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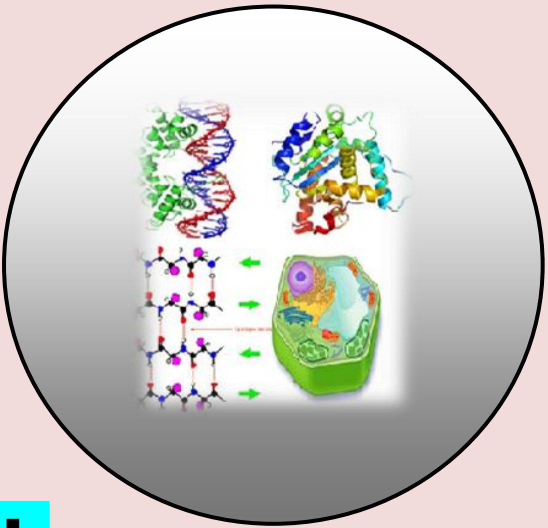

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RESEARCH PAPER

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Suitability Evaluation of Soils of Ohimini Area of Benue State, Nigeria for Sustainable Rainfed Arable Crop Production

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ABSTRACT

Suitability evaluation of soils of ohimini area of Benue state, Nigeria for sustainable rainfed arable crop production was carried out. This study evaluates the suitability and limitations of soils of Ohimini area of Benue State for sustainable maize and Rice production. The research was carried out in Atlo,Ochobo, Atakpa, Ojano,Ijami and Anmoda areas within Ohimin area of Benue State, Nigeria. Soil sampling was carried out from July to August, 2014 at six different locations at 0 - 15 cm and 15 – 30. The bulk samples were air dried and gently crushed using mortar and pestle. The samples were then passed through 2 mm sieve for laboratory analysis. The suitability of the soils was assessed for Rice and Maize by matching their characteristics with the requirements of the crops and their critical limits. The suitability class of a soil is that indicated by its most limiting characteristics. Thus the classes S1, S2, S3 and N represent highly, moderately, marginally and not suitable respectively. The interpretation of critical limit of analytical parameter was done according to the procedure stated by Esu (1991). The soils were generally rated suitable for Rice and Maize production; however, CEC was identified as the most limiting factor. Based on the results, the N status of the soil should be increased by practicing O-minimum tillage and planting crops that are capable of fixing N. Organic carbon level should also be raised through appropriate organic matter maintenance strategies.
Key words: Suitability, Evaluation, Rainfed, Maize, Rice and Arable Crops.

INTRODUCTION

Land evaluation is the process of estimating the potential of a land for alternate uses (FAO, 1976). Land evaluation tells the farmer the suitability of his/her land for specific uses and it limitations. This is achieved by matching land qualities/characteristics with the requirements of the envisaged land use (FAO, 1976). Soil productivity is the capacity of a soil in its natural environment to produce a certain amount of crop per annum. Soil productivity is largely determined by its ability to provide water and nutrients to allow deep rooting of agricultural plants. To better understand the potential productivity of soil, it is important to examine key soil characteristics and indicators, such as soil texture, depth, pH, organic matter and fertility. Soil productivity evaluation remains the most valuable tool for assessing soil health, as a guide in to elucidating processes that could had to increased crop productivity. One of the most serious problems affecting agricultural productivity in tropical regions and developing countries like Nigeria is the ineffective and unplanned use of agricultural land. It is therefore necessary that every piece of land should be used according to its potential capacity (Fasina and Adeyanju, 2006).

The primary and most effective land conservation method is appropriate allocation of lands to uses for who they are most suitable. Land suitability assessment can aid a farmer on the suitability level of his land and its limitations. Increasingly demand for food in Nigeria as a result of rapid population expansion necessitates a substantial expansion of cultivated areas. Some plants may grow under different soil and extreme agro-ecological conditions, yet not all can grow on the some soil and under the same environment (Dent and Young, 1981). Rice and Maize are crops of economic importance; Rice is a staple food of over 50% of the total world population (Adesemuyi, 2014,). Rice is a unique crop grown both in upland and lowland. Yield under lowland could reach 2.3 t/ha and able to play dominant role in future production (IITA, 1989), Maize (*Zea mays)* is the most important cereal crop in Sub-Saharan Africa. Every part of Maize has an economic value; the grain, leaves, stalk, tassel and the cob can all be used to produce a large variety of food and non-food products. In industrialized countries, maize is largely used as livestock feed and as raw materials for industrial products, while in developing countries it is used mainly for human consumption, further more it is a source of carbohydrate, protein, iron, vitamin B and minerals.

