxygen supply. However, this deficiency seems to compensate the dry months of the year, when other sites suffer moisture deficits. This perhaps explains the relative high rating of other soil qualities in the sites.

The physical and chemical properties of soils are recorded in tables 3 and 4.

Table 3 shows that the surface soils' (0 – 20cm) textures are mostly sandy loam, while subsurface (20 – 40cm) textures are dominated by sandyclay loam. By the rating of FAO (1987), the soils are medium textured. FCC (table 5) classifies the topsoils mainly as Loam, with only sites 9 and 10 rated as sand. At the subsurface soils' textures have also been dominated by Loam with the exception of site 2 rated as clay. But relative to Loam (considered ideal for oilpalm cultivation) the topsoil textures have rated marginally suitable (S3), while the subsoil is mostly moderately suitable (S2) as indicated by table 6. The textures of sites (1, 2, 3) on alluvium are most suitable, while those of delta (site 10) is most unsuitable due to its sandy nature. The soils' textures do not only show ability to retain moisture, but also potential for nutrient retention. But generally, the soils' textures are good for the cultivation of oilpalm.

The organic matter (OM) contents of soils (table 3) range between 1.0g/kg to 4.7g/kg at the surface, but 0.14g/kg to 1.71g/kg at the subsurface. By the rating of Landon (1991), the OM contents are generally low. This is reflected by table 6 as the parameter rated 'not suitable' – N, in all the sites and at both depths considered. The low contents agree with, what is recorded about the 'Acid Sands' of southeastern Nigeria by Enwezor et al (1981), the low contents being attributed to rapid rate of mineralization in the humid tropics. The highest value of 4.74g/kg was got at the surface of Imo river valley, subject to seasonal water logging which slows down rate of decomposition. The low OM contents limit soils both physically and chemically.

The soil's effective cation exchange capacity (ECEC) has been found to range between 5.3 – 9.4cmol/kg at the surface, but 5.3 – 16.8 cmol/kg at the subsurface (table 3). Followign the rating for oilpalm in surinam (FAO, 1976), these values are high and therefore do not limit crop growth and yield. However, FCC identifies it as low, with 90% of sites studied having the condition modifier 'e'. This means low ability to retain nutrients, hence fertilizer application

