HP
JAESR2025
Hummingbird Publications
Journal of Agricultural & Env. Sci. Research
www.hummingbirdjournals.com
© February, 2025
Vol. 7 No. 1

Soil Evaluation for Cacao *(Theobroma cacao)*, Oil Palm *(Elaeis guineensis)* and Cashew *(Anacodium occidentalis)* in Ika North East and Ika South Local Government Areas, Delta State, Nigeria

Ogboi E[1].; Ewulo B. S[2].; Adeyemo A. J[2].; Adejoro S. A.[2]; & Nmor E. I[1]

[1]Crop Science Department, Delta State University of Science and Technology, P.M.B. 5, Ozoro. [2]Crop, Soil and Pest Management Department, Federal University of Technology P.M.B 754, Akure

Corresponding Author: ogboiedward71@gmail.com

DOI: https://doi.org/10.70382/hujaesr.v7i1.017

Keywords:
Aggregate,
Suitable,
Adequate,
Recommended,
Essential

Abstract

A study to evaluate the suitability of soil for cocoa, oil palm and cashew was conducted in Ika North East and Ika South Local Government Areas, Delta State, Nigeria. Eight communities were purposefully selected for the study. Forty auger soil samples were randomly collected across each community at 0 – 20 cm and 21 – 40 cm depth respectively. The collected soil samples were bulked into two composite samples. All the collected soil samples were air dried and subjected to laboratory analysis using appropriate laboratory techniques. All data obtained were subjected to statistical analysis for variability across communities. The result obtained revealed that the soils are sandyclayloam within the depth of 21 – 40 cm and sandy loam within 0 -20 cm depth with low variation in sand and silt across the communities and moderate variation in clay across the communities. The pH ranges between 4.98 and 6.6, organic carbon ranges from 0.54 to 1.62%, organic matter ranges from 0.94 to 2.82%. Effective cation exchange capacity (ECEC) ranges from 8.08 to 15.13 cmolkg^{-1}. The Base Saturation ranges between 27.18 and 55.46%, Low variations were obtained across communities in soil pH and ECEC while high variations across communities were recorded or obtained from organic carbon, organic matter, and Base Saturation. The aggregate suitability scores revealed the soils are highly suitable potentially for the cultivation of cocoa, oil palm and cashew. However, currently, the soils are moderately and marginally suitable for oil palm and cocoa respectively but not suitable for cashew cultivation. Good management practices that will enrich the soils with adequate essential elements are recommended.

Introduction

Soil is our most valuable resources that can be easily damaged due to poor usage and management. Soil evaluation provides information on how soils are to be utilized sustainably. The growing human population demand more food and proper utilization of the soil on sustainable bases. Agricultural land must be developed to the completest possible scope.

Soil evaluation aims at utilizing the soil more normally without compromising their quality (Stavi et al., 2015). Risk of minimum output or product is reduced when the soil characteristics are matched with crop requirements (Jeoffery, 2020). Apportioning land to what it can be used for is one of the best management practices that can ensure maximum returns or yield from land (Kingsley and Ackey, 2009).

Cacao, oil palm, cashew, rubber are important economic trees that have contributed to Nigeria economy positively, provided employment to many

Nigerians and raw materials to industries. The growing of these economic trees can boast and revive the economy, increase foreign exchange and earning, provide food security, increase farmer's income, provide raw materials to indigenous industries. However, the suitability of the land for these crops is a key to survival and productivity of these crops. Soil evaluation will play the role of matching the requirements of land usage to terrestrial potentials (Rossiter, 2018).

Ika North East and Ika South Local Government Areas of Delta State are agrarian local government areas with increasing population due to influx of people because of their position and peaceful atmosphere for business and other meaningful activities for life. It has been observed that among the above mentioned economic trees, only oil palm is cultivated or grown in Ika North East and Ika South Local Government Areas of Delta State, Nigeria. The reason may be lack of knowledge or information about the suitability of the soil/land for other economic trees. Hence, the initiation of this study. Therefore, the objective of this study was to evaluate the suitability of soil of Ika North-East and Ika South Local Government Areas for the cultivation of oil palm, cacao and cashew crops. The information obtained from this study will reveal the relevance of the soils for oil-palm, cacao and cashew crops in the study areas as well as suggest proper management practice to be adopted for better productivity.

Materials and Methods

Study Site

This study was carried out in Ika North-East and Ika South Local Government Areas of Delta State, Nigeria (Fig. I &II). The area is located within Latitude 6^o05^{11}N and 6^o43^1N of the Equator and Longitude 6^o05^{11} and 6^o27^{11}E of the Greenwich Median. The elevation of the area above sea level ranges between 115 and 205 meters (Nwajei, 2019). Mean Annual Rainfall is between the range of 2000 mm and 2500 mm. The rainfall period is between March and November. The mean annual temperature is between 28^oC and 32^oC (Mat Station, 2022). The vegetation is forest-savanna transition ecological (Nwajei, 2019).