However, there is paucity of information in the study area on the extends to which the soils of Ohimini area can satisfy the agronomic requirements of Maize and Rice. This study therefore, evaluates the suitability and limitations of soils of Ohimini area of Benue State for sustainable maize and Rice production.

MATERIALS AND METHODS

Study Area

The research was carried out in Atlo,Ochobo, Atakpa, Ojano,Ijami and Anmoda areas within Ohimin area of Benue State, Nigeria. The area experiences a hot tropical climate with distinct wet and dry seasons. The rainy season starts from April and last till November to March. The mean annual rainfall for this period ranges between 100 - 1600 mm. Crops like Maize, Rice, Soybeans and Cassava are the major crops grown in the area.(Idoga and Ogbu, 2012). The study area (Ohimini) lies between 7 '30, and 8' 00E. The area has average annual temperature of 28º C. The average relative humidity is highest in September and lowest in December or January with an average of 80%. The major soil type is sandy.

Field Methods

Soil sampling was carried out from July to August, 2014. Samples were collected from six different locations, in each location, soil samples were collected from an adjacent soil distances of about 50m away. In each location soil samples were obtained from three (3) different points at 0 - 15 cm and 15 - 30 cm using an auger making a total of six (6) soil samples in each location and 36 samples. The bulk samples were air dried and gently crushed using mortar and pestle. The samples were then passed through 2 mm sieve for laboratory analysis.

The Bouyoucos hydrometer method (1951) was used to determine the particle size distribution of the samples. The soil pH in water (1:1) and KCl (1:1) was determined by electromagnetic method as described by IITA (1979).The organic carbon content of the soil samples were determined using the Walkley - Black method described by IITA (1979). Cation Exchange Capacity (CEC) of the soil was obtained by the ammonium acetale (NHOAL) method (IITA 1979).Bray -1 method was used to determine the extractable Phosphorous (Bray and Kurts, 1945).Total Nitrogen was determined by the macro - Kjeldal digestion method (Jackson. 1965).Exchangeable acidity was determined by EDTA hydration method (Jackson, 1965).

Land Evaluation

The suitability of the soils was assessed for Rice and Maize. Soil was placed in suitability classes by matching their characteristics with the requirements of the crops and their critical limits. The suitability class of a soil is that indicated by its most limiting characteristics. Thus the classes S1, S2, S3 and N represent highly, moderately, marginally and not suitable respectively.

Critical Limits for Interpreting Levels of Analytical Parameters

The interpretation of critical limit of analytical parameter was done according to the procedure stated by Esu (1991).

Table 1. Land and Soil Requirements for Maize, and Rice Adapted from Sys 1985.

Characteristics	Maize				Rice			
Climate	S1	S2	S3	N	S1	S2	S3	N
Rainfall	850-1250	750	600	<500	1800	1400	600	1250
Temperature	22-25	18-22	14-16	<14	22-25	18-22	14-16	<14
Length of dry	3-4	4-6	6-7	>7	4-5	5-7	>8	<3
Season								
Slope	0-2	4-8	8-16	>16	<4	<8	<16	<25
Drainage	CL.L	SL.LS	LSC	CS	L	LS	S	S
Soil depth	>100	50-75	20-25	<20	>90	>50	>20	>20
CECmolkg^{-1}	>24	16-24	16-24	10	>16	>5	Any	Any
BS (%)	>50	35-50	<20	<10	>35	>15	>10	>5
OM (%)	>2	0.8-1.2	<0.8	<0.5	>1.5	>0.8	>0.8	<0.3

Symbols: CL = Clay loam L = Loam LCS = Loamy Coarse Sand
SL = Sandy loam SC = Sandy clay CS = Clay sand LS = Loamy sand, S = Sandy
S1 = Highly suitable S2 = moderately suitable S3 = Marginally suitable N = Not suitable

Table 2. Critical limits for interpreting levels of analytical parameters.

