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Soil Suitability Evaluation for Rice and Sugarcane in Lowland Soils of Anegbette, Edo State, Nigeria

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ABSTRACT

Soil suitability evaluation for rice and sugarcane in lowland soils of Anegbette, Edo State was investigated. Soil samples from ten different land uses were collected at a depth of 0 – 15 cm. Soil samples were analysed for their physic-chemical properties and evaluated for rice and sugarcane based on rating factor of FAO (1976) and FAO (1983) respectively. Results of the evaluation showed that 10%, 30% and 60% of the soils were highly, moderately and marginally suitable for sugarcane production. The soils mainly used for rice production was rated unsuitable for rice. Soil properties limiting the suitability of the soils for sugarcane production includes available P, exchangeable K and total N. Suitability for rice was limited by Al saturation, exchangeable K, Ca and Mg. For rice and sugarcane cultivation in the lowland soils of Anegbette, organic manure and fertilizer should be applied in addition to liming to reduce Al concentrations.

Keywords- *Evaluation, land use, rice, sugarcane, suitability*

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I. INTRODUCTION

Soil suitability evaluation involves characterizing the soils in a given area for specific land use type. The information collected in soil survey helps in the development of land use plans, which evaluates and predicts the effects of the land use on the environment [1].

For assessing the suitability of soils for crop production, soil requirement of crops must be known. Also, these entire requirements must be understood within the next context of limitations imposed by land forms and other features which do not form a part of the soil but may have a significant influence on use that can be made of the soil [2] From the basic soil requirements of crops, a number of soil characteristics are directly related to crop yield performance. Soil suitability classifications are based on knowledge of crop requirement, of prevailing soil conditions, qualifies in broad terms to what extent soil conditions match the areas.

To date, the FAO guideline on the land evaluation system [3] is widely accepted for the evaluation. The system is based primarily on an integration of land qualities as related to individual crop requirements. The similar system developed by Sys et al. [4] reports the crop requirements based on the experiments/experience for the land in the tropics. Evaluation developed by Clarke [5] was modified by Gbadegbesin and Nwagwu, [6], FAO [7]) was modified by Aiboni and Ogunkunle [8] and that of Onasanya and Ogunkunle [9].

The following soil parameters; cation exchange capacity; soil organic matter content expressed by the organic carbon content, soil depth and stoniness are amongst the main factors that influence crop adaptability to a given land area [10]. Some conservative farming practices could as well accelerate soil chemical and physical degradation and create some of the unfavourable soils.

To date, the FAO guideline on the land system [3] is widely accepted for the evaluation of soil suitability for crops production. The system is based primarily on integration of land qualities as related to individual crop requirements. The similar system developed by Sys et al. [4] reports the crop requirement based on the experiments/experiences for the land in the tropics. To formulate the land use planning, Mongkolsawat and Paiboonsak [11] suggested that the evaluation has to provide the alternatives with less marking risk.

In evaluating the suitability of soil for rice, cassava production, land units resulting from the overlay operation of the defined land qualities should be established [12]. The crop requirements in terms of land qualities to be used in the evaluation process should be reviewed [4]. According to Mongkolsarvat et al. [11] land qualities used for evaluating soil for rice and cassava were water availability (w), soil (s), salt Hazard (sn) and tarrian (t),. Each of which was considered as a thematic layer in the GIS database. The suitability evaluation for the crops was assessed using the equation suitability = W x S x Sa x T