The major economic activity of the area is farming. The crops mostly cultivated are Maize (zeamays), Cassava (Manihot spp); Yam (Dioscorea spp); Oil Palm (Elaeis guineensis). The land area of Ika North East and Ika South is $899km^2$ and they are bounded on the West and North by Edo State, on the East by Aniocha

Federal Constituency and on the South by Ndokwa West Local Government Area of Delta State.

Field Work and Laboratory Analysis

Reconnaissance survey was conducted on the area of study and eight communities (Ute-Okkpu, Ute_Ogbeje, Mbiri, Igbodo, Alidinma, Abavo, Emuhu and Alifekede) were purposefully selected based on more agricultural activities. Forty auger soil samples were randomly collected at 0 – 20 cm and 21 – 40 cm depth in each community and were bulked into

Composite samples in each community. All composite samples were air dried and prepared for laboratory analysis.

All the prepared soil samples were analyzed laboratically using appropriate standard procedure outlined by IITA (1979) and Udo et al., (2009). Parameters analyzed were: particle size distribution, soil pH, organic carbon, nitrogen available phosphorus, exchangeable bases and acidity. Effective cation exchange capacity (ECEC) was determined by the summation of exchangeable bases (Ca, Mg, K, Na) and exchangeable acidity (H^+, Al^{3+}). Percentage base saturation was obtained by dividing exchangeable basic cation by ECEC and multiplying by 100.

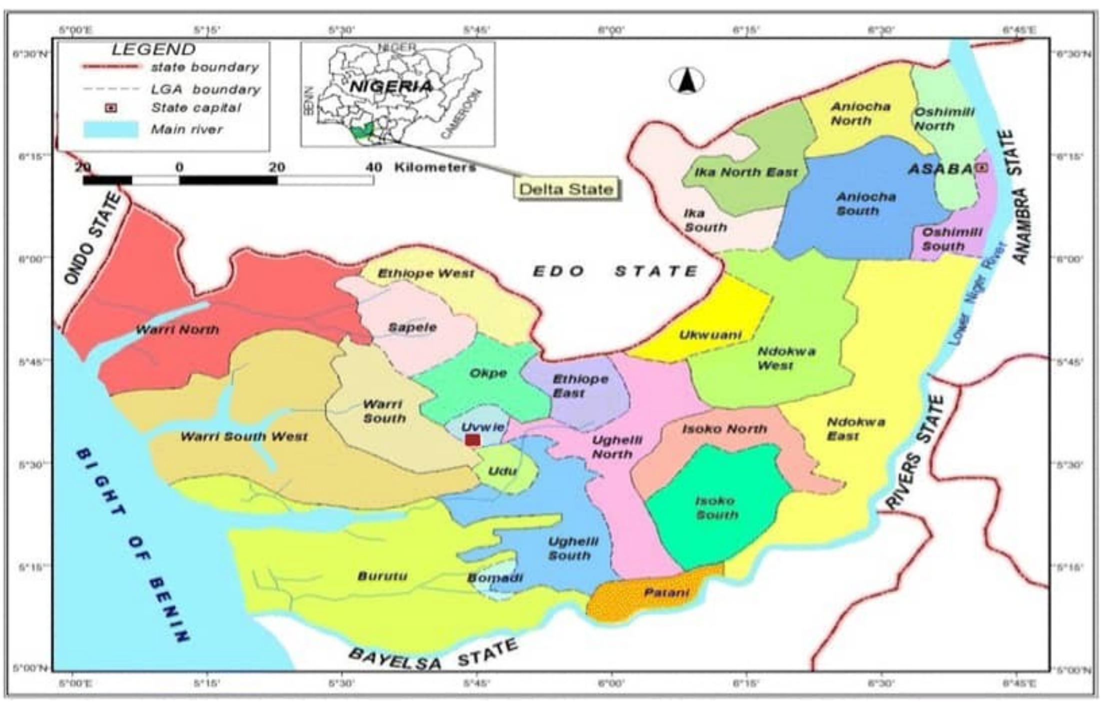

Fig. I: Delta State Map showing Ika North-East and Ika South Local Government Areas