Parameter	Low	Medium	Medium
Ca^{2+} ($cmol_{(+)}$ kg^{-1})	< 2	< 2	< 2
Mg^{2+} ($cmol_{(+)}$ kg^{-1})	<0.3	0.3 - 1	> 1
K^{+}($cmol_{(+)}$ kg^{-1})	<0.15	0.15-0.2	>0.3
Na^{2+} ($cmol_{(+)}$ kg^{-1})	<0.1	0.1-0.3	>0.3
CEC ($cmol_{(+)}$ kg^{-1})	<6	6-12	>12
Org. C (g kg^{-1})	<10	10-15	>15
Total N (g kg^{-1})	<0.1	0.1-0.2	>0.2
Avail. P (mg kg-1)	<10	10-20	>20
B.S (%)	<50	30-80	>80

Source: Esu (1991)

RESULTS AND DISCUSSION

Soil Properties of the Study Sites

The textural class of the surface and subsurface horizons was sandy loam. Generally, sand content was higher than clay and silt across the locations. The soils across the locations could generally, be described as sandy loam. The predominance of sand separates indicates that the water holding capacity of the soils is low; this could be due to high weathering in the tropics. The textural class of the soil indicates that the soils are likely to be well drained during the wet season and moderately hard during the dry season.

Table 3. Soil Physical Properties of the Study Sites.

Location	Sand	Silt	Clay	Textural Class	Sand	Silt	Clay	Textural class
	0 – 15 cm				15 – 30 cm			
Atk1	78.36	6.0	15.64	SL	74.8	9.0	15.2	SL
Atk2	**76.79**	**7.01**	**16.20**	**SL**	**75.8**	**9.64**	**14.0**	**SL**
Atl1	75.36	8.40	16.24	SL	76.64	10.0	13.76	SL
Atl2	78.08	7.28	14.64	SL	76.34	10.2	13.46	SL
Atl3	77.8	7.28	15.42	SL	75.72	11.0	13.28	SL
Anm1	77.08	7.28	14.64	SL	76.04	10.64	13.32	SL
Anm2	77.24	9.0	13.76	SL	76.08	9.9	14.02	SL
Anm3	76.82	9.0	14.13	SL	75.64	10.76	13.6	SL
Ija1	75.36	9.22	15.42	SL	75.6	10.40	14. 24	SL
Ija2	75.8	9.4	14.80	SL	74.08	10.9	15.02	SL
Ija3	75.08	9.72	15.20	SL	75.64	10.7	13.66	SL
Och1	79.2	8.0	12.8	SL	74.8	9.96	15.24	SL
Och2	78.8	8.0	13.2	SL	75.02	9.9	15.08	SL
Och3	79.20	7.9	13.08	SL	74.8	9.96	15.24	SL
Oj1	76.36	10.0	13.64	SL	75.18	10.6	14.22	SL
Oj2	76.20	10.08	13.72	SL	75.34	10.06	14.06	SL
Oj3	76.08	9.9	14.02	SL	75.64	11.1	13.26	SL

SL = Sandy loam, Atk =Atakpa, Atl =Atlo, Anm =Anmoda, Ija =Ijami, Och = Ochobo, Oj=Ojano

The soil reaction for the sites was strongly acidic in Ojano (4.8), moderately acidic in Atakpa and Atlo (pH 6.7) and alkaline in Ochobo and Ijami (pH 7.1). The low pH was associated with their silica rich parent material (Ojanuga 2006). Most of the pH values of the locations fell within the normal range of 5.5-7.0 reported to be optimum for the release of some plant nutrients (Brady and Weil 2010).The soils of Ojano, Atakpa and Atlo may require liming to raise their pH level to the normal range. The soils were characterized with decreasing pH down their profile. This trend may be due partly to Al^{3+} and H^{+} into the soil solution through isormophous substitution (Tisdale *et al.,* 1995) or maybe linked to the effect of nutrient bio-cycling. The available P varied amongst the sites. P ranged from 0.28-0.52. The values for the surface horizon were 0.34-0.54 respectively and was rated low, the low P status in these soils maybe due to frequent bush burning or lack of applied phosphorus containing fertilizers by the farmers.

