

Soil classification and suitability evaluation of some agricultural land in Kogi State, Nigeria

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Abstract:

Solution to farmer's problems are largely dependent on the characterization and suitability studies of the land, this is because of soil diversity. Soil properties play a great role in the identification and assessment of potentials of different soil in any given environment. This study was conducted at Anyigba in Dekina Local Government Area of Kogi State on three agricultural land use types (Cassava, Maize and Oil palm). The land use types were classified using USDA and FAO UNESCO method of soil classification and were also examined for its suitability to different crops taking cognizance of some limitation identified in the study area. Reconnaissance survey was conducted to get acquainted with the agricultural lands identified and during the field work, two profile pits were dug at the middle slope of the field, the profiles were described and samples were taken from each generic horizon identified in the profiles, both undisturbed and disturbed samples were taken using a core samplers and cellophane bags respectively. All samples were transported to the laboratory for different soil analysis. The soils were generally classified as Rhodustalf and Haplic Luvisol and the suitability evaluation falls between Suitable (S₂) and currently not suitable (N₁). The information provided by this research will help in the management of the land in the study area..

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1. Introduction

Soil is a valuable resources and critical components in many of the environmental and economic issues facing today's society. Soil characterization provides the information for our understanding of the physical, chemical, mineralogical and microbiological properties of the soil we depend on to grow crops, sustain forest and grassland (Ogunkunle, 2009). Soil classification deals with the systematic categorization of soils based on distinguishing characteristics as well as criteria that dictate choices in use. It is the grouping of soils with a similar range of properties (chemical, physical and biological) into units that can be geo-referenced and mapped. Soils are a very complex natural resource than air and water (FAO, 2002). Land suitability evaluation is very important in this direction as it provides information on the potentials and constraints of land for a defined land use in terms of crop performance as affected by physical environment. Soil suitability classification is based on knowledge of crop requirement, prevailing conditions and applied soil management methods (Ande, 2011). In Nigeria, demographic factors, poor soil management and inherent low soil fertility (Enwezor, *et al.*, 1990) of different land result in poor crop yield and also determines the level of the land suitability. According to Esu (2004), one of the strategies to achieve

food security with sustainable environment is to study soil resources in details through soil characterization and land suitability evaluation for various land utilization types. It is important to manage soil resources so that planned adjustments to meet development needs can be implemented without reducing the likelihood that they will be used in the future.

Population growth has led to indiscriminate use of land to sustain and feed the increasing population without considering the effect on the soil (degradation) e.g physical, chemical and biological soil properties. In general, the use of a particular land may not be related to the potential capacity of the land (Senjobi, 2001). Land has been utilized for all purposes without considering its suitability for the purpose; this has resulted in land/soil degradation, altering the natural ecological balance of the land which adversely affects soil productivity (Senjobi, *et al.*, 2007). Babalola, *et al.*, (2010) classified some soils in Kogi State to series level, Aina, (2023), classified some soils in Anyigba under cashew and oil palm generally to be Rhodustalf and Haplic Luvisol and he also evaluate the lands to be between moderately suitable and marginally suitable. Understanding the impact of land use on soil will greatly help in proffering solution to soil degradation problems, sustainable agricultural management and

provide early warning signs of adverse situation (Doran and Zeiss, 2000; Marzaioli, *et al.*, 2010; Takoutsing, *et al.* 2016).

2. Materials and methods

2.1 Study Location

The study area is located at Anyigba in Dekina Local Government Area of Kogi State. Anyigba is located on latitude 7°15'N – 7°29'N and longitude 7° 11'E - 7° 32'E with an average altitude of 420 meters above sea level, the mean annual rainfall is 1570mm per annum with an annual temperature of 18°C to 32°C (Amhakhian, 2016; Aina, 2023). And rainfall is characterized by a mobile bimodal rainfall pattern with the peak occurring in July and September. The relative humidity is moderately high and varies from 65% to 85% throughout the year (Amhakhian, *et al.*, 2012).