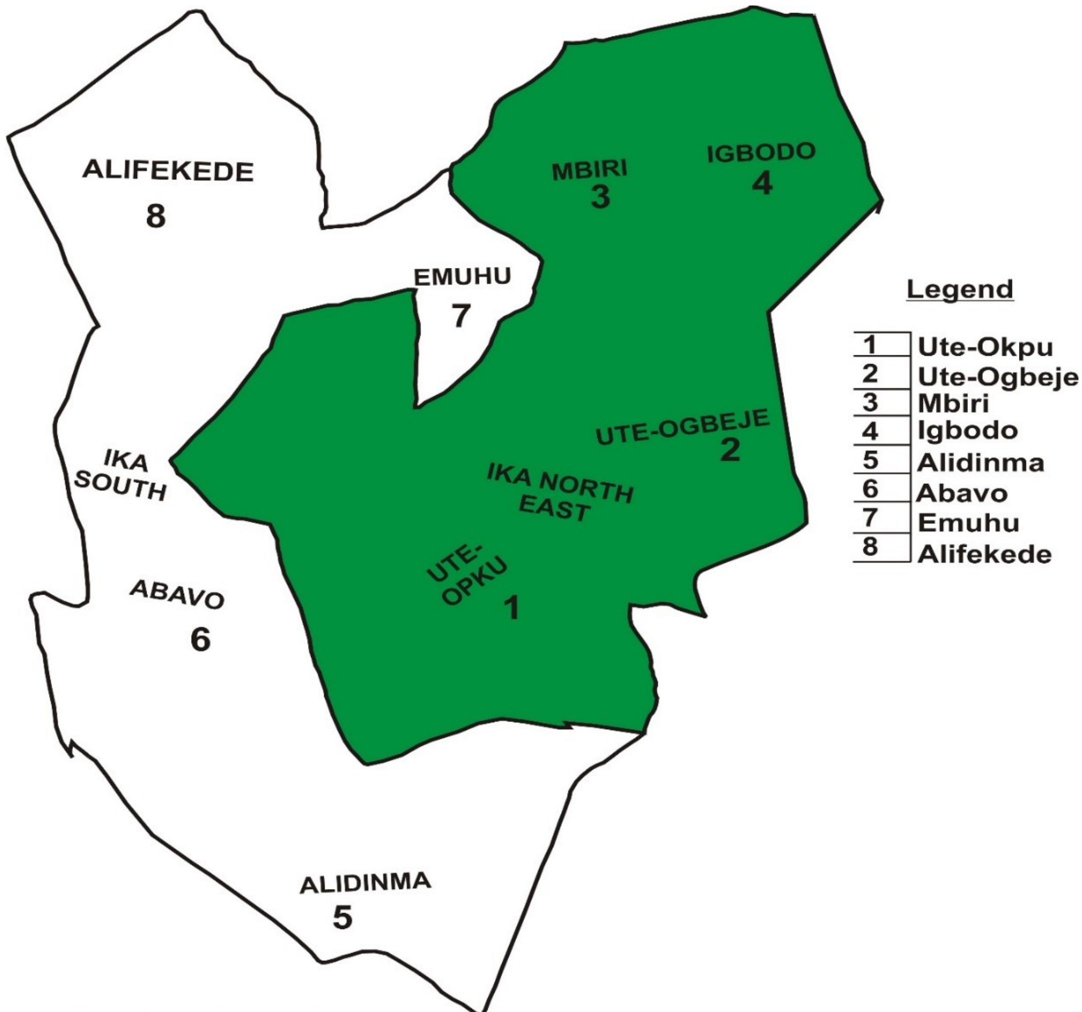

Fig. II: Map of Ika North East and Ika South showing areas of study

Land Suitability Evaluation

Suitability evaluation of the crops (Oil Palm, Cacao and Cashew), was done using parametric index of productivity techniques (Sys. Et al., 1993). Each soil (Pedon) was allocated to a suitability class by rating the land desires for each crop production (Table 1 – 3) with the soil features obtained from laboratory analysis (Table 4 -5).

The suitability rating of each defining parameter (quality) was obtained by dividing the value of parameter over higher range of parameter multiply by 100 (Ravic and Terribi, 2013).

$$S\ I = \frac{Value\ of\ parameter}{Higher\ range\ of\ parameter} \times 100 \text{ -------------} \qquad (1)$$

Most preventive characteristics in a clutch controls it performance according to Liebig's law of minimum and this was applied to the suitability for soil types. The group of land potentials considered for evaluation includes: climate(c), topography (t), drainage characteristics(w), soil physical characteristics(s) and soil chemical fertility(f). Suitability classes of S1(highly suitable); S2(moderately suitable); S3(marginally suitable) and N(not suitable) were established.

The final (aggregate suitability classes were designed as index of yield using square root method as prescribed by Khiddir (1986) as thus:

$$IP = A \text{ x } \sqrt{\frac{B}{100} x \frac{C}{100} x \frac{D}{100} x \frac{E}{100}} \text{ ----------------------- } \quad (2)$$

Where: IP = Index of productivity, A = the overall lowest characteristics rating and B, C, D, E are the lowest characteristics rating for each land quality group (Udoh et al., 2006). For calculation purposes, only one number in each group was used because there are usually strong correlation among members of the same group (Ogunkunle, 1993).

The fertility component that is impacted by fertilizer application and management techniques is not included in the calculation of prospective suitability for crop production.

All of the lowest characteristic ratings for each land quality category were included into the productivity index calculation above to get the actual which is current productivity index. It was expected, therefore, that the fertility limitation would no longer apply to corrective fertility measures in the case of the potential productivity index.

Therefore, the qualities except fertility(f) were used to calculate the potential productivity index. The index of productivity was then arranged into suitability classes as follows: IP values of 100 – 75% equivalent to S1 (Highly suitable), 74 – 50% equivalent to S2 (Moderately suitable), 49 – 25% equivalent to S3 (Marginally suitable) and 24 – 0% equivalent to N (Not suitable). This N group was sub divided into two groups. N1 and N2. N1 (24 – 15%) currently not-suitable, N2 (14 – 0) permanently not suitable (Ogunkunle, 1993).