The organic carbon range from 0.40-2.57% and was slightly more in the subsurface, it was rated low for all sites irrespective of the depth. The low organic content of the soil is a characteristic of the Guinea savannah and mineralization of organic matter and to poor management sometimes by burning crop residues by farmers. The N values across the locations range from 0.006 in Ijami to 0.0083 in Atlo and were rated low both at surface and subsurface. The increase in soil organic carbon and N in the soil profile depth is an indication of the young or immature nature of the profile due to seasonal deposition of materials. Generally, the C/N ratio may favour nitrogen mineralization in these soils (Brady and Weil 2010). The Ca values ranged from 4.60 at Ojano having the highest value to 2.24 at Ijami and were rated high; Ca was the dominant cation in all sites probably because the alluvial materials from which these soils were formed were derived from sedimentary rocks.

Table 4 a. Soil Chemical Properties of the Study Sites (0 – 15 cm).

Location	pH	O.C (%)	O.M (%)	P (mg/l)	N (%)	K	Na	Mg	Ca	E.A	TEB	CEC	BS (%)
Atk_1	6.02	1.40	2.41	0.40	0.084	0.38	0.34	3.6	3.8	1.04	8.12	9.16	88.6
Atk_2	5.88	1.64	2.83	0.34	0.081	0.35	0.31	3.3	3.5	1.00	7.46	8.46	88.2
Atk_3	5.96	1.76	3.04	0.48	0.084	0.42	0.36	3.4	3.6	1.10	7.78	8.88	87.6
Atl_1	5.04	0.64	1.10	0.32	0.077	0.28	0.23	2.28	3.10	1.12	6.41	7.53	85.1
Atl_2	5.78	0.80	1.38	0.34	0.079	0.31	0.26	2.6	2.92	0.96	6.09	7.05	86.4
Atl_3	6.27	0.80	1.38	0.32	0.077	0.30	0.26	2.7	2.84	0.98	6.10	7.08	86.2
Anm_1	6.30	1.60	2.76	0.44	0.070	0.34	0.30	3.20	3.42	1.12	7.26	8.38	86.6
Anm_2	6.74	1.06	1.83	0.41	0.074	0.36	0.32	3.40	3.60	1.10	7.68	8.78	87.5
Anm_3	6.70	1.38	2.38	0.48	0.076	0.34	0.30	3.22	3.34	1.00	7.2	8.20	87.8
Ija_1	7.17	0.44	0.76	0.28	0.069	0.26	0.22	2.43	2.54	0.97	5.45	6.42	84.9
Ija_2	7.22	0.90	1.55	0.31	0.067	0.29	0.23	2.34	2.40	0.96	5.26	6.22	84.6
Ija_3	7.43	0.40	0.69	0.26	0.066	0.24	0.21	2.12	2.24	0.94	4.8	5.75	83.7
Och_1	7.42	2.59	4.48	0.56	0.071	0.40	0.37	3.52	3.70	1.20	7.99	9.19	87.00
Och_2	7.75	1.18	2.04	0.46	0.069	0.38	0.36	3.50	3.60	1.13	7.84	8.97	87.4
Och_3	7.06	2.33	4.04	0.52	0.072	0.43	0.39	3.38	3.90	1.10	8.52	9.62	88.6
Oja_1	6.32	2.60	4.48	0.55	0.077	0.46	0.42	4.40	4.60	1.12	9.88	11.08	89.2
Oja_2	4.81	2.55	4.42	0.54	0.076	0.44	0.40	4.0	4.40	1.12	9.24	10.36	89.2
Oja_3	4.37	2.63	4.55	0.54	0.074	0.46	0.41	4.10	4.42	1.20	9.39	10.59	88.7

Atk =Atakpa, Atl =Atlo, Anm =Anmoda , Ija =Ijami, Och = Ochobo, Oja=Ojano

Table 4b. Soil Chemical Properties of the Sites (15 – 30 cm).