Table 3: Physico-Chemical Properties of Soils

Site	Sampling Depth (cm)	Particle Size Distribution (%) Sand	Silt	Clay	Text. Class	pH (H_2O)	Exch. Bases Ca^{++}	Mg^{++}	K^+	Na^+	Al^{3+} (cmol/kg)	H^+	Al+H	ECEC	B.S. (%)	ESP	Al-Sat.	OM (g/kg)	TN (g/kg)	Av.P (mg/kg)
1.	0 – 20	66	13	21	SCL	5.6	0.8	2.8	0.09	0.19	1.76	1.56	3.28	7.2	54	2.64	24.44	1.23	0.12	19.0
	20 – 40	50	20	30	SCL	5.8	2.0	0.8	0.10	0.24	2.56	2.40	4.96	8.1	39	2.96	31.60	1.52	0.12	18.0
2.	0 – 20	20	51	29	SiCL	5.0	4.8	0.8	0.28	0.11	0.36	1.0	1.36	7.4	81	1.49	4.86	4.74	0.06	32.0
	20 – 40	12	48	40	SiC	4.3	5.6	0.4	0.12	0.10	4.20	6.36	10.56	16.8	37	0.60	25.0	1.71	0.02	46.0
3.	0 – 20	76	9	15	SL	4.6	2.0	2.0	0.12	0.16	0.04	1.0	1.04	5.3	81	3.02	0.75	1.97	0.03	28.0
	20 – 40	68	11	21	SCL	4.8	2.8	1.20	0.11	0.25	0.40	0.80	1.20	5.6	78	4.46	7.14	1.71	0.03	44.0
4.	0 – 20	76	7	17	SL	4.4	4.8	1.6	0.09	0.24	0.56	1.44	2.0	8.7	77	2.76	6.44	1.19	0.01	17.0
	20 – 40	68	3	29	SL	4.5	2.8	0.8	0.04	0.20	0.24	1.52	1.76	5.6	69	3.57	4.29	0.14	0.20	17.0
5.	0 – 20	79	7	15	SL	5.5	1.6	2.8	0.20	0.15	0	1.68	1.68	6.4	74	2.34	0	1.31	0.04	48.0
	20 – 40	69	7	24	SCL	4.9	0.8	2.0	0.09	0.08	0.56	2.32	2.88	5.9	51	1.36	9.49	1.57	0.04	26.0
6.	0 – 20	74	11	15	SL	5.0	2.0	1.6	0.17	0.06	1.32	2.0	3.32	7.1	54	0.85	18.59	1.45	0.14	18.0
	20 – 40	56	19	25	SCL	5.0	1.0	0.6	0.11	0.27	0.16	3.12	3.28	5.3	38	5.09	3.02	0.69	0.04	44.0
7.	0 – 20	75	10	15	SL	5.3	4.4	4.8	0.15	0.24	1.04	0.88	1.92	11.5	83	2.09	9.04	1.83	0.01	14.0
	20 – 40	75	6	19	SL	5.2	2.4	1.6	0.10	0.20	0.80	1.36	2.16	6.5	67	3.08	12.31	1.59	0.01	18.0
8.	0 – 20	71	5	24	SCL	5.3	1.2	0.8	0.17	0.09	0.88	3.20	4.08	6.3	36	1.43	13.97	1.0	0.04	10.0
	20 – 40	67	6	27	SCL	5.1	1.6	0.8	0.06	0.04	0.96	2.56	3.52	6.0	42	0.67	16.0	0.69	0.04	8.5
9.	0 – 20	86	3	11	LS	4.2	2.4	1.2	0.09	0.17	0.72	0.72	1.44	5.3	73	3.21	13.58	2.24	0.11	15.0
	20 – 40	75	2	23	SCL	4.2	1.6	2.8	0.06	0.23	1.20	0.64	1.84	6.5	72	3.54	18.46	0.66	0.02	14.0
10.	0 – 20	90	5	5	S	4.1	5.6	2.4	0.09	0.12	0.42	0.82	1.22	9.4	87	1.28	4.47	1.33	0.01	6.0
	20 – 40	86	8	6	LS	5.0	4.6	1.4	0.08	0.12	0.28	1.0	1.28	7.5	83	1.60	3.73	0.95	0.02	13.0

Key:

SCL	=	Sandyclayloam	SiCL	=	Siltyclayloam
SiC	=	Siltyclay	SL	=	Sandyloam
LS	=	Loamysand	S	=	Sand

Table 4: Topsoil contents of some Micronutrient Elements at the sites

Site	Fe	Cu	Zn	Mn
	mg/kg	mg/kg	mg/kg	mg/kg
1.	233.0	0.4	1.6	4.9
2.	72.4	0.7	6.5	145.6
3.	207.3	1.2	14.0	24.2
4.	0	0.3	0.7	7.7
5.	66.5	0.3	2.0	24.9
6.	19.1	0.1	0.5	22.1
7.	12.5	1.5	2.3	5.4
8.	38.9	0.1	0.3	5.7
9.	16.8	0	0.4	44.7
10.	0	0	7.0	55.3

should be split. The ECEC values signify the dominance of the 1:1 type of clay and of course the importance of OM in sustaining soil fertility.

The soils' reactions are extremely acid to moderately acid at both surface and subsurface soils. The pH values are 4.1 to 5.6 at the surface but 4.2 to 5.8 at the subsurface. The acid nature of soils is also captured by FCC with 90% of sites studied registering the condition modifier 'h', indicating strong to medium acidity. The exch. acidity values also reflect the soils' reactions. At the surface, values range between 1.04 – 4.08 cmol/kg, but 1.20 – 10.56 cmol/kg at the subsurface, with the highest value of 10.56 cmol/kg got at the subsurface soil of Imo river valley. This result compares with the finding of Ibanga and Iren (2006) on soils of plantations of University of Calabar, Cross River State and Ikot Ekpene of Akwa Ibom State. However, the crop seems to withstand the acidity. Jacquemard et al (1998) note that oil palm can cope with acid soils with a pH as low as 4. This claim is supported by the rating of the soils' pH (table 6), using pH 6.5 as optimal for the crop. Table 6