Statistical Analysis

Data obtained were subjected to statistical analysis for variability among the soil parameters across the communities.

Table 1: Land and Soil Requirement for Oil Palm

Land Qualities	100 $S1_1$	95 $S1_2$	85 S2	60 S3	40 N1	25 N2
Climate(c)						
Actual Rainfall (mm)	>2000	1700-2000	1450-1700	1300-1450	1300-1250	<1250
Length of Growing Season (Months)	<1	1-2	2-3	3-4	3-4	<4
Annual Temperature(°C)	>25	22-25	20-22	18-20	16-18	<16
Relative Humidity(%)	>75	70-75	65-70	62-65	60-62	<60
Topography(t)						
Slope(%)	0-4	4-8	8-16	16-30	>30	>30
Wetness(w)						
Drainage	Fo well drained	Fo moderately drained	F1 moderately drained	F2 moderately drained	F2 poor drainable	F3 Poor, very poor, not drainable
Soil Physical Characteristics (s)						
Texture	CL, SCL, L	CL, SCL, L	SCL	SCL-Lfs	Any	C, Cs, any
Structure	Blooky	Blooky				
Depth(cm)	>25 > 100	>100	90 – 100	50 – 90	5 – 50	<25
Fertility (f)						
CEC(cmol/kg-1 Clay)	>16	10 – 16	8 – 10	6 – 8		
Base Saturation(%)	>35	35-20	20-15	15-10	<10	
Organic Matters (%) (0-15cm)	>1.5	0.8-1.5	<0.8	<0.5	<0.3	<0.2

Source: Sys. 1985

Used for soil texture, structure and flooding are defined as follow: Cs: structure clay; Cm: massive clay; SiCs: silty clay, blooky clay; SiCL: silty clay loam; CL: clay loam; Si: silt; Sil: silty loam; SC: sandy clay; L: loam; SCL: sandy clay loam; Lfs: loamy fine stand; Lcs: loam coarse sand; S: sand; CS: clay sand; Fo = No flooding, F1 = 1 – 2 flooding months in > 10 years, F2 = not more than 2 – 3 months in 5 years out of 10 years, F3 = 2 months almost every year, F4 months every year.

Table 2: Land Use Requirement for Cacao

Land Qualities	Highly-Suitable S1(100-95%)	Moderately-Suitable S2(94-85%)	Marginal-Suitable S3(84-40%)	Unsuitable N1(39-20%)	Highly - Unsuitable N2(19-0%)
Climate(c):					
Annual	1600-	1400-1600	1250-1450	≤ 1250	≤ 1250
Mean Annual Temperature (°c)	23-32	22/35	22/38	18-20	≤ 18
Length of dry season	≤ 2	2-3	3-4	-	-
Topography (t)					
Slope(%)	≤ 8	≤ 16	≤ 30	>30	>30
Wetness(w)					
Drainage	Well	Moderate	Imperfect	Poor	Very Poor
Soil Physical Characteristics(s)					
Texture	CL, SC,	SC, SCL	SL	LS	S
Coarse Fragments (1), 0-10cm	≤ 15	15-35	35-55	>55	-
Depth(cm)	>150	>100	50-90	25-50	≤ 25
Fertility (f)					
CEC(cmolkg-	>16	10-16	6-9	≤ 6	-
Base Saturation(%)	>35	20-35	≤ 20	-	-
pH	6.0-7.5	5.1-5.5/8.0	4.0-5.0	≤ 4.0, >7.0	≤ 4.0, >7.0
OC(%); 0-	>1.5	1.5-0.8	≤0.8	-	-
Exch. K ($cmolkg^{-1}$)	>1.5	1.2-1.5	1.2-0.5	≤ 0.5	≤ 0.2

Source: Modified from Sys. et al., 1991

CL = Clay loam; SC = Sandy clay; C = Clay; SCL = Sandy clay loam; LS = Loamy sand; SL = Sandy loam; S = Sand

Table 3: Land Use Requirement for Cashew

Land Qualities/ Land Characteristics	Very-Suitable S1	Moderately-Suitable S2	Marginal-Suitable S3	Un-Suitable N1
Temperature	25-32	<25 >32	<22/>28	18-20
Elevation	≤ 196	196-324	324-456	>456
Water Availability				
Rainfall(mm)	987-2247	827-987	601-877	≤ 601
Dry Month (Number)			≤ 4	>4.926
Wet Month (Number)	0-10		10-11	>11
Rooting Media	1-3	≤ 3-5	5.0-8.0	>8
Texture	Clay-loam, sand, clay-loam, loam	Sand-clay, sand-loam	Silt-clay, silty-clay	Heavy-clay, silt, loam-sand, sand
Effective Depth(cm)	> 40cm	21-40	7-21	≤ 7
Nutrient retention		8.5-12.4	2.6-8.5	≤ 2.6
CEC (cmol/kg)	12.4	5.1-5.4/6.4-6.9	4.6-5.1	≤ 4.6
pH	5,4-6.4	6.4-6.9	6.9-7.7	> 7.7
OC	> 0.8	0.5-.08	0.1-0.5	≤ 0.1
Base Saturation(%)	> 66	≤ 66		
Available Nutrient				
Total N (%)	> 0.07	0.05-0.07	0.03-0.05	≤ 0.03
Available p (ppm)	> 40	11-40	1.0-11.0	≤ 1
Exchangeable k (cmol/kg)	> 0.37	0.27-0.37	0.10-0.27	≤ 0.10
Slope %	≤ 12	12.0-23	23-77	> 77
Surface Rock {	15	15-29	29-76	> 76