2.2 Reconnaissance survey

Reconnaissance survey was conducted to identify the different Agricultural land uses considered (cassava, maize and oil palm). Geographical positioning system GPS was used for the locations coordinates of the profiles pits on the different land use in the study area.

2.3 Field Study

Two profiles pits were dug on each of the land uses, making a total of 6 soil profiles, the pits were described according to the procedure in Soil Survey Manual (Soil Survey Staff, 2014).

Table: 1: Land Uses and Codes

S/No	Land uses considered	Code
1	Cassava	Ca
2	Maize	Mz
3	Oil palm	Op

2.4 Soil Sampling

After the profile description, core (undisturbed) and composite samples were taken with core ring samplers and polythene bags respectively from each of the generic horizons identified in the profiles. Core samples were used for bulk, density, hydraulic conductivity etc while the bulk samples were used for routine soil analysis (soil physical and chemical analysis).

2.5 Preparation of Soil Samples

Collected soil samples (composite) from generic horizons were air dried, crushed with pestle and mortar and sieved to remove material greater than 2mm. Those less than 2mm were used for laboratory analysis using standard procedures in the laboratory.

2.6 Laboratory analysis

2.6.1 Particles size distributions

Particle size distribution was determined using Bouyous Hydrometer method (Gee and Or, 2002). The textural class was determined using the USDA textural triangle.

2.6.2 Bulk Density (BD)

Bulk density was determined using undisturbed core sampling method. After the initial weight, core samples collected were even dried to remove the entire moisture content. B.D is expressed as mass of dry soil per unit volume (Campbell and Henshall, 1994; Aina, *et al.* 2019).

2.6.3 Particle Density

The Particle Density was determined using the Pycnometer method as described by Blake and Hartage (2009)

2.6.4 Soil pH

The pH was determined both in water and calcium chloride (0.01M CaCl₂) using 1:1 soil to water ratio (IITA, 1979). The soil pH was read with a glass electrode on pH meter (Maclean 1966; Aina, *et al.* 2019).

2.6.5 Exchangeable Bases

The exchangeable bases (Ca, Mg, K, and Na) were extracted with 1M ammonium acetate solution (1M NH₄OAC) solution, buffered at pH 7.0 as described by Anderson and Ingram, (1993).

2.6.6 Effective Cation Exchange Capacity

Effective CEC was determined from the summation of the exchangeable bases by 1M NH₄OAC extraction and the exchange acidity by 1M KCl extraction (Culman, *et al.* 2019) as indicated by the following equation 1:

$$ECEC (cmolkg^{-1}) = \sum Exch. (K^{+} + Ca^{++} + Mg^{++} + Na^{+} + Acidity) \quad (1)$$

2.6.7 Percentage Base Saturation

Percent base saturation was calculated dividing the total exchangeable cations (Ca, Mg, K and Na) by the Cation Exchange Capacity (CEC) obtained from 1M NH₄OAC (pH 7.0) as defined by (Havlin, *et al.*, 2005). equation 2

$$\%BS = \frac{\text{Total exchange bases}}{CEC (NH_4OAC)} \times 100 \quad (2)$$

2.6.8 Exchangeable Acidity

Exchangeable acidity will be determined by leaching the soil with (1M KCl) solution. The Al³⁺ and H⁺ ions in the 1M KCl extract will be determined by titrating with sodium hydroxide (0.5M NaOH) solution as described by (Anderson and Ingram, 1993).

2.6.9 Organic Carbon

Soil organic carbon was determined by the wet oxidation method of Walkley and Black as described by (Nelson and Sommers, 1996). The result obtain was multiplied by a factor (1.724) to get organic matter.

2.6.10 Total Nitrogen

Total Nitrogen content was determined using the Micro-Kjeldhal technique as described by (Bremner and Mulvaney, 1982; Ayodele, *et al.* 2019).

2.6.11 Available Phosphorus

Available phosphorous was extracted using the Bray 1 method (Ziadi et al. 2013).

2.7 Statistical Analysis

The data collected were analyzed using descriptive statistics and analysis of variance (ANOVA) to establish the relationship between the parameters using correlation analysis.