Efforts have been made in various parts of the world to assess the suitability of the land for specific and other uses including those of the United States Bureau of reclamation for irrigation. Ogunkule [13] evaluated the Nigeria institute for oil palm research (NIFOR) main station for site suitability for oil palm cultivation according to FAO system using data from 12 pedons representing four soil series. He classified more than half of the pedons as potentially moderately.(S_2), or fertility and particle size as the major imitations. Gbadegesin and Nwagu [6] carried out the suitability assessment of the forest and savanna ecological zones of southwestern Nigeria for maize production. Generally, they found that 65 percent of the forest zone to be fairly suitable to suitable and the whole of savanna zone to be fairly suitable to very suitable. Ogunwale et al. [14] evaluated the suitability of University of Ilorin farm land in the Southern guinea savanna ecological zone of Nigeria for cowpea. They also found out that the topography is not a constraint to the production of cowpea in Ilorin and environs. Otomi [15] evaluated land use along the course of river Ethiope in Abraka, Delta State. The study emphasized the suitability of the farmland across the banks of the river for some crops like maize, okro, and other vegetable crops. She maintained that the suitability of the lands for those crops was due to the availability of water in the soil. Agbogidi et al. [2007] in a study carried out at the Research farm of the Delta State University, Asaba Campus and Delta State College of Agriculture Research Farm, Ozoro, demonstrated that soil contamination with crude oil has a highly significant effect of reducing some mineral element composition of maize. Their results showed that the suitability of the soil for maize production is minimized as a result of the contamination.

Udoh et al. [17] evaluated two alluvial soils in Akwa Ibom state using both the conventional and the parametric approaches. They found that despite the favourable climatic factors and soil physical characteristics; there was no highly suitable (SI) land for rice cultivation. By the non-parametric method, potentially and currently, all the soils were marginally suitable (S3) for rice cultivation. But by the parametric approach, currently, 12.5% of the pedons were marginally suitable (S3) while 87.5% were not suitable (N1) for rice cultivation. Potentially, 50% of the pedons were marginal (S3) while 50% were not suitable (N1) for rice cultivation. In southwestern Nigeria, Olaleye [18] assessed representative pedons used for rice cultivation and reported that the aggregate suitability of the pedons for rice were between marginal (S3) and unsuitable (N1). The major constraints they identified in the pedons were poor soil texture, which translates to poor water management coupled with suboptimal nutrient contents (i.e., available P, exchangeable potassium K, and cation exchange capacity, which may predispose rice plants to excessive Fe^{2+} uptake (or bronzing or yellowing symptoms). They found that grain yields collected from the farmers' field (1994 and 1995 cropping seasons) showed that in the current state of two of the soil series (Apomu and Matako), the grain yield of the two rice cultivars ranged between 0.61 and 2.13 t/ha and declines progressively across the two cropping seasons.

The study area (Anegbette) is one of the localities highly noted for intensive cultivation of rice. Many private companies as well as local farmers engaged in rice production are numerous. Thus, resulting in continuous cultivation; decline in crop yields under continuous cultivation have been documented in the area. This has been attributed to lack of plant nutrients, acidification, and inappropriate land use among other factors. Hence the objective of the study was to evaluate the soil for rice and sugarcane suitability.

II. MATERIALS AND METHODS

2.1 Study Area

The study was located in one of the fields in Anegbette, Edo state. Edo State is located between latitudes 50^0 41^I and 7^0 38^I North and longitudes 50 4^1 and 6^0 11^1 East of the equator. Edo state has a tropical climate characterized by one rainy season between April and October and one dry season lasting from November to March. The state has a mean annual rainfall ranging from about 1300 to 1500 mm around Auchi in Edo North [19]. The temperature of Edo state is characterized of tropical climate with mean daily temperature of about 26.7^0C. The farm is located in the derived savannah zone of Edo State, the farm is composed of different land use that includes; fallows, open savanna vegetation with average trees, grasslands, cassava and rice. The predominant land use was rice cultivation.

2.2 Soil Studies

A total of ten different land use located in the study area was investigated (Table 1). Surface soil depths (0 -15 cm) were critically examined at each sampling points with the aid of a probe Auger. Soil colour, structure, consistency, presence or absence of roots and degree of wetness were the major parameters determined in the field. Vegetation of the area ranged from predominant derived savanna (35%) to secondary forest (15%), fully regenerated fallow land (20%) and cropped land within the area currently supporting rice (30%). Composite soil samples collected from the area were analyzed for their physico-chemical properties in the laboratory according to Anderson and Ingram [20]in Nigerian Institute for Oil Palm (NIFOR), Benin City and Agronomy Laboratory of Ambrose Alli University, Ekpoma.