Source: Sys.et al., 1991

Result and Discussion

Soil Properties

The properties of the soil of the study area are as shown in Tables (4 and 5). The particle size distribution shows that sand particles ranged from 43.2 to 69.0% with a mean of 57.3 and low coefficient of variation (CV) of 7.93%. Silt particles ranged from 112.0 – 27.0% with low CV of 13.226. Clay particles ranged from 16.0 to 36.0% with moderate variations (17.94%). In all the pedons, sand particles dominated within the depth of collection. The textural distribution of particles within the depth enhances perfect surface drainage and lesser leaching. Thus, the soil cannot be easily exhausted of important nutrient elements, humidity through leaching (Dada et al.; 2020). The textural classes ranged between sandy loam and sandy clay loam.

The pH values ranged from 4.52 to 60.13 with low variation of 14.52% across the communities. By implications, the soils of the area are strongly acidic to slightly acidic. The low pH observed in some areas may be due to continuous cultivation, application of acidophilic fertilizer, nutrient removal and bush burning (Ogboi, 2018). The organic carbon content of the soils is low to moderate value (Shehu et al., 2015). The values ranged from 0.54 – 1.62% with high variation (36.56%) across the communities. The low organic carbon content of the soil may be related to high temperature and relative humidity which favour rapid mineralization of organic matter (Dada et al., 2022), poor cultural practices like crop removal effect and bush burning (Ogboi and Odeh, 2018) and continuous cultivation of land (Enwezor et al, 1989). Good cultural practices like introduction of organic manure, organic fertilizer, planting of cover crops and mulching should be encouraged to be adopted by the farmers.

The nitrogen content of the soils ranges from 0.12 to 1.83% with high variation (97.71%) across communities. These values are low to medium compared with the critical level of fertility assessment in the tropics (Shehu et al., 2015). The effective cation exchange capacity (ECEC) of the soils ranges from 8.08 to 15.13 $cmolkg^{-1}$ with moderate variation (18.44%) across the communities. These are low moderate values according to Enwezor et at., (1989) and Shehu, et al., (2015). The low value of phosphorus in these soils may be associated with high phosphorus fixing capacity (Ahukaemere, 2018) and low pH. The potassium, calcium and magnesium content of the soils of the study area ranged from 0.20 – 0.85 $cmolkg^{-1}$; 1.20 – 8.02 $cmolkg^{-1}$ and 0.22 – 2.64 $cmolkg^{-1}$ respectively. The values of these exchange cations are low to high, low to medium and low to high respectively compared with the critical limit for interpreting fertility status level of soils. The coefficient of variation across the communities for potassium calcium and magnesium is high (40.22%), (40.83%) and moderate (34.27%) respectively.

Table 4: Physical Characteristics of Auger Soils in Ika North-East and Ika South Local Government Areas of Delta State.

Auger No.	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Silt/Clay Ratio	Textural Class
UIK1	0 – 20 20 – 40	61.2 54.6	15.4 18.2	23.4 27.2	0.65 0.66	Sandy loam Sandy clay loam
OIK2	0 – 20 20 – 40	60.4 60.2	18.2 18.4	21.4 21.4	0.85 0.85	Sandy loam Sandy loam
MIK3	0 – 20 20 – 40	69.0 65.0	15.0 17.0	16.0 18.0	0.93 0.94	Sandy loam Sandy loam
GIK4	0 – 20 20 – 40	60.0 53.0	19.0 22.0	21.0 25.0	0.90 0.88	Sandy loam Sandy clay loam
AIK5	0 – 20 20 – 40	54.0 51.2	18.8 21.8	27.2 27.0	0.69 0.80	Sandy clay loam Sandy clay loam
BIK6	0 – 20 20 – 40	65.4 43.2	13.3 27.2	21.3 29.4	0.62 0.92	Sandy loam Clay loam
EK7	0 – 20 20 – 40	58.0 54.0	20.0 19.0	30.0 27.0	0.66 0.70	Sandy clay loam Sandy clay loam
KIK8	0 – 20 20 – 40	55.0 52.0	15.0 12.0	30.0 36.0	0.50 0.33	Sandy clay loam Sandy clay loam
	Mean	57.3	18.9	25.1	0.74	
	CV (%)	7.93	13.22	17.94	20.80	
	Ranking	LV	LV	MV	MV	

IK1 = Ute-Opku, IK2 = Ute-Ogbeje, IK3 = Mbiri, IK4 = Igbodo, IK5 = Owa-Alidinma, IK6 = Abavo, IK7 = Emuhu, IK8 = Aliefekede

Table 5: Chemical Characteristics of the Soils of Ika North East and Ika South Local Government Areas of Delta State (Cont'd.)