2.8 Land Suitability Evaluation (LSE)

The land suitability evaluation of the soil was done using the conventional parametric methods (FAO, 2022). Pedons were placed in suitability classes by matching their characteristics with the established requirements for cassava, maize and oil palm. The final aggregate suitability classes will indicate the most limiting characteristics of the pedons (Anderson and Ingram 2018).

Table 2: Land requirements for suitability classes for cassava cultivation (modified by Nuga and Akinbola, 2015)

Land qualities	S11 (100%)	S12 (95%)	S2 (85%)	S3 (60%)	N1 (40%)	N2 (25%)
Climate (c) :						
Annual rainfall (mm)	1400-1800	1000-1400	600-1000	500-600	-	<500
Length dry season (months)	3-4	4-5	5-6	6-7	-	>7
Mean annual temp°C	26-20	26-30	>30	-	-	-
Topography (t)	-	-	-	-	-	-
Slope (%)	0-4	4-8	8-16	16-30	30-50	>50
Wetness (w) :	-	-	-	-	-	-
Drainage	Good	-	Moderate	Imperfect	poor drainable	poor non drainable
Soil physical properties (s):						
Texture	L, SCL	SL, SiC, SiCL, CL, SiL, SC	LFS, LS, LCS, FS	CS	-	Si
Soil Depth (cm)	>125	>100	>75	>50	-	<50
Fertility (f) :						
Cation exchange capacity (Cmol/Kg) clay	>16	Any				
Base saturation (%)	>35	35-20	<20			
Organic carbon (g/Kg), 0-15c; m	>15	8-15	< 8			

CL, clay loam; SCL, sandy clay loam; L, loam; LFS, loamy fine sand; Loamy coarse sand; FS, Fine sand; C, clay; CS, clayey sand; C – clay; SiC, silty clay; SiCL, silty clay loam; Si, Silt; SC – sandy clay

Table 3: Land requirements for suitability classes for oil palm cultivation (Modified by Udoh, 2008)

Land qualities	S1 100-85	S2 85-61	S3 60-30	N1 29-20	N2 19-0
Climate (C):					
Annual rainfall (mm)	> 2000	1700-2000	1450-1700	1250-1450	<1250
Length dry season	1-2	2-3	3-4	-	>4
Mean annual temp°C	>29	25-29	22-24	-	< 22
Relative humidity (%)	>75	65-75	60-65	-	<65
Topography (t)	-	-	-	-	-
Slope (%)	0-8	8-16	16-30	>30	>30
Wetness (w) :					
Flooding	F0	F0	F1	F2	F3
Drainage	Perfect	Mod. well	Mod. well	Poor, aeric	Poor, v. poor, not drainable
Soil physical properties (s):					
Texture	CL, SCL, L	CL, SCL, L	SCL	SCL – LFS	C, Cs,
Depth (cm)	>100	90-100	50-90	25-50	<25
Fertility (f) :					
Cation exchange capacity (Cmol/Kg) clay	8-10	6-8	<6	<5	<5
Base saturation (%)	>35	20-35	<20	-	-
pH	5.5-6	5.5-6	5.5-6	6.5-7	<4, >7.0
Organic carbon (g/Kg), 0-15cm	>12	<8	<5	-	Any
Available P (ppm)	>15	10-15	5-10	<3	-

**F0, no flooding; F1, 1-2 months flooding in >10years; F2, not more than 2-3 months in 5 years out of 10; F3 2-4 months almost every year; F4, >4 months in almost every year.

CL, clay loam; SCL, sandy clay loam; L, loam; LFS, loamy fine sand; C, clay; CS, clayey sand

Table 4: Land Requirements for Suitability Classes for Maize Cultivation (Modified by Nuga and Akinbola, 2015)