2.3 Laboratory Studies

Particle size distribution was determined by the hydrometer method according to Okalebo *et al.* [21]. The soils were dispersed with sodium hexamethaphosphate solution. The soil texture was determined using the soil texturial triangle according to Anderson and Ingram [20]. Soil pH was measured in a 1:1 soil-water suspension using glass electrode pH meter [22]. Organic carbon was determined by wet dichromate acid oxidation method [23]. Exchangeable $Al^{3+}$and H^+ were extracted with IN KCL [24] and determined by titration with 0.05 Na0H using phenophthalin as indicator. Total nitrogen was determined by the micro-kjeldahi method [25]. Available phosphorus was extracted with Bray-P1 solution and measured by the molybdenum blue method on the technicon auto analyzer as modified by Olsen and Sommers [26]. Exchangeable cations (Ca, Mg, Na and K) were extracted with 1N NH_4OAC**.** PH 7.0 (ammonium acetate), K and Na were determined with flame emission photometer while Ca and Mg were determined with atomic absorption spectrophotometer [20]. Effective cation exchange capacity (ECEC) was calculated by the summation of exchangeable bases and exchangeable acidity [27].

All data collected from the laboratory was analyzed using percent coefficient of variability according to Frank and Althoen [28]. Matrix of correlation between macronutrients and other parameters was done using Genstat at 5% level of probability.

2.4 Land Evaluation

The conventional (non-parametric) methods as well as the parametric method were used to evaluate the suitability of the soils of the different land use for rice cultivation. In conventional (non-parametric) method [29] and as modified by Ogunkunle [30] soils were first placed in suitability classes by matching their land characteristics (Table 2), with the agronomic requirements of rice (Tables 5).

Five land quality groups were used for this study and only a member of each of the five land quality groups was used in the calculation because there is strong, correlation among members of the same group. The five land quality groups were climate (c), soil physical characteristic (s), wetness (w), fertility status (f) and toxicity (t) (Table 2).

2.4.1 Evaluation for Sugarcane

FAO [3] for sugar-cane crop, land units resulting from the overlay operation of the defined land qualities were digitally established (Table 3). The crop requirement in terms of land qualities to be used in the evaluation process was reviewed (4, 31). Some land qualities as defined by FAO with negligible difference within the region were excluded for the evaluation. Moreover the experiment reports and regional experiences were reviewed to define the land qualities. The land qualities used in this evaluation include water availability (W), Soil (S), Salt Hazard (Sa) and Terrain (T). Each of which is considered as a thematic layers in the GIS database. The suitability evaluation for the crop watershed is based on the equation:

Suitability = W x S x T with the following procedures.

a) Water availability (W): Rainfall data of the area recorded by the Meteorological stations were used for the establishment of W layer. Mean annual rainfall for the area was determined.

b) Soil (S) = Nutrient Availability Index (NAI) and Physical properties (PP) of soil, (S = NAI x PP). The NAI, is based on the method developed by Radcliffe et al. (1982) and is given by NAI= N x P x K x pH. The physical properties of soil is defined as a multiplication of soil drainage (dr), texture (t) and depth (d) (PP = dr x t x d). Each of the properties was obtained from the soil studies in the field.

c) Salt hazard (Sa): The soil salinity is an important edaphic constraints for sugar-cane. However, this was not determined.

III. RESULTS AND DISCUSSION

3.1 Soil Properties

The particle size distribution and texture of the soils are shown in Table 4. Clay contents of the derived savanna/river bank soils (SS7) followed by land use for rice (SS3) were significantly different from other land use types. Silt content was generally low in the soils of the area. Sand content was slightly variable (5.61%). The higher sand content of the soil compared to very low clay and silt contents will affect soil moisture retention and aggregate stability of the soils [32]. Higher sand content but very low clay and silt contents accounted for the sand, loamy sand and sandy loam texture of the soils. Land use for rice was predominantly sandy loam texture. The derived savanna vegetation ranged from sand, loamy sand to sandy loam.

The chemical properties of the different soils due to different land use are shown in Table 4. Soil pH ranged from very strongly acidic to extremely acidic. The range suggests solubilization of macronutrient and very low concentration of macronutrients in soils of the different land use.