Table 5: Fertility Capability Classification (FCC) of Soils

	substrata		Condition Modifiers														FCC
Site	Type 1	Type 2	g	d	e	a	h	i	x	v	k	b	s	n	c	Unit
1.	L	-	+	-	+	-	+	-	-	-	+	-	-	-	-	Lgehk
2.	L	C	+	-	+	+	-	-	-	-	-	-	-	-	-	LCgea
3.	L	-	+	-	+	-	+	-	-	-	+	-	-	-	-	Lgehk
4.	L	-	-	-	+	-	+	-	-	-	+	-	-	-	-	Lehk
5.	L	-	-		+	-	+	-	-	-	+	-	-	-	-	Lehk
6.	L	-	-	-	+	-	+	-	-	-	+	-	-	-	-	Lehk
7.	L	-	-	-	-	-	+	-	-	-	+	-	-	-	-	Lhk
8.	L	-	-	-	+	-	+	-	-	-	+	-	-	-	-	Lehk
9.	S	L	-	-	+	-	+	-	-	-	+	-	-	-	-	SLehk
10.	S	-	-	-	+	-	+	-	-	-	+	-	-	-	-	Sehk

Key:

S = Sandy, L = Loamy, C = Clayey,
g = gley, d = dry, e = low CEC,
a = aluminium toxicity, h = acidic, i = high fixation of p by iron,
x = x-ray amorphous, v = vertisol, k = k deficient,
b = basic reaction, s = salinity, n = nitric, c = cat clay

shows the soils to rate between S1 and S2 at both depths, in all sites. This is corroborated by the soils' base saturation ranging between 36% and 87% at the surface, but 37% to 83% at the sub-surface. By the standards of FAO (1987) these are between medium and high. The parameter

Table 6: Productivity Rating of Parameters given as percentages of their Optimal Rate and their Suitability Classes

									Average Rating of Soils	
Site	**Depth (cm)**	**Texture**	**OM**	**pH**	**TN**	**Av.P**	**K**	**BS**	**A**	**B**
1.	0 – 20	48(S_2)	4(N)	86.2(S_1)	80(S_1)	76(S_2)	36(S_3)	54(S_2)	54.9(S_2)	
	20 - 40	70(S_2)	5(N)	89.2(S_1)	80(S_1)	72(S_2)	40(S_3)	39(S_3)	56.4(S_2)	55.7(S_2)
2.	0 – 20	99(S_1)	15.8(N)	76.9(S_2)	40(S_3)	128(S_1)	112(S_1)	81(S_1)	79(S_2)	
	20 - 40	114.7(S_1)	5.7(N)	66.2(S_2)	13.3(N)	184(S_1)	40(S_3)	37(S_3)	67(S_2)	73(S_2)
3.	0 – 20	34(S_3)	6.7(N)	70.8(S_2)	20(S_3)	112(S_1)	48(S_2)	81(S_1)	53.3(S_2)	
	20 - 40	46(S_2)	5.7(N)	73.9(S_2)	20(S_3)	176(S_1)	44(S_2)	78(S_2)	63.4(S_2)	58.4(S_2)
4.	0 – 20	35.3(S_3)	4(N)	67.7(S_2)	6.7(N)	68(S_2)	36(S_3)	77(S_2)	42.1(S_2)	
	20 - 40	50.1(S_2)	0.31(N)	69.2(S_2)	133.3(S_1)	68(S_2)	16(N)	69(S_2)	57.9(S_2)	50(S_2)
5.	0 – 20	32(S_3)	4.3(N)	84.6(S_1)	26.7(S_3)	192(S_1)	80(S_1)	74(S_2)	78.7(S_2)	
	20 - 40	47(S_2)	5(N)	75.4(S_2)	26.7(S_3)	104(S_1)	36(S_3)	51(S_2)	71.3(S_2)	75(S_2)
6.	0 – 20	36(S_3)	5(N)	76.9(S_2)	93.3(S_1)	72(S_2)	68(S_2)	54(S_2)	57.9(S_2)	
	20 - 40	60.6(S_2)	2.3(N)	76.9(S_2)	26.7(S_3)	176(S_1)	44(S_2)	38(S_3)	60.7(S_2)	59.3(S_2)
7.	0 – 20	35S_3)	6(N)	81.5(S_1)	6.7(N)	56(S_2)	60(S_2)	83(S_1)	47(S_2)	
	20 - 40	37.6(S_3)	5.3(N)	80(S_1)	6.7(N)	72(S_2)	40(S_3)	67(S_2)	44.1(S_2)	45.6(S_2)
8.	0 – 20	45(S_2)	3.3(N)	81.5(S_1)	26.7(S_3)	40(S_3)	68(S_2)	36(S_3)	43(S_2)	
	20 - 40	51(S_2)	2.3(N)	78.5(S_2)	26.7(S_3)	34(S_3)	24(S_3)	42(S_2)	37(S_3)	40(S_3)
9.	0 – 20	21.3(S_3)	7.3(N)	64.6(S_2)	73.3(S_2)	60(S_2)	36(S_3)	73(S_2)	47.9(S_2)	
	20 - 40	40.3(S_3)	2.3(N)	64.6(S_2)	13.3(N)	56(S_2)	24(S_3)	72(S_2)	38.9(S_3)	43.4(S_2)
10.	0 – 20	13.3(N)	4.3(N)	63.1(S_2)	6.7(N)	25(S_3)	36(S_3)	87(S_1)	33.6(S_3)	
	20 - 40	18(N)	3.3(N)	76.9(S_2)	13.3(N)	52(S_2)	32(S_3)	83(S_1)	42.7(S_2)	38.2(S_3)