Land qualities	S11 (100%)	S12 (95%)	S2 (85%)	S3 (60%)	N1 (40%)	N2 (25%)
Climate (c) :	-	-	-	-	-	-
Annual rainfall (mm)	850-1250	850-750	750-600	600-500	-	<500
Length growing season (days)	150-220	220-270	270-325	325-345	-	>345
Mean annual temp°C	22-26	22-18	18-16	16-14	-	<14
Relative humidity (%)	50-80	50-42	42-36	36-30	-	>30
Topography (t)	-	-	-	-	-	-
Slope (%)	0-2	2-4	4-8	8-16	-	>16
Wetness (w) :	-	-	-	-	-	-
Flooding (4) (4)	F0	-	-	F1	-	F2
Drainage (5)	Good Imperfect	Moderate Moderate	imperfect Good	Poor Aeric	poor drainable	poor and very poor not drainable
Physical properties						
Texture	SiC, SiCL, CL, SiL,	SC, L, SCL	SL, LFS, LS	LCS, FS,	-	S,
Depth (cm)	>100	75-100	50-75	20-50	-	<20
Fertility (f) :						
Cation exchange capacity (Cmol/Kg)	>24	16-24	<16	<16		
Base saturation (%)	>50	35-50	20-35	<20		
Organic carbon (g/Kg), 0-15cm	>20	12-20	8-12	<8		

CL, clay loam; SCL, sandy clay loam; SL, sandy loam; loamy sand; L, loam; LFS, loamy fine sand; LCS loamy coarse sand; FS. Fine sand; SiC, silty clay; SiCL, silty clay loam; SC, sandy clay; S, sand

In the framework for land evaluation, differences occur in the degree of suitability and these are determined by the relationship between benefits and required inputs (FAO, 2002). Land suitability evaluation is described in terms of Orders, Classes, Sub-classes, and Units. The categories of orders are Suitable (S), and Not suitable (N). The following classes indicate the degree of suitability within an order:

- S1 = highly suitable
- S2 = moderately suitable
- S3 = marginally suitable
- N1 = currently not suitable
- N2 = permanently not suitable

The suitability classes are equivalent to index of productivity or suitability values of 100 – 75, 74 – 50, 49 – 25, 24 – 12.5 and 12.4 – 0 respectively.

The suitability evaluation of the land uses in the study area was evaluated using parametric approach (Sys, 1991., modified by Ogunkunle, 1993). Crops selected include: cassava, maize and oil palm. The limiting factors of each land uses were rated in percentage and the index of suitability of each profile was computed using equation 3:

$$IP = A \sqrt{\frac{B}{100} \times \frac{C}{100} \times \dots \times F/100} \quad (3)$$

Where IP = Index of suitability, A= the overall lowest characteristics, B, C, ..., F = the lowest characteristics in each quality group..

2.9 Soil Classification

Data collected from field and laboratory analysis was used to classify the soils based on criteria of the USDA Soil Taxonomy System (Soil Survey Staff, 2014) and the World Reference Base for Soil Resource (FAO, 2010).

3. Results and discussion

3.1 Soil Classification

Soils of the different land uses (LUCa, LUMz and LUOp), were classified (Table 4) according to USDA soil taxonomy, (Soil Survey Staff 2014), using the following criteria which includes physical and chemical properties, temperature, morphology and soil moisture regimes; also, classification was done using FAO/UNESCO world Reference base for soil Resources Classification (2014). In Table 4, Using USDA soil classification, the soils were all classified as Alfisols at the order level, at the suborder level they were classified as Ustalf, Great group as Rhodustalf, Sub group Typic Rhodustalf. For FAO/UNESCO method of classification, all the soils were classified as Haplic Luvisol (Eutric).

Table 5: Soil Classification under the land uses in the study area

Location Anyigba	Land use	USDA					FAO/ UNESCO
		Order	Suborder	Great group	Sub Group	Family	
	LUCa	Alfisol	Ustalf	Rhodustalf	Typic Rhodustalf	Fine loamy skeletal, mixed, subactive, isohyperthermic	Haplic Luvisol (Eutric)
	LUMz	Alfisol	Ustalf	Rhodustalf	Typic Rhodustalf	Fine loamy skeletal, mixed, subactive, isohyperthermic	Haplic Luvisol (Eutric)
	LUOp	Alfisol	Ustalf	Rhodustalf	Typic Rhodustalf	Fine loamy skeletal, mixed, subactive, isohyperthermic	Haplic Luvisol (Eutric)

Key: LUCa – Cassava, LUMz – Maize, LUOp – Oil palm.