Soil organic carbon content ranged from 9.80 to 44.80 g/kg with a mean of 26.73 g/kg. Soil supporting derived savanna has organic carbon levels that were below the general mean value for the different land use. However, other land use had higher values, especially land use for rice production.

Nitrogen content, with general mean 0.90 g/kg, other land use types were significantly low in total N content. Percentage variability was low (24.44%) thus, indicate low nitrogen. The contents were low when compared to adequate level of 1.5 g/kg.

Phosphorus content of the soil was generally very low in all the land use types. With adequate level of 15 mg/kg, the soils of the area are deficient in available phosphorus.

Exchangeable calcium ranged from 0.56 to 2.96 cmol/kg with general mean of 1.59 cmol/kg; Mg 0.16 to 2.40 cmol/kg; H^+ 0.10 to 0.40 and Al^{3+} 0.30 – 5.40 cmol/kg. Aluminium content was highly variable; this was accounted for by coefficient of variability of 64.44%. The higher coefficient of variability was due to land use for rice (SS1, SS3, SS4). Effective cation exchange capacity content ranged from 1.58 to 9.78 with a total mean of 6.1 cmol/kg. Effective cation exchange capacity content was moderately variable with a coefficient variability of 44.3%. This was due to land use for rice.

3.2 Suitability Evaluation

Land quality and factor rating for rice and soil suitability classes are shown in Table 2. Table 1 and 4 shows the morphological and physico-chemical properties of the soils respectively. The non parametric approach with reference to all the rating factors is shown in Table 5. The area was classified as unsuitable for rice cultivation (N2). The suitability index ranged from 0.01% in the land use for rice production (SS4) and derived savanna (SS10) to 3.02% in the derived savanna river bank (SS6). The soil was strongly limited by soil nutrients (P, K, Ca, Mg) deficiency and extreme Al saturation. However, the soil texture which was predominantly sandy loam was favourable for rice cultivation. Similarly in alluvial soils of southern Nigeria Udoh et al. [17] reported serious fertility constraints, especially P, N, pH, organic carbon and K. They classified the area as marginally suitable for rice. The unsuitability of the area was in agreement with Olaleye [18] who assessed representative pedons used for rice cultivation and reported marginal (S3) to unsuitable (N1). The major constraints they identified in the pedons were poor soil texture, which translates to poor water management coupled with suboptimal nutrient contents (i.e., available P, exchangeable potassium K, and cation exchange capacity, which may predispose rice plants to excessive Fe^{2+} uptake (or bronzing or yellowing symptoms).

Land quality and factor rating for sugarcane and soil suitability classes are shown in Table 3. Table 1 and 4 shows the morphological and physico-chemical properties of the soils respectively. The non parametric approach with reference to all the rating factors is shown in Table 6. The soil suitability ranged from highly (S1) and moderately suitable (S2) to marginally (S3) suitable for sugarcane. However, in accordance to the suitability classes, 10% of the soils was rated highly suitable, 30% moderately suitable and 60% rated marginally suitable for sugarcane. For sugarcane cultivation, the soils were strongly limited by soil nutrient (N, P and K) deficiency and extreme soil acidity. However, the soil texture that was mainly sandy loam favours sugarcane cultivation. The observation disagrees with Ogunkule [30] who noted poor soil texture as a limiting factor in soils of Edo State for oil palm cultivation. But in line with poor nutrient condition as a limiting factor in the soils. Low Though the current land use is predominantly rice cultivation, it was however found to be moderately and highly suitable for sugarcane production.

Table 1 some morphological characteristics of the different land use in the study area.