Location	pH	O.C (%)	O.M (%)	P (mg/l)	N (%)	K	Na	Mg	Ca	E.A	TEB	CEC	BS (%)
Atk_1	5.66	1.36	2.35	0.38	0.077	0.40	0.37	3.20	3.50	1.20	7.47	8.67	86.2
Atk_2	5.95	1.38	2.38	0.40	0.077	0.30	0.29	2.70	3.20	1.10	6.69	7.59	85.5
Atk_3	6.00	1.62	2.80	0.44	0.075	0.36	0.31	2.80	3.00	1.00	6.47	7.47	86.6
Atl_1	5.67	2.39	4.14	0.52	0.083	0.39	0.33	2.70	3.20	1.00	6.62	7.62	86.9
Atl_2	6.18	2.63	4.55	0.56	0.084	0.42	0.38	3.40	3.80	1.22	8.02	9.22	87.0
Atl_3	6.22	2.23	3.86	0.43	0.081	0.38	0.34	3.00	3.80	1.22	8.02	9.22	87.0
Anm_1	6.63	2.25	3.90	0.44	0.070	0.36	0.31	2.50	2.90	1.00	6.07	7.07	85.4
Anm_2	6.93	2.57	4.45	0.53	0.069	0.35	0.31	2.60	3.00	1.10	6.36	7.36	86.4
Anm_3	7.16	0.74	1.28	0.32	0.073	0.36	0.32	2.80	3.10	1.10	6.58	7.68	85.7
Ija_1	7.31	2.31	4.01	0.46	0.074	0.39	0.33	2.81	3.20	1.21	6.73	7.94	84.8
Ija_2	7.30	1.56	2.69	0.41	0.073	0.36	0.32	2.80	3.10	1.10	6.58	7.68	85.7
Ija_3	7.46	0.98	1.69	0.37	0.074	0.35	0.29	2.60	2.80	0.97	6.14	7.11	86.4
Och_1	7.42	2.59	4.48	0.56	0.071	0.40	0.37	3.52	3.70	1.20	7.99	9.19	87.00
Och_2	7.75	1.18	2.04	0.46	0.069	0.38	0.36	3.50	3.60	1.13	7.84	8.97	87.4
Och_3	7.06	2.33	4.04	0.52	0.072	0.46	0.43	3.38	3.90	1.10	8.52	9.62	88.6
Oja_1	6.32	2.60	4.48	0.55	0.077	0.46	0.42	4.40	4.60	1.20	9.88	11.08	89.2
Oja_2	4.81	2.55	4.42	0.54	0.076	0.44	0.40	4.0	4.40	1.12	9.24	10.36	89.2
Oja_3	4.37	2.63	4.55	0.54	0.074	0.46	0.41	4.10	4.42	1.20	9.39	10.59	88.7

Atk =Atakpa, Atl =Atlo, Anm =Anmoda, Ija =Ijami, Och = Ochobo, Oj=Ojano

The dominance of Ca on the exchange sites may also be attributed to Ca being the least easily lost from the soil exchange complex. It has been said to be the most abundant cation in exchange complex of nearly all soils that are not so acidic as to have high aluminum saturation (Brady and Weil, 2010) in all the sites. Mg was high irrespective of soil depth and was more in the subsurface than the surface
K was high across all locations with values ranging from 0.38 at Ojano to 0.40 at Ochobo at the subsurface. Na was high in all sites except the subsurface region of Atakpa, Atlo, Anmoda And Ochobo, Na reduced with increasing depth and had values of 0.37 at the surface region of Atakpa to 0.21 at the subsurface region of Ijami. The CEC values ranged from 6.22-11.08 at the surface to 7.07-8.34 at the subsurface respectively for Atakpa, Atlo, Ijami, Ochobo and Ojano, CEC was rated medium to low, CEC values was probably as a result of fairly high clay content of the soils. The B.S% values ranged from 87.6-88.6 in Atakpa, 85.1-86.4 in Atlo, 86.6-87.8 in Anmoda, 83.7-84.9 in Ijami,87.00-88.6 in Ochobo and 88.7-89.2 in Ojano respectively. B.S (%) was high across all locations.