Table 6: Land Suitability Evaluation for Cassava in the study area

Land Qualities Climate	Cassava	Maize	palm
Annual rainfall (mm)	S11 (100%)	S1 1(100%)	S11 (100%)
Dry season (months)	S12 (95%)	S12 (95%)	S12 (95%)
Mean annual temp (°C)	S12 (95%)	S12 (95%)	S12 (95%)
Topography (t)			
Slope	S11 (80%)	S11 (80%)	S11 (80%)
Wetness (w)			
Drainage	S11 (100%)	S11 (100%)	S11 (100%)
Soil physical Properties. (s)			
Texture	S2 (85%)	N2 (25%)	S2 (85%)
Soil Depth	S11 (100%)	S11 (100%)	S11 (100%)
Fertility (f)			
CEC (cmol/kg)	N1 (40%)	N2 (25%)	S3 (60%)
BS (%)	S11 (100%)	S11 (100%)	S11 (100%)
OC (g/kg)	S11 (100%)	S11 (100%)	S11 (100%)
Actual	S3 (35.9%)	N2 (12.18%)	S2 (53.92%)
Potential	S1 (82%)	N1 (24.37%)	S1 (82.50%)

Table 7: Land Suitability Evaluation for Oil Palm in the study area

Land qualitiesClimate	Cassava	Maize	Palm
Annual rainfall (mm)	S3 (60%)	S3 (60%)	S3 (60%)
Dry season (months)	N2 (19%)	N2 (19%)	N2 (19%)
Mean annual temp (°C)	S2 (95%)	S2 (95%)	S2 (95%)
Topography (t)			
Slope	S1 (80%)	S11 (80%)	S1 (80%)
Wetness (w)			
Drainage	S1 (100%)	S1 (100%)	S1 (100%)
Soil physical. Properties. (s)			
Texture	S2 (95%)	S2 (95%)	S2 (95%)
Soil Depth	S1 (100%)	S1 (100%)	S1 (100%)
Fertility (f)			
CEC (cmol/kg)	S3 (60%)	S3 (60%)	S3 (60%)
BS (%)	S1 (100%)	S1 (100%)	S1 (100%)
OC (g/kg)	S1 (80%)	S1 (85%)	S1 (95%)
Ph	S3 (60%)	S2 (85%)	S1 (100%)
Avail. P	S3 (60%)	S3 (60%)	S3 (60%)
Actual	N1 (21.29%)	N1 (21.29%)	N1 (21.29%)
Potential	S3 (28.27%)	S3 (28.27%)	S3 (28.27%)

Table 8: Land Suitability Evaluation for Maize in the study area

Land qualities Climate	Cassava	Maize	palm
Annual rainfall (mm)	S3 (60%)	S3 (60%)	S3 (60%)
Length of growing season (months)	N1 (40%)	N1 (40%)	N1 (40%)
Mean annual temp (°C)	S3 (60%)	S3 (60%)	S3 (60%)
Topography (t)			
Slope	S1 (80%)	S11 (80%)	S1 (80%)
Wetness (w)			
Drainage	S11 (100%)	S12 (95%)	S12 (95%)
Soil physical. Properties. (s)			
Texture	S3 (60%)	S12 (95%)	S2 (85%)
Soil Depth	S11 (100%)	S11 (100%)	S11 (100%)
Fertility (f)			
CEC (cmol/kg)	S3 (60%)	S2 (85%)	S3 (60%)
BS (%)	S11 (100%)	S2 (85%)	S2 (85%)
OC (g/kg)	S12 (95%)	S12 (95%)	S1 (95%)
pH	S3 (60%)	S2 (85%)	S12 (95%)
Avail. P	S3 (60%)	S3 (60%)	S3 (60%)
Actual	N1 (24%)	S3 (35.04%)	S3 (27.72%)
Potential	S3 (30.8%)	S3 (38.00%)	S3 (35.96%)

3.2 The suitability evaluation

The suitability evaluation for Cassava, Maize and palm under the three land uses considered are shown in table 6, 7 and 8. The potential suitability evaluation for cassava were rated S1 (82%), N1 (24.37%) and S1 (82.5%) for

cassava, Maize and Palm land uses respectively. The potential suitability evaluation for palm were rated S3 (28.27%), S3 (28.27%) and S3 (28.27%) for cassava, Maize and Palm land uses respectively.