Locations/Land Use	Colour	Structure	Root hairs	Drainage	Consistence
1(Rice Farmland)	Dark brown	Sab	present	Imperfect	Slightly -sticky
2(Rice Farmland)	Dark brown	Sab	present	Imperfect	Slightly -sticky
3(Rice Farmland)	Grey brown	sab	present	Imperfect	Slightly -sticky
4(fallow land)	Grey brown	Sab	present	Imperfect	Slightly -sticky
5 (Rice Farmland)	Grey black	sab	present	Imperfect	Slightly -sticky
6 (River bank)	Grey brown	sab	present	Imperfect	Sticky
7 (Derived savanna)	Grey brown	sab	present	Imperfect	Slightly -sticky
8 (Cassava farmland)	Grey brown	Sab	present	Imperfect	Non- sticky
9 (River bank)	Grey brown	Sab	present	Imperfect	Sticky
10 (Along Anegbette-Ekperi road)	Grey black	Blocky	present	Well drained	Non- sticky

Table 2 Factor ratings of land use requirements for rice

Land qualities/characteristics	Unit	S1 0.95-0.85	S2 0.85-060	S3 0.60-20	N1 0.20-0
Climate (c)					
Soil pHysical characteristics (s)					
Soil depth	Cm	>150	100-150	80-100	<80
Texture	-	Loam	Clay loam	Clay	Any
WetneSS (w) or ground water table					
Drainage	-	2-3	2-3	2-3	Any
fertility status (f)		7.5-60			
PH	-	760	6.0-50	<5.0	Any
Organic matter	%	>60	60-431	43.1	Any
Available p	mgkg -1	>15	6-15	<5	Any
Exchangeable k	cmolkg-1	>0.31	0.30-0.11	<0.11	Any
Exchangeable ca	cmolkg-1	12-6	6-3	<3	Any
Exchangeable mg	cmolkg-1	12-6	6-3	<3	Any
Toxicity (t)					
Aluminum saturation	%				Any

Suitability classes for rice: S1= 75-100, S2 = 50-74, S3 = 25- 49, N1 = 15-24, N2 = 0.14

Table 3 Land quality and factor rating for sugar-cane

Land use requirement	Factor rating			
Land quality diagnostic factor	S1 (1.0)	S2 (0.8)	S3(0.4)	N(0)
Water availability (w) annual rain fall mm	1,600-2,5000	1,200-1,600	900-1,200	<900
unit	>0.6	0.3-0-6	0.1-0.3	>0.1
Soil (s) s=NAIXPP	0.5	0.1-0.5	<0.1	-
Nutrient availability index (NAI)	>2.0	-2.0	<1.0	
Nitrogen %	>25	6-25	<6	
P mg/kg	>0.153	0.076-0.153	0.076	
K mg/kg	6.1-73	7.4-8,51-60	7.9-8.4,4.0-45	>8.4<4
PH	>0.8	0.4-0.8	0.1-0.4	<0.1
PHysical properties (pp)	Very well	moderately well	somewhat well	very poor/poor
Pp = drxtxd	Cl, scl, sil	sicc, sl sic, ls cgscacs		
Soil range (dr) claSS (USDA)	Si, cl, l			
Soil texture (t)	>100	50-100	25-50	>25
Soil depth (d) cm				
Salt hazards (sa) salinity -	Non salline	low	medium high	
Terrain (t) landform & slope claSS&%	combination of land forms and slope			

Suitability classes for sugarcane: S1= 0.64-1.00, S2= 0.40-0.64, S3 = 0.01-0.40, N = <0.01
Remark: S1= highly suitable, S2 = moderately suitable, S3 = marginally suitable, N = unsuitable/not suitable

