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Land Suitability Evaluation of The Wetland Soils of Obukiyo, Oju LGA of Benue State, Nigeria For Rice (*Oryza Sativa*) Production.

[1]Ogbu O. J, [2]S. Idoga, [3]Abagyeh S. O and [4]J. Usman

[1]College of Education, Oju
[2]Department of Soil Science, University of Agriculture, Makurdi

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ABSTRACT

The inland wetland soils of Obukiyo, Oju Local Government Area of Benue State, Nigeria were evaluated for the production of rice. The physical, chemical and morphological features of the soils were matched with the requirements of the crop (rice), and the overall suitability rating of the soils was obtained using limitation method. Unit 1 soils were rated as marginally suitable (S_3) for rice production due to their drainage condition being ustic moisture regime. Units III and IV soils were considered moderately suitable (S_2) on account of water availability and nutrient status while unit ll soils which occupied the lowest elevation with endo saturation and high clay content were rated as highly suitable (S_1) for rice production.

Corresponding Author'S E-mail Address:

johnogbu55@gmail.com. +2347062091526

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1. Introduction

In recognition of the current global food crises and poor economic situation, Nigeria currently pursues a policy of expanding the land area under cultivation as well as intensifying crop production by continuing cropping system of which rice is included. Rice is one of the main staple foods in Nigeria (Ufot, 2012) and the world at large. Its demand for domestic consumption, ceremonial purpose, economic growth, and export for foreign exchange return is on the increase along with low production and discouraging yield (Ogbu, 2019).This could be partly attributed to incessant crop failure in recent times due to erratic and unpredictable rainfall pattern and severely eroded soils of upland currently being experienced throughout the country due to global climatic change. The apparent effects of this observed trend are more significant pressure on the wetland soils, which invariably may lead to abuse, the consequence of which may lead to soil degradation and reduced rice yield. The knowledge of the soil properties will significantly aid in the management of the soil and its suitability rating for the crop (Idoga and Ogbu, 2012). Parcels of land vary in their suitability for use and adaptable management. Rice yield depends significantly on the availability of water throughout the growing period (Idoga, 2005) and other soil properties such as; soil texture, structure, depth and nutrient availability: Therefore the objective of this study is to evaluate the suitability of the wetland soils of Obukiyo for production of rice.

2.0 Materials and Method

2.1 Study Area

Obukiyo lies about 2 km southeast of Oju Local Government Headquarter. The area lies between latitude 06.52'N and 06.56'N and longitude 07.37' and 07.45'E with an elevation of about 65m above sea level. The study site covers about 600 hectares of land. The area falls within the humid tropical climate. The rainy seasons start from April and last till October while the dry season covers the month of November to March. The mean annual rainfall is about 1100mm falling between April and October. The mean monthly maximum temperature is 34^0c. The area was named after river Obukiyo which rises from Andibilla Plateau. The soils were derived from sedimentary rocks of sandstones and shales (claystone). The sediment was transported from the upland, Andibilla Plateau by water, deposited on the lowland and weathered into clay soil with time.

2.2 Field and Laboratory Studies

The area was surveyed using the rigid grid method. Auger point investigations were carried out at 100m intervals along traverses cut at 100m apart on the baseline and morphological features were studied. Based on similarities and differences of the morphological results, four soil units were identified, and two profile pits were sunk in each (fig.1). The pits were described according to the guideline for soil profile description (SSS, 2014) and the samples were collected and taken to the laboratory for physical and chemical analysis. The samples were air-dried, crushed and sieved (d<2mm) samples were analyzed for particle size distribution, pH, organic carbon, cation exchange capacity (CEC), exchangeable bases, total N, available P, and base saturation.
Particle size distribution was determined by Bouyoucos hydrometer method (Day, 1965). Soil pH was determined by electrometric methods as described by IITA (2015). Walkley-black method, as described by Nelson and Sommers (1982) was employed for organic matter content. TN was determined using the modified macro-Kjeldahl method, as described by IITA (2015). Bray No.1 method was used for extractable P. For exchangeable bases, Ca and Mg were determined in full while K and Na were done by flame photometer. CEC was determined by IITA (2015) procedures, while base saturation was calculated by dividing total exchangeable bases by effective cation exchange capacity and multiply by 100%.