Table 8: Chemical Properties of the soils in the study area

Location/ Pedon	Depth cm	pH (H ₂ O)	OC (g/kg)	OM (%)	TN (g/kg)	Avail. P (mg/kg)	CN Ratio (g/kg)	K	Na	Ca Cmol/kg	Mg	CEC	Exch Acidity Cmol/kg	ECEC Cmol/kg	% Base saturation
LUCa1															
AP	0-40	5.10	14.0	2.42	0.94	5.41	14.89	1.98	0.37	3.79	2.11	8.25	1.08	9.33	88.42
BA	40-68	5.10	7.0	1.21	0.47	4.85	14.89	1.80	0.41	3.51	2.01	7.73	1.10	8.83	87.54
Bt1	68-100	5.20	4.1	0.71	0.27	5.21	15.18	1.65	0.39	3.80	1.78	7.62	1.12	8.74	87.18
Bt2	100-140	5.00	3.8	0.65	0.25	4.48	15.2	1.46	0.51	3.51	1.70	7.18	1.16	8.34	86.09
LUCa2															
AP	0-20	5.76	13.20	2.27	2.10	4.86	6.28	0.11	0.04	2.78	0.71	3.64	2.10	5.74	63.41
BA	20-43	5.13	64.00	1.11	1.12	1.59	57.14	0.06	0.05	1.87	0.61	2.59	1.70	4.29	60.37
Bt1	43-100	5.69	9.10	1.56	1.26	3.70	7.22	0.03	0.07	3.18	0.84	4.12	1.00	5.12	80.46
Bt2	100-144	4.9	6.10	1.04	1.30	3.17	4.69	0.03	0.06	2.39	0.67	3.15	1.55	4.70	67.02
LUMz1															
AP	0-21	5.30	12.3	2.12	0.82	5.48	15	2.10	0.27	4.23	2.34	8.94	0.97	9.91	90.21
AB	21-44	5.40	10.1	1.74	0.67	6.00	15.07	2.31	0.25	4.32	2.46	9.34	0.91	10.25	91.12
Bt1	44-81	5.20	4.1	0.71	0.27	4.85	15.18	1.94	0.30	3.96	2.04	8.24	1.09	9.33	88.32
Bt2	81-120	5.40	2.3	0.40	0.16	7.01	14.37	1.43	0.49	3.33	1.57	6.82	1.24	8.06	84.61
Bt3	120-160	5.30	4.1	0.71	0.27	4.80	15.18	1.69	0.42	3.56	1.75	7.42	1.11	8.53	86.99
LUMz2															
AP	0-16	5.20	18.9	3.26	1.26	5.02	15	2.18	0.31	4.51	2.36	9.36	0.89	10.25	91.32
AB	16-45	5.10	4.3	0.74	0.29	4.99	14.83	1.96	0.35	3.94	2.10	8.35	1.04	9.39	88.92
Bt1	45-80	5.30	3.2	0.59	0.22	4.31	14.54	1.80	0.36	3.52	1.94	7.62	1.09	10.71	71.15
Bt2	80-140	5.20	13.5	2.33	0.9	7.96	15	1.99	0.41	4.06	2.04	8.50	1.02	9.52	89.28
Bt3	140-200	5.50	2.7	0.47	0.18	4.14	15	1.72	0.53	3.77	1.86	7.88	1.05	8.93	88.24
LUOp1															
AP	0-9	5.40	31.1	5.37	2.08	5.80	14.95	2.51	0.30	5.10	2.60	10.51	0.87	11.38	92.35
AB	9-50	5.10	11.3	1.96	0.76	7.39	14.87	1.88	0.41	3.94	2.10	8.33	1.05	9.38	88.80
Bt1	50-88	5.10	6.1	1.06	0.41	5.63	14.88	1.52	0.48	3.41	1.75	7.16	1.18	8.34	85.85
Bt2	88-128	5.10	3.8	0.65	0.25	5.43	15.2	1.46	0.52	3.36	1.57	6.91	1.25	8.17	84.58
Bt3	128-200	5.20	5.4	0.93	0.35	5.46	15.42	1.52	0.51	3.42	1.68	7.13	1.20	8.33	85.59
LUOp2															
A	0-25	5.58	13.7	2.36	0.91	5.41	15.05	1.86	0.40	3.64	1.94	7.84	1.07	8.91	87.99
AB	25-60	5.30	9.9	1.71	0.66	5.97	15	1.52	0.44	3.42	1.78	7.16	1.19	8.35	85.75
Bt1	60-100	5.30	1.9	0.34	0.13	5.02	14.61	1.33	0.57	3.27	1.50	6.67	1.27	7.94	84.00
Bt2	100-135	5.20	3.1	0.53	0.2	5.85	15.5	1.48	0.52	3.39	1.61	7.00	1.23	8.23	85.05
Bt3	135-200	5.90	4.9	0.84	0.33	5.07	14.85	1.52	0.49	3.46	1.70	7.17	1.21	8.38	85.56