Table 5a. Analytical Status of the Soil Chemical Properties of Soils of the Study Sites.

Sample Locations/ Depth(0-15cm)	Ca2+	Mg2+	K+	Na2+	CEC	O.C	N	P	BS (%)
ATAKPA 1	M	H	H	M	M	L	L	L	H
ATAKPA 2	M	H	M	M	M	L	L	L	H
ATAKPA 3	M	H	H	M	M	L	L	L	H
ATLO 1	M	H	H	M	M	L	L	L	H
ATLO 2	M	H	H	M	M	L	L	L	H
ATLO 3	M	H	H	M	M	L	L	L	H
ANMODA 1	M	H	H	M	M	L	L	L	H
ANMODA 2	M	H	H	M	M	L	L	L	H
ANMODA 3	M	H	H	M	M	L	L	L	H
IJAMI 1	M	H	H	M	M	L	L	L	H
IJAMI 2	M	H	H	M	M	L	L	L	H
IJAMI 3	M	H	H	M	M	L	L	L	H
OCHOBO 1	M	H	H	H	M	L	L	L	H
OCHOBO 2	M	H	H	M	M	L	L	L	H
OCHOBO 3	M	H	H	H	M	L	L	L	H
OJANO 1	M	H	H	H	M	L	L	L	H
OJANO 2	M	H	H	H	M	L	L	L	H
OJANO 3	M	H	H	H	M	L	L	L	H

KEY: **L** = LOW, **M** = MEDIUM, **H** = HIGH

Fertility Status of Soils the Study Sites

Critical nutrient status of the soils indicates that Ca^{2+} at both surface and subsurface was rated medium (M) for about 100% of the location, Mg^{2+} rated high both at surface and subsurface, K^{+}

was rated high also both at surface and subsurface in about 98 (%) of the location, Na^{2+} was high (H) in about 60 (%) of the locations and medium for about 40 (%) of the same location except for Ijami at the subsurface, OC, N and P were rated low (L) for all locations both at surface and subsurface, B.S (%) was high (H) across the locations. The low levels of organic content, N and P of the soil are a characteristic of the Guinea savannah and mineralization of organic matter and to poor management sometimes by burning crop residues by farmers.

Table 5 b. Analytical Status of the Soil Chemical Properties of Soils of the Study Sites.

Sample Locations/ depth(15-30cm)	Ca2+	Mg2+	K^+	Na^{2+}	CEC	O.C	N	P	BS (%)
ATAKPA 1	M	H	H	H	M	L	L	L	H
ATAKPA 2	M	H	M	M	M	L	L	L	H
ATAKPA 3	M	H	H	H	M	L	L	L	H
ATLO 1	M	H	H	H	M	L	L	L	H
ATLO 2	M	H	H	H	M	L	L	L	H
ATLO 3	M	H	H	H	M	L	L	L	H
ANMODA 1	M	H	H	H	M	L	L	L	H
ANMODA 2	M	H	H	H	M	L	L	L	H
ANMODA 3	M	H	H	H	M	L	L	L	H
IJAMI 1	M	H	H	H	M	L	L	L	H
IJAMI 2	M	H	H	H	M	L	L	L	H
IJAMI 3	M	H	H	M	M	L	L	L	H
OCHOBO 1	M	H	H	H	M	L	L	L	H
OCHOBO 2	M	H	H	H	M	L	L	L	H
OCHOBO 3	M	H	H	H	M	L	L	L	H
OJANO 1	M	H	H	H	M	L	L	L	H
OJANO 2	M	H	H	H	M	L	L	L	H
OJANO 3	M	H	H	H	M	L	L	L	H

KEY: **L** = LOW, **M** = MEDIUM, **H** = HIGH

Suitability Status of Soils of the Study Sites

Suitability status of soils of the study sites as it influenced the cultivation of Rice and Maize are presented in Tables 6 and 7. The annual rainfall for the study areas was highly suitable for rice and maize production. Mean Temperature for the locations was 28º and is suitable for both rice and maize production. Base Saturation was rated high across the locations; this indicates high fertility status in the areas. This could be as a result of the non acidic condition of the soils. Soils with high percentage base saturation have higher pH, therefore they are more buffered against acid conditions for plant roots, and they also contain greater amounts of the essential plant nutrient for use by plants. The CEC with respect to rice production was moderately suitable, while CEC with respect to maize production was not suitable. Organic matter content in the study sites was found to be suitable for rice and maize production. Drainage was moderately suitable for rice production and highly suitable for maize production.