Pedon	Depth	pH (H_2O 1:2)	OC	OM	N	P	K	Na	Ca	Mg	H^+	Al^{3+}	TEB	ECEC	BS	AI Sat
	(cm)		(%)	(%)	(%)	(mg/kg)				(cmolkg^{-1})					(%)	(%)
UIK1	0 – 20	5.02	0.92	1.60	0.17	9.0	0.28	0.49	2.1	0.90	5.23	0.52	3.77	9.52	39.60	5.46
	20 – 40	5.01	0.85	1.48	0.15	8.12	0.25	0.43	1.9	0.75	4.30	0.45	3.33	8.08	41.21	5.11
OIK2	0 – 20	5.05	0.63	1.09	0.28	9.50	0.23	0.43	4.65	1.84	6.32	0.46	7.15	13.93	51.32	3.30
	20 – 40	5.01	0.60	1.04	0.24	9.30	0.20	0.41	4.30	1.72	6.14	0.45	6.63	13.22	50.15	3.40
MIK3	0 – 20	6.6	1.60	2.78	1.56	6.67	0.38	0.12	3.80	1.86	6.35	0.93	6.16	13.44	45.83	6.91
	20 – 40	6.5	1.50	2.61	1.08	6.89	0.37	0.18	3.85	1.96	6.12	0.98	6.32	13.42	47.09	7.30
GIK4	0 – 20	6.3	1.52	2.64	1.83	6.85	0.43	0.28	8.02	2.64	5.82	0.90	8.37	15.09	55.46	5.96
	20 – 40	6.5	1.02	1.77	1.72	6.50	0.41	0.19	5.00	2.60	5.63	1.30	8.20	15.13	54.19	8.59
AIK5	0 – 20	4.98	0.96	1.67	0.32	7.63	0.85	0.78	1.80	0.90	9.21	0.53	4.33	14.07	30.77	3.76
	20 – 40	4.52	0.54	0.94	0.20	9,32	0.72	0.63	1.20	0.72	8.34	0.42	3.27	12.03	27.18	3.49
BIK6	0 – 20	5.01	1.56	2.71	0.32	14.2	0.26	0.52	3.45	1.82	5.52	0.49	6.05	12.06	40.17	4.06
	20 – 40	5.01	1.32	2.29	0.28	8.3	0.31	0.51	2.15	1.52	5.32	0.48	4.49	10.29	43.63	4.66
EIK7	0 – 20	6.5	1.48	2.57	0.18	7.36	0.68	0.32	5.82	1.62	5.23	0.82	6.44	12.49	51.56	6.56
	20 – 40	6.3	1.42	2.47	0.12	7.01	0.62	0.29	4.02	1.60	5.02	0.63	6.53	12.18	53.61	5.17
KIK8	0 – 20	6.5	1.62	2.82	0.32	6.96	0.39	0.27	3.82	1.63	6.12	0.93	6.11	13.16	46.42	7.08
	20 – 40	6.5	1.32	2.29	0.68	6.52	0.35	0.24	3.63	1.51	6.12	0.68	5.73	12.53	45.83	5.42
	Mean	5.7	1.18	2.03	0.59	8.14	0.42	0.38	3.72	1.59	6.06	0.58	5.80	12.54	45.25	5.34
	CV	14.52	36.56	63	97.31	18.44	40.22	44.45	40.83	34.27	18.86	47.89	25.44	14.26	71.82	22.79
	Ranking	LV	HV	HV	HV	MV	HV	HV	HV	MV	MV	HV	MV	LV	HV	MV

K; Na; Ca and Mg = Exchangeable Bases, H^+ and Al^{3+} = Exchangeable Acidity, CEC = Cation Exchange Capacity, TEB = Total exchangeable Bases; ECEC = Effective Cation exchange capacity, BS = Base Saturation, Al sat = Aluminum saturation, CV = Coefficient of variation; LV = low variation, MV = moderate variation; HV = High variation

Judging from the soil organic carbon content ranging between 0.54 and 1.62% and the CEC values ranging from 8.08 to 15.13 cmolkg^{-1}, the soil under good management practices will support the cultivation of many arable and permanent crops.

Soil Suitability

Suitability of the soils for oil palm, cacao and cashew are as shown in Tables (6-8). The results as shown in the table revealed that all the pedons are highly suitable (S1) for the cultivation of oil palm, cacao and cashew, potentially. However, suitability of the soils for cultivation of oil palm, cacao and cashew differed currently. Aggregate suitability of the soils for cultivation of oil palm ranges from highly suitable to moderately suitable S1(95) – S2(59). Therefore, growing or cultivation of oil palm in this area of study will not meet with difficulties under good management practices. This agrees with the findings of Ahukaemere (2018).