The potential suitability evaluation for maize were rated S3 (30.80%), S3 (38.60%) and S3 (35.96%) for cassava, maize and palm land uses respectively, the major limitations common to all the units is soil fertility. In general the suitability evaluation fall in suitability class S3 (marginally suitable) for palm and maize land uses while under cassava land use, cassava and palm fell under suitability class S1 (highly suitable) and maize fell under N1 (currently not suitable); this agrees with the report of Ande (2011), soils under cassava land use were grouped into units and some were classified as marginally suitable (S3) limited by gravel and rock and currently not suitable (N1) limited by susceptibility to water logging during 5-6 months of rainy season.

Also in support of the findings Ogunkunle (2000); reported that 60 – 70% of Nigeria lands are cultivated with crops under rain fed; 8 – 10% of the land fell under moderately suitable (S2) while 25-85% are marginally suitable (S3). In the same vein, Akpan-idiok et al; (2013), reported that some soils are of the sand stone origin are marginally suitable (S3) on different land uses. Babalola, (2017), observed similar trend in soils of Kogi West (Kabba); it was noted the land uses were either moderately suitable (N1) currently not suitable (N1) or permanently not suitable (N).

4. Conclusion

The soil characterization, classification and soil suitability evaluation of some agricultural land use types were studied based on their morphological, physical and chemical of these soils. The locations for each of the land uses were selected based on the current land use and their age, different land uses were considered, LUCa (Cassava), (LUMz) Maize and (LUOp) oil palm to classify the soils and evaluate their suitability for maize, cassava and oil palm. The profiles (pedon) in all the land use types were very deep because is above 150cm, this shows that the land in the study area are developed (USDA 2022). According to soil taxonomy system of classification and FAO/UNESCO word reference base on soil resources, the soils were classified in all the land use types as *Typic Rhodustal / Haplic Luvisols*. The frequent use of land has cause problems especially with availability of agricultural land.

Characterization of land in the area of study is important, so that the soil can be grouped and defined to know the management practices required for the different land use types as classified by; USDA and FAO/UNESCO. The color of the soil is generally red, which shows the presence of high iron oxide. Land needs to be evaluated depending on the specific purposes or objective of the farmer. So that the use of productive land (fertile land) will be maximized and areas good for agricultural purpose will not be used for other purposes, which will bring about high crop production in the study area. The suitability evaluation is necessary and parametric method was used in this research, the results presented as actual and potential values for the different land use types; generally the potential of the land falls between is suitable (S₂) and currently not suitable (N₁).

Recommendations

From the conclusions, the following are recommended;

- Evaluation of the study area should be carried out in future so as to ascertain the necessary requirement and management for certain crop production.
- Regular application of organic matter especially (poultry manure, green manure etc) will help replenish soil nutrient every cropping season and it is save for the environment.

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