NB:

A = Average rating of soils for each of the depths considered.

B = Average rating of soils for both depths.

has rated high (S1) and moderate (S2), as shown by table 6. The values exceed 35% regarded as critical for the growth of oilpalm, according to Ibanga and Udo (1996).

Similarly, using a critical value of 20% for Al-saturation (Abangwu et al., 1978), it is only at sites 1 and 2 (table 3) that the value is exceeded. At a critical value of 0.2 cmol/kg (Meredith, 1965), the soils are not deficient in calcium. Similarly, using the critical value of 0.5 cmol/kg (Landon, 1991) the soils are not deficient in magnesium. However, most of the soils are deficient in exch. K using the critical value of 0.2 cmol/kg of Kyuma et al. (1986). The FCC, as shown in table 5, rates 90% of sites deficient (k) in potassium. However, using an optimal value of 0.25 cmol/kg, 40% of sites rated marginal (S3), while 60% rated between moderate and high. At the subsurface, 70% of sites rated marginal (S3). This is shown by table 6.

By the rating of Chude et al. (2011) 80% of sites are deficient in total nitrogen at both depths. The range at the surface is 0.01 to 0.14, while at the subsurface it is 0.01 to 0.20. The parameter (table 6) rates marginal (S3) and not suitable (N) at the topsoil for 70% of sites; while at the subsurface, 80% of sites are between marginal (S3) and not suitable (N). The low nitrogen contents are associated with the low OM contents of the soils.

On the other hand, available-P contents of the soils have been found high following the rating of Chude et al. (2011). At the surface, it ranges between 6mg/kg and 48mg/kg, while it is 8.5 to 46mg/kg at the subsurface. Table 6 shows the parameter to rate between moderate (S2) and high (S1) at the surface for 80% of the sites; while at the subsurface 90% of sites rate between moderate (S2) and high (S1). The parameter is not limiting, but the very high contents in some sites could upset the balance of nutrients. NIFOR (1986) notes that magnesium deficiency may be induced by the application of potassium fertilizer. But the high content of phosphorus may not adversely affect trace element availability. In land suitability assessment of Surinam for Oilpalm as recorded by FAO (1976) trace element availability or phosphate fixation was not considered, the reason being that oilpalm is a deep rooting perennial and has relatively low requirement with regard to nutrient activity. The available-P content seems influenced by management as the sties with high contents have recent mounds used for arable cultivation.

Table 4 shows the surface soil micronutrient contents. The high iron (Fe) content of highly weathered tropical soils is also found in the location, where it ranges between 0 and 233 mg/kg. Mn ranges between 4.9 and 145.6 mg/kg. The rest (Cu and Zn) range between 0 and 14mg/kg. Apart from site 10 where Fe was not detected, and sites 9 and 10 where Cu was not detected, the soils generally were not deficient in the micronutrient elements. Rather, there could be micronutrient (iron) toxicity, particularly in the alluvial soils. The high contents of Fe in the sites (1, 2, 3) are attributable to the periodic flooding of sites.