Table 6. Suitability Status of Soils of the Study Sites for Rice Production.

Location	Annual. R	M. Temp	Slope	Texture	CEC	B.S (%)	O.M	Drainage
ATK1	S1	S1	S2	S1	S2	S1	S1	S2
ATK2	S1	S1	S2	S1	S2	S1	S1	S2
ATK3	S1	S1	S2	S1	S2	S1	S1	S2
ATK3	S1	S1	S2	S1	S2	S1	S1	S2
ATL1	S1	S1	S2	S1	S2	S1	S2	S2
ATL2	S1	S1	S2	S1	S2	S1	S2	S2
ATL3	S1	S1	S2	S1	S2	S1	S2	S2
ANM1	S1	S1	S2	S1	S2	S1	S1	S2
ANM2	S1	S1	S2	S1	S2	S1	S1	S2
ANM3	S1	S1	S2	S1	S2	S1	S1	S2
IJA1	S1	S1	S2	S1	S2	S1	N	S2
IJA2	S1	S1	S2	S1	S2	S1	S1	S2
IJA3	S1	S1	S2	S1	S2	S1	S3	S2
OCH1	S1	S1	S2	S1	S2	S1	S1	S2
OCH2	S1	S1	S2	S1	S2	S1	S1	S2
OCH3	S1	S1	S2	S1	S2	S1	S1	S2
OJA1	S1	S1	S2	S1	S2	S1	S1	S2
OJA2	S1	S1	S2	S1	S2	S1	S1	S2
OJA3	S1	S1	S2	S1	S2	S1	S1	S2

KEY: S1, S2, S3 and N represent highly, moderately, marginally and not suitable respectively.

Table 7. Suitability Status of Soils of study sites for Maize Production.

Location	Annual. R	M. Temp	Slope	Texture	CEC	B.S. (%)	O.M	Drainage
ATK1	S1	S1	S1	S1	N	S1	S1	S2
ATK2	S1	S1	S1	S1	N	S1	S1	S2
ATK3	S1	S1	S1	S1	N	S1	S1	S2
ATK3	S1	S1	S1	S1	N	S1	S1	S2
ATL1	S1	S1	S1	S1	N	S1	S2	S2
ATL2	S1	S1	S1	S1	N	S1	S2	S2
ATL3	S1	S1	S1	S1	N	S1	S2	S2
ANM1	S1	S1	S1	S1	N	S1	S1	S2
ANM2	S1	S1	S1	S1	N	S1	S1	S2
ANM3	S1	S1	S1	S1	N	S1	S1	S2
IJA1	S1	S1	S1	S1	N	S1	N	S2
IJA2	S1	S1	S1	S1	N	S1	S1	S2
IJA3	S1	S1	S1	S1	N	S1	S3	S2
OCH1	S1	S1	S1	S1	N	S1	S1	S2
OCH2	S1	S1	S1	S1	N	S1	S1	S2
OCH3	S1	S1	S1	S1	N	S1	S1	S2
OJA1	S1	S1	S1	S1	N	S1	S1	S2
OJA2	S1	S1	S1	S1	N	S1	S1	S2
OJA3	S1	S1	S1	S1	N	S1	S1	S2

KEY: S1, S2, S3 and N represent highly, moderately, marginally and not suitable respectively.

CONCLUSION

The soils were generally rated suitable for Rice and Maize production; however, CEC was identified as the most limiting factor. Based on the results, the N status of the soil should be increased by practicing O- minimum tillage and planting crops that are capable of fixing N. Organic carbon level should also be raised through appropriate organic matter maintenance.

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