The aggregate suitability of the soil for cacao varies from moderately suitable to marginally suitable S2(73)-S3(32). Soil fertility is the major limiting factor. Low organic carbon content and potassium were the observed qualities that may have contributed to this major limiting factor. Good cultural practice of applying organic manure like poultry dropping, and other animal wastes will help to reduce this limiting factor.

The suitability of soil for cashew cultivation in the area of study is permanently not suitable. However, since fertility problem can be addressed with good management practices, it is recommended that good management practices such as planting of cover crops, mulching, application of organic manures and fertilizer should be adopted to boast the nutrient status of these soils for the cultivation of cashew, cacao and oil palm.

Conclusion/Recommendations

The soils of the study area have the potentiality to support and produce oil palm, cacao and cashew, it is therefore recommended that good management practices like application of animal waste products and inorganic fertilizer, as well as planting of cover crops like cowpeas and other leguminous crops in form of intercrop with the economic trees should be adopted. Moreso, cultivation of cacao, oil palm and cashew would be encouraged among the farmers/people of

Ika North-East and Ika South Local Government Area as the results of the study revealed that the soils are potentially-suitable for cultivation of the crops.

Table 6: Suitability Class Scores of the Study Area for Oil Palm

Climate/Land Characteristics	IK1	IK2	IK3	IK4	IK5	IK6	IK7	IK8
Climate (c)								
Annual Rainfall	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Mean Annual Temperature	S1(93)	S1(93)	S1(93)	S1(93)	S2(93)	S2(93)	S2(93)	S2(93)
Topography(t)								
Slope	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Wetness(w)								
Drainage	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(95)
Soil Physical Characteristics(s)								
Soil Texture	S1(95)	S1(100)	S1(100)	S1(100)	S1(95)	S1(95)	S1(95)	S1(95)
Soil Depth	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Soil Fertility(f)								
Organic Matter	S1(92)	S3(59)	S1(100)	S1(100)	S1(97)	S1(100)	S1(100)	S1(100)
CEC	S2(69)	S2(80)	S2(81)	S1(95)	S2(77)	S2(75)	S2(75)	S2(71)
Base-Saturation	S2(78)	S1(100)	S1(100)	S1(100)	S1(85)	S1(90)	S1(100)	S1(100)
Aggregate Suitability								
Potential	S1(95)	S1(100)	S1(100)	S1(100)	S1(95)	S1(100)	S1(100)	S1(95)
Actual(Current)	S2(67)	S2(59)	S1(81)	S1(91)	S2(72)	S1(95)	S1(75)	S2(69)
Limiting Factor		-	-	-		-	-	

Aggregate-Suitability-Score: S1 = 100-75; S2 = 74-50; S3 = 49-25; N1 = 24-15; N2; N2 =14-0. S1 = Highly suitable; S2 = Moderately suitable; S3 = Marginally suitable; N1 = Currently not suitable; N2 = Permanently not suitable

Table 7: Suitability Class Scores of the Study Area for Cacao

Climate/Land Characteristics	IK1	IK2	IK3	IK4	IK5	IK6	IK7	IK8
Climate(c)								
Annual Rainfall	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Mean Annual Temperature	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)
Length of Dry Season (Months)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)	S1(94)
Topography(t)								
Slope	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Wetness(w)								
Soil Drainage	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Soil Physical Characteristics(s)								
Soil Texture	S1(100)	S1(90)	S1(90)	S1(90)	S1(100)	S1(100)	S1(95)	S1(95)
Soil Depth	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Soil Fertility(f)								
Exch. K	S3(53)	N1(33)	S1(88)	S2(74)	S3(44)	S2(73)	S1(95)	S1(86)
Organic Carbon	S3(53)	N1(33)	S1(88)	S2(74)	S3(44)	S2(73)	S1(95)	S1(86)
pH	S3(57)	S2(70)	S2(73)	S2(76)	S2(60)	S3(57)	S2(70)	S2(70)
CEC	S2(69)	S2(80)	S2(81)	S1(95)	S2(77)	S2(75)	S2(75)	S2(71)
Base-Saturation	S2(79)	S1(100)	S1(100)	S1(100)	S1(85)	S1(90)	S1(100)	S1(100)
Aggregate Suitability								
Potential	S1(94)	S1(87)	S1(87)	S1(82)	S1(94)	S1(94)	S1(94)	S1(94)
Actual(Current)	S2(51)	S3(28)	S2(63)	S2(60)	S3(42)	S2(55)	S2(67)	S2(67)
Major Limiting Factor	F	F	F	F	F	F	F	F

Aggregate-Suitability-Score: S1 = 100-75; S2 = 74-50; S3 = 49-25; N1 = 24-15; N2; N2 =14-0

S1 = Highly suitable; S2 = Moderately suitable; S3 = Marginally suitable; N1 = Currently not suitable; N2 = Permanently not suitable