Generally, the soils have rated moderately suitable (S2) for oilpalm cultivation, as shown by table 6. The rating seems influenced by management. Sites 8, 9 and 10 having least scores (38.2 to 43.4%) had least rating scores for available-P and exch. K, both of which are highly influenced by management. Sites used for arable cultivation (e.g. site 5) have palm fronds pruned and trash burnt before cultivation. And subsequently, there is fertilizer application. These practices reduce soil acidity, while increasing the N, P and K contents of soils. However, the moderate (S2) rating of soils means that inputs needed to raise soil productivity to >80% of those under optimal conditions are both practicable and economic.

The parametric method of assessment is more realistic than the non-parametric as all sites would have rated ‘N’ by the later method on grounds of limiting OM content – a result that would not agree with popularity of crop in the location.

CONCLUSION

Oilpalms are concentrated on the well drained uplands of coastal plains sand where soils’ productivity is limited mainly by low contents of OM, TN, and exch. K; while alluvial soils supporting a few plantations are limited mainly by water logging.

Generally, the soils are moderately suitable (S2) for oilpalm cultivation.

REFERENCES

Abangwu, A.R., Udo, E.J. and Edward, D.G. (1978). The effect of liming of acid tropical soils on the yield response and nutrient uptake of two cowpea cultivars. Nig. J. Sci. 12:151-161.

Adeniji, M.O., Udeogalanya, A.C., Okeke, G.C., Abdullahi, Y., Iheukwumere, C.A. (1991). Countdown to Senior Secondary Certificate Examination: Agricultural Science. Ibadan, Evans Brothers (Nigeria Publishers) Ltd. Pp 214.

Black, C.A. (1965). Methods of Soils Analysis. Agronomy No. 9 Amer. Soc. of Agron. Madison, Wisconsin.

Bouyoucos, G.J. (1951). A recalibration of the hydrometer method for making mechanical analysis of soils. Agronomy Journal 43:435-438.

Bray, R.H. and Kurtz, L.T. (1945). Determination of total and available forms of phosphorus in soils. J. Soils Sc. 53:39-45.

Chude, V.O., Malgwi, W.B., Amapu, I.Y., Ano, O.A. (2011). Manual on Soil Fertility Assessment. Federal Fertilizer Department in Collaboration with, National Programme for Food Security, Abuja-Nigeria. Pp 62.

Dent, D. and Young, A. (1981). Soil Survey and Land Evaluation. George Allen and Unwin, London. 278pp.

Enwezor, W.O., Udo, E.J. and Sobulo, R.A. (1981). Fertility Status and Productivity of the “Acid Sands”, In: Udo, E.J. and Sobulo, R.A. (Eds). “Acid Sands” of Southern Nigeria, SSSN Special Pub. Monograph No. 1, 56-73.

Enwezor, W.O., Udo, E.J., Usoroh, N.J., Ayotade, K.A., Adepeta, J.A., Chude, V.O. and Udegbe, C.I. (1989). Fertilizer use and Management Practices for Crops in Nigeria. Series No 2. Fertilizer Procurement and Distribution Division, Federal Ministry of Agriculture, Water Resources and Rural Development, Lagos, Nigeria 163pp.

FAO (1976). A Framework for Land Evaluation. FAO Soils Bull. 32. FAO, Rome. 87pp.

F.A.O. (1987). World Soil Resources Report No. 60, FAO/UNESCO Soil Map of the World, Revised Legend. FAO, Rome, Italy.

F.A.O. (1998). World reference base for soil resources. 84 World Soil Resources Report, Int. Soc. of Soil Science. Rome.

Ibanga, I.J. and Udo, E.J. (1996). Soil Survey and Fertility Baseline Data Collection of Akwa Ikot Effanga Farm, Akbabuyo L.G.A., Cross River State, Nigeria. National Agricultural Land Development Authority, Abuja.

Ibanga, I.J. and Iren, B. (2006). Chemical properties and management of the ‘Acid Sands’ supporting oilpalm plantations in South eastern Nigeria. In, Asumugha, G.N., Olojede, A.O., Ikerogu, F.G., Ano, A.O., and Herbert U. (ed.) Repositioning Agriculture for Sustainable Millennium Development Goals in Nigeria. Proceedings of the 40th Annual Conference of the Agricultural Soc. of Nigeria, Held Oct. 16-20th, 2006 at NRCRI, Umudike, Abia State.