Table 4 Soil physic- chemical properties of soils of the different land use

SOIL	pH	Oc ← g/kg	N →	P mg/kg	Ca^{2+} ECEC ← →		Mg^{2+}	Na^{+} cmol/kg	K^{+}	H^{+}	AL^{3+}	Al Sat %	Particle size distribution Clay texture		sand	silt
Rice SS_1	4.50	28.80	0.80	2.37	2.96	0.64	0.28	0.6	0.10	5.40	9.34	58.89	104.0	49.0	847.0	SL
Rice SS_2	4.40	28.80	0.80	1.48	2.24	2.08	0.27	0.12	0.30	3.20	8.21	40.44	109.0	64.0	827.0	SL
Rice SS_3	4.10	44.80	1.20	1.09	2.16	2.40	0.22	0.08	0.10	4.80	9.78	50.10	134.0	79.0	787.0	SL
Rice SS_4	4.00	21.80	0.80	3.23	1.12	0.24	0.21	0.11	0.20	4.80	6.68	74.85	84.0	69.0	847.0	LS
Rice SS_5	4.60	43.20	1.30	5.75	2.56	0.16	0.22	0.05	0.10	3.20	6.29	52.46	104.0	84.0	812.0	SL
Derived. savanna/ river bank SS6	4.00	31.60	1.10	0.69	1.04	0.56	0.17	0.09	0.10	3.80	5.76	75.58	84.0	99.0	817.0	SL
Derived. savanna/ river bank SS7	4.10	20.90	0.70	0.42	1.04	0.48	0.20	0.12	0.30	3.10	5.24	64.89	164.0	54.0	782.0	LS
Derived. savanna/ river bank SS8	4.20	24.80	0.90	2.17	1.28	0.64	0.27	0.06	0.70	2.70	5.35	63.55	37.0	89.0	874.0	SL
Cassava farmland SS9	4.20	12.80	0.80	9.14	0.96	0.64	0.16	0.04	0.40	0.30	2.50	28.88	39.0	44.0	917.0	S
Derived. savanna SS 10	4.20	9.80	0.60	1.14	0.56	0.32	0.25	0.05	0.40	0.30	1.58	44.30	39.0	48.0	913.0	S
Mean	4.21	26.73	0.90	2.75	1.59	0.81	0.23	0.10	0.24	3.20	6.1	55.31	89.8	67.9	842.3	
SD	4.22	11.4	0.22	2.7	0.8	0.77	0.04	0.03	0.13	1.74	2.70	15.23	42.49	19.2	47.27	
% CV	4.96	42.65	24.44	98.2	50.3	93.9	17.4	30	54.2	64.44	44.30	27.54	47.32	28.24	5.61	

Table 5 Suitability of the different location soils for rice cultivation

Location	Soil depth	Texture	Orainage	pH	O.M	Avail P	K	Ca	Mg	Al Sat %	% Rating	Class
Rice SS1	0.95	0. 85	0. 85	0. 60	0.85	0. 60	0. 60	0. 60	0.30	0.30	0.10%	N_2
Rice SS2	0. 95	0. 85	0. 85	0. 60	0.85	0. 60	0.75	0. 60	0.50	0.40	0.20%	N_2
Rice SS3	0. 95	0. 85	0. 85	0. 60	0.95	0. 60	0. 60	0. 60	0.60	0.30	0.20%	N_2
Rice SS4	0. 95	0. 85	0. 85	0. 60	0.60	0. 60	0. 60	0.40	0.20	0.20	0.01%	N_2
Rice SS5	0. 95	0. 85	0. 85	0. 60	0.95	0.85	0. 60	0. 60	0.20	0.30	0.25%	N_2
Derived savanna/ river bank SS6	0. 95	0. 85	0. 85	0. 60	0.85	0. 60	0. 60	0.40	0.20	0.30	3.02.%	N_2
Derived savanna/ river bank SS7	0. 95	0. 85	0. 85	0. 60	0. 60	0. 60	0. 60	0.40	0.20	0.30	0.02%	N_2
Derived savanna/ river bank SS8	0. 95	0. 85	0. 85	0. 60	0. 60	0. 60	0. 60	0.50	0.20	0.30	0.03%	N_2
Cassava / SS9	0. 95	0. 85	0.60	0. 60	0. 60	0.85	0. 60	0.20	0.20	0.40	0.02%	N_2
Derived savanna / SS10	0. 95	0.85	0.60	0. 60	0. 60	0. 60	0. 60	0.20	0. 20	0.60	0.01%	N_2