Table 8: Suitability Class Scores of the Study Area for Cashew

Climate/Land Characteristics	IK1	IK2	IK3	IK4	IK5	IK6	IK7	IK8
Climate(c)								
Annual Rainfall	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Mean Annual Temperature	S1(93)	S1(93)	S1(93)	S1(93)	S1(93)	S1(93)	S1(93)	S1(93)
Topography(t)								
Slope	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Wetness(w)								
Soil Drainage	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Soil Physical Characteristics (s)								
Soil Texture	S2(84)	S1(100)	S1(100)	S1(100)	S2(84)	S1(100)	S1(100)	S1(100)
Soil Depth	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Soil Fertility(f)								
Total N	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Available P	N2(15)	N2(18)	N2(13)	N2(15)	N2(19)	N2(19)	N2(15)	N2(14)
Exch. K	S3(43)	S3(45)	S2(81)	S2(64)	S2(81)	S2(62)	S2(64)	S2(70)
pH	S2(66)	S2(76)	S2(84)	S1(87)	S3(69)	S3(66)	S1(81)	S1(81)
CEC	S1(89)	S1(100)	S1(100)	S1(100)	S1(95)	S1(97)	S2(81)	S1(92)
Base-Saturation	S3(42)	S2(65)	S2(65)	S2(73)	S3(45)	S3(48)	S2(67)	S3(73)
Organic Carbon	N2(10)	N2(6)	N2(16)	N2(14)	N2(8)	N2(16)	N2(19)	N2(16)
Aggregate Suitability								
Potential	S1(81)	S1(93)	S1(93)	S1(93)	S1(81)	S1(93)	S1(93)	S1(93)
Actual(Current)	N2(8)	N2(5)	N2(5)	N2(12)	N2(7)	N2(14)	N2(13)	N2(12)
Limiting factor	F	F	F	F	F	F	F	F

Aggregate-SuitabilityoScore: S1 = 100-75; S2 = 74-50; S3 = 49-25; N1 = 24-15; N2; N2 =14-0. S1 = Highly suitable; S2 = Moderately suitable; S3 = Marginally suitable; N1 = Currently not suitable; N2 = Permanently not suitable

References

Ahukaemere, C. M. (2018). Suitability evaluation of some soils of south eastern Nigeria for oil palm (Elaesis guineensis) and cacao (Thebroma cacao) cultivation. *International Journal of Agriculture and Rural Development* 21:3355-3361.

Ajiboye, G.A. and Uaniyan, J. O. (2016). Characteristics and suitability evaluation of the white soils of etung local government area for oil palm and plantain production. *Agrosearch* 16(2): 25-40.

Dada, B.F.; Ewulo, B.S.; Awodun, M. A. and Ajaji, S. O. (2020). Soil organic carbon pool assessment and chemical evaluation of soils in akure north and south local government areas of ondo state. *International Journal of Agricultural and Biosystem Engineering.* 69-74.

Enwezo, W.; Udo, E. and Usoro, N. (1989). *Fertilizer and measurement practices for crops in nigeria.* Federal Ministry of Agriculture, Water Resources, Rural Development, Federal Procurement and Distribution Division Series. 2 p 163.

FAO (2006). *Guidelines for soil description* (4th eds.). Food and Agricultural Organization, Rome.

IITA (1979). Selected methods for soil and plant analysis. Manual Series 1. *International Institute of Tropical Agriculture, Ibadan, Nigeria,* 70 pp.

Jeoffery, A. (2020). *Land evaluation for agricultural purpose.* Offline Nigeria Com.

Kingsley, J. and Ackley, U. A. I. (2019). Land evaluation, characterization and classification of soil foe oil palm plantation proposal in Ekpri-Ibanti Akwa Ibom State, Nigeria. *Int. Journal of Environmental Agriculture and Biotech.* (IJEAB), 4(3): 121 – 134.

Nwajei, F. A. (2019). *An atlas of delta state, Nigeria.* Macmillan Publishing Press, London. 55pp

Ogboi, E. (2018). Forms and causes of land degradation in selected areas of delta state. *Journal of Environmental Issues,* 2: 15-25.

Ogboi, E. and Odeh, H. (2018). Environmental problems of delta state. *International Journal of Science and Agriculture.* 10 (2): 15-28.

Rossiter, D. G. (2018). A theoretical framework for land evaluation. *Geoderma,* 72: 165 – 190.

Shehu, B. M.; Jabrin, J. M. and Samudu, A. M. (2015). Fertilizer status of selected soils in the sudan savanna bioma of northern Nigeria. *International Journal of Soil Science.* 10(2): 74-83.

Stavi, C.; Han, N. and Lal, R. (2015). Achieving zero net land degredation. Challenges and opportunities. *Journal of Arid Environments.* 112(2015) 44-51.

Sys, C. (1985). Land evaluation: part 1,2 and 3 series, admin, *Dev. Crops (ABOS) Agric. Publication*. No. 7.

Udo, E.; Ibia, T.; Ogunwale, J.; Ano, A. and Esu, I. (2009). *Manual of soil, plant and water analysis,* Sibon Books Limited, Lagos, Nigeria. 183pp.

Udoh, B.T and Ogunkunle, A. O. (2012). Land suitability evaluation for maize (zea mays) cultivation in a tropical area of south eastern Nigeria: *Nigeria Journal of Soil Science.* 22(1): 1-10.