Igbozurike, M.U. (1975). Vegetation Types. In: Ofomata, G.E.K. Nigeria in Maps: Eastern States.

Ethiope Pub. House, Benin City, Nigeria.

Inyang, P.E.B. (1975). Eastern States of Nigeria: Climatic Regions. In: Ofomata, G.E.K. (Ed). Nigeria in Maps: Eastern States. Ethiope Pub. House, Benin …..City Nigeria. P. 27-29.

Jacquemard, J.C., Baudouin, L., Berthaud, A., Graille, J., Huquest, R., Mariau, D., Noel, J.M., Quencez, P. and Tailliez, B. (1998). Oilpalm (The Tropical Agriculturist). London: Macmillian, Basingstoke. pp 647.

Jasbir, S., Sharma, R.L. and Sharma, V.K. (1988). Agro Environmental. Units and Agricultural Land-Use Planning. Vishal Publications, University Campus 81pp.

Komolafe, M.F., Adegbola, A.A., Are, L.A., Ashaye, T.I. (1979). Agricultural Science for West African Schools and Colleges (2nd edn.). Ibadan: Univ. Press Ltd. pp 228.

Kyuma, K., Rosaki, T. and Juo, A.S.R. (1986). Evaluation of the Fertility of the Soils. In: Juo, A.S.R. and Low 9ed). The Wetland Soil and Rice in Subsahara Africa. Proceeding in International Conference of Wetland Soil Utilization for Rice Production in Subsahara Africa.

Landon, J.R. [ED.] (1991). Brooker Tropical Soil Manual: A handbook for Soil Survey and agricultural land evaluation in the tropics and subtropics. John Wiley and Sons Inc., 605, Third Avenue, New York, USA, pp 474.

Mclean, E.O. (1965). Aluminum. In: Black C.A. 9ed). Methods of Soil Analysis. Part 2, Agronomy, Madison, Wisconsin, pp. 986-994.

Meredith, R.N. (1965). A review of the responses to fertilizer of the crops of northern Nigeria. Samara Misc. Papers No. 41, Zaria, Nigeria.

Monanu, P.C. (1975A). Temperature and Sunshine. In Ofomata, G.E.K. (Ed.) Nigeria in Maps: Eastern States. Benin City, Nigeria: Ethiope Pub. House.

Monanu, P.C. (1975b). Rainfall. In Ofomata, G.E.K. (Ed.) Nigeria in Maps: Eastern States. Benin City Nigeria: Ethiope Pub. House.

Nigerian Institute for Oil Palm Research (NIFOR) (1986). A manual on oilpalm production. pp 45.

Ohajianya, D.O. (2006). Resource use Efficiency of Land Owners and Tenants in Food Crop Production in Imo State, Nigeria. Journ. of Sustainable Tropical Agricultural Research, Vol. 17:26-30.

Orajaka, S.O. (1975). Geology. In: Ofomata,, G.E.K. (ed). Nigeria in maps: Eastern States. Ethiope Pub. House, Benin City, Nigeria.

Sanchez, P.A., Couto, W. and Buol, S.W. (1982). The Fertility Capability Classification System. Interpretation, applicability and modification. Geoderma, 27:283-309.

Savalia, S.G., Golakiya, B.A., Patel, S.V. (2009). Textbook of Soil Physics-Theory and Practices. Kalyani Publishers, New Delhi, 353pp.

Soil Survey Staff (2010). Keys to Soil Taxonomy (11th Edn). Basic System of Soil Classification for making and interpreting soil survey. Natural Resource Conservation Services, Agricultural Dept. Soil Survey Div., Washington D.C. USA.

Udom, D.S. (2002). Declining Yield of Oilpalm: A case study of four oil palm plantations in Nigeria and Cameroon. Niger Agric. J. 33:32-47.

Ukaegbu, E.P. (2014). Soil Characterization and Land Evaluation of Owerri Agricultural Zone, Imo State Nigeria. An unpublished Ph.D Thesis. Dept. of Soil Science, University of Nigeria, Nsukka.

Walkley, A. and Black, I.A. (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chronic acid titration method. Soil Science 37:29-38.

Young, A. (1976). Tropical Soil and Soil Survey. Cambridge: Cambridge Univ. Press.