Table 6 Suitability of the different location soils for sugarcane cultivation

Location	Water availability (w)	NutrientAvailability Index (NAI)				Particle Size (PS)	Rooting conditions (r)	Topography (topo)	Suitability Index	Class	Remark
		N	P	K	pH						
Rice SS_1	1.0	0.4	0.4	0.4	0.4	0.8	1.0	1.0	0.21	S3	Marginally suitable
Rice SS_2	1.0	0.4	0.4	0.8	0.4	0.8	1.0	1.0	0.41	S2	Moderately suitable
Rice SS_3	1.0	0.8	0.4	0.8	0.4	0.8	1.0	1.0	0.82	S1	Highly suitable
Rice SS_4	1.0	0.4	0.4	0.8	0.4	0.4	1.0	1.0	0.21	S3	Marginally suitable
Rice SS_5	1.0	0.8	0.4	0.4	0.4	0.8	1.0	1.0	0.41	S2	Marginally suitable
d. savanna/ SS_6 river bank	1.0	0.4	0.4	0.8	0.4	0.8	1.0	1.0	0.41	S2	Moderately suitable
d. savanna/ SS_7 river bank	1.0	0.4	0.4	0.8	0.4	0.4	1.0	1.0	0.21	S3	Moderately suitable
d. savanna/ SS_8 river bank	1.0	0.4	0.4	0.4	0.4	0.4	1.0	1.0	0.10	S3	Marginally suitable
Cassava / SS_9	1.0	0.4	0.4	0.4	0.4	0.4	1.0	1.0	0.02	N	Marginally suitable
d. savanna / SS_{10}	1.0	0.4	0.8	0.4	0.4	0.4	1.0	1.0	0.02	N	Marginally suitable

IV. CONCLUSION

Evaluation of different land use soils for rice in Anegbette, Edo state was conducted. The soils of the area were unsuitable for rice cultivation. For sugarcane cultivation 10%, 30% and 60% of the soils were highly, moderately and marginally suitable for sugarcane cultivation respectively. The limiting factors for sugarcane cultivation are available P, exchangeable K and total N. For rice cultivation, the limiting factors are Al saturation, K, Ca and Mg. It is recommended that organic manures, fertilizer and liming be carried out to supply deficient nutrients and enhance soil pH.

REFERENCES

[1] Rossiter, D.G. 1990. ALES: A framework for land evaluation using a microcomputer. *Soil Use & Management* 6: 7-20p.

[2] FAO. 1978 Crop calendars. Plant Production and Protection Paper 12. FAO, Rome. 124 p.

[3] FAO (1983). Land evaluation for rainfed agriculture. FAO Soils Bulletin 52, Rome, Italy. 237p.

[4] Sys, C; Van Ranst, E and Debaveye, J. (1991). Land evaluation, Part l, principles in land evaluation and crop production calculations. International Training Centre for Post-graduate Soil Scientists, University Ghent, www.plr.ugent.be/publicatie.html.

[5] Clarke, R.V. (1992) "Situational Crime Prevention". Successful Case Studies. New York: Harrow and Hesston the future p. 63-84.

[6] Gbadegesin A; Nwagwu, U. (1990). Stability assessment of the forest and savanna ecological zones of south western nigeria for maize production. *Agriculture Ecosystems and Environment*. 31(2): 99-114p.

[7] FAO. 1980a Land evaluation guidelines for rainfed agriculture. Report of an expert consultation. World Soil resources Report 52. FAO, Rome. 118 p.

[8]. Aiboni, V. U. (1985). Land evaluation under different environmental and geological condition in South Western Nigeria. *Ph. D. Thesis*; University of Ife, Il Ife, Nigeria: 150 – 286 p.

[9] Ogunkunle, A. O. and Onasanya, S. (1992). Soil landscape relationship in a forest zone in Southern Western Nigeria. *Samaru Journal of Agricultural Research* 9: 19 -33p.

[10] Dent, D and Young, A. (1981). Soil Survey and Land Evaluation. George Alien and Unwin Ltd., London, UK.

[11] Paiboonsak, S. and Mongkolsawat, C. (2004). Agricultural Land Use Planning in KhonKaenProvince : GIS Application. Proceedings of the 25 th Asian Conference on Remote Sensing, Chiangmai, November 22-25.
[12] 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.
[13] Ogunkunle, O.A (1993). Soil in land suitability evaluation. An example with oil palm in Nigeria. Soil use and management. 1993:9:35-40.
[14] Ogunwale, J.A; Olaniyan, J.O and Aduloju, M.O. (2009). Suitability evaluation of the university of Ilorin farmland for cowpea. *Journal of Crop Resources* 37 (1,2 and 3): 34-39.
[15] Otomi, E.L. (2009). Land use along the course of river Ethiope in Abraka, Delta state. Unpublished MSc. *Thesis.* Delta State University, Abraka.
[16] Agbogidi. O M, Eruotor, P. G, Akparobi, S. O. and Nnaji, G. U. (2007). Evaluation of crude oil contaminated soil on the Mineral Nutrient Elements of Maize (Zea Mays L). Journal of Agriculture, 6:188 – 193.
[17] Udoh, B.T; Henry, H.B and Akpan, U.S. (2011). Suitability evaluation of alluvial soils for rice (*Oryza sativa*) and cocoa (*Theobroma cacao*) cultivation in an acid sands area of Southeastern Nigeria. Journal of Innovative Research in Engineering and Science 2(3): *148-161).*
[18] Olaleye, A.O; Akinbola, G.E; Marake, V.M; Molete, S.F; Mapheshoane, B, (2008). Soil in suitability evaluation for irrigated lowland rice culture in Southwestern Nigeria management implications for sustainability. *Communications in Soil Science and Plant Analysis* Vol. 39, Issue 19-20: 2920-2938.
[19] EADP. (1995). Edo Agricultural Development Programme Main Station, Irrua, Esan West L.G.A.
[20] Anderson, J. M. and Ingram, J.S. (1993) Tropical soil biology and fertility. *A handbook of methods*. Information Press Eynsham.
[21] Okalebo, J.R; Gathua, K.W and Woomer, P.L (2002).Laboratory methods of soil and plant analysis. *A working manual.*2nd edition. Sacred Africa, Nairobi, Kenya 22 – 77.
[22] MaClean, E.O (1982). Soil pH and lime requirement in Black, C, A. (Ed): *Methods in soil analysis of chemical and microbiological properties* part II- American Society of Agronomy, Maidison, Wiscousin USA pp 927-932.
[23] Nelson D.W. and Sommers L.E. (1982) *Total carbon, organic carbon and organic matter*. In: Page, A.L., Miller R.H. and Keeney D.R. (eds.) Methods of Soil Analysis, Part 2. American Society of Agronomy, Madison. Pp. 539-579.
[24] Thomas, G.W (1982). Exchangeable Cation. In page, A.L *et al* (eds) methods of soil analysis. Part 2, *Agronomy monograph*, a second edition, pp 159 – 165. ASA and SSSA, Madison, wiscosin.
[25] Bremner, J.M. (1982) Inorganic nitrogen. In: Page, A.L., Miller R.H. and Keeney, D.R. (eds.) Methods of Soil Analysis, Part 2. Second Edition. American Society of Agronomy, Madison.
[26] Olson and Sommers, L.E (1992). Phosphorus in Page A.L., Miller, R.H and Keeney, D.R (eds). *Method of soil analysis* Part II 2ND edition.America society of Agronomy Madison, Wiscousin USA.pp 402-403.
[27] Chapman, H. D. (1997).Cation exchange capacity. In C. A. Black (edition) method of soil analysis. Part 11 Agronomy Monograph 9 page 891-901 Agronomy Society America. Incorporated published Madison Wisconsin.
[28] Frank, H and Althoen, S.C. (1995). *Statistics concepts and applications*. Low price (ed). Cambridge University Press. 539.
[29] FAO (1976). A Framework for Land Evaluation. 1st Edn., FAO., Rome, Italy.
[30] Ogunkunle, A. O. 1993. Soil in Land Suitability Evaluation: An Example with oil palm in Nigeria. Soil Use and Management. 9(1): 35-40.
[31] Paiboonsak, S., Chanket, U., Yommaraka, B. &Mongkolsawat, C., 2004a. Land Suitability Evaluation for Sugarcane : GIS Application. Proceedings of the 25th Asian Conference on Remote Sensing, Chiangmai, November 22-25.
[32] Foth, H.D., (1984). *F*undamentals of Soil Science. 7$^{th.}$ Ed., John Wiley and Sons, New York 435.