3.0 Result and Discussion

3.1 Morphological characteristics

The soils were deep, ranging from 160cm to 190cm. Unit I soils were well-drained with a high sand fraction (42.4-74.40%) at the surface A and Ap horizons (Table 1). The high sand fraction is characteristics of most savannah soils and is mainly due to the nature of the parent materials, constant weathering of rocks, and the downward movement of clay through the soil mass. It also indicates the Aeolian source as the parent materials of the upper horizons and the possible occurrences of soil erosion, which carried away the finer fraction in the surface horizons (Idoga and Azagaku, 2005).The soils of units II, III, and IV were poorly drained as indicated by the presence of mottles in the surface horizons and gleyed lower horizons. The poor drainage could be due to the accumulation of surface water as a result of the depressional landscape as well as the high clay fraction of the soils. Soils of unit III and IV had gilgai micro-relief in some places with cracks >2mm. The soils were well structured, having strong to moderate coarse and medium sub angular blocky. The good structural development could have been influenced by the high clay content of the soils. The massive lower horizons of some pedons could be due to the weight of the overlying horizons (Idoga, 1985). The soil textures were predominantly sandy clay loam especially at surface A and Ap horizons, while the subsurfaces horizons were sandy clay and clay in some places. The relatively high clay content (19.76%-58.26%) could be due to the alluvial parent materials as well as the nature of the underlying geology. The relative differences in clay content among the soil units could be due to slight differences in topography and cultivation. The clay fraction was inconsistent in distribution pattern within profiles 1, 2, 4, and 7 but increased with depth in profiles 3, 5, 6, and 8. Though in all, the clay content was higher in the lower horizons than the upper A and Ap horizons. This is in agreement with the report of Idoga, 2002 and Ugwu et al., 2001that clay content generally increases with depth due to some pedogenic processes such as lessivage, eluviations, and illuviation as well as the contribution of the underlying geology through weathering. The percentage silt fraction ranged from 0.0% to 36.56% with inconsistent distribution pattern with depth. This may be attributed to the differences in relief and the rate of deposition of accumulated materials brought down from the upper slope by fluvial processes into the depressional lowland. The silt content was high (15.84% to 36.56%) in profiles 3 and 4. This is contrary to the popular opinion on tropical soils having low silt of less than 15% (Young, 1976). The very low silt content (0.0%-8.64%) of pedons 1, 2, 5, 6, 7 and 8 may be due to excessive washing away of the soil particles by water erosion and runoff (Idoga, 2012). The soils have various colours in their surface A and AP horizons. Soils of profiles 1 and 7 had predominantly dark brown (10 YR 3/3, 10YR 4/3 and 7.5 YR 4/3, moist) color in their A and AP horizons. This could be attributed to the presence of relatively high O.M, which is the primary colouring agent in the topsoil (Ufot, 2012; Bradyand Weil, 2014).

3.2 Soil Chemical properties

The soils of the area were rated as strongly acidic to slightly alkaline in reaction with pH values ranging from 4.1 to 7.8 in H_2O (Table 2). It was lowest (4.1) in the surface horizon of profile 4 and highest (7.8) in the surface horizon of profile 6. It was inconsistently distributed down the profile. Profiles

1, 2, and 6 had high pH values on the surface than the subsoil as a result of nutrient biocycling and high percentage base saturation at the surface horizon (Idoga and Azagaku, 2005). This could also be accounted for by the direct deposition of crop and vegetable residues on the soil surface and their subsequent decomposition to release basic cations to the soil. Idoga and Ogbu,(2012) attributed the reduction in soil pH with depth to frequent crop harvesting and leaching of bases. The percentage O.C of the soil was low to moderately high for savannah soils, and the values ranged from 0.30% to 2.25%. The high value may be attributed to the incorporation of plant and animals residues to the soil. The low soil temperature resulting from poor drainage could also encourage O.M accumulation among the poorly drained soils of Obukiyo. The low amount of OC of profiles 1,2,5 and 8 is probably due to continuing cropping for an extended period, bush burning, high erosive rate, grazing, harvested crop residues without replacement and very poor management activities. TN ranged between 0.01% and 0.42%. The high amount of OC and TN in some subsoil is an indication of the young or immature nature of the soil profile due to the seasonal deposit of material. The low level of N in the soils may be attributed to release from plant tissues, gaseous loss, surface runoff, leaching, climatic factors, vegetation, human activities, initial soil pH and low activities of symbiotic and non-symbiotic N-fixing bacteria. Loss of N through denitrification and volatilization may also contribute to the low level of N in the area. Available P values were very low, with values ranging from 1.213mg/kg to 6.515mg/kg. This may be attributed to the low pH level, which fixed the P and makes it unavailable. It may also be attributed to the low amount of OC, continue cropping, crop removal, erosion of P-carrying particles, P dissolved in surface runoff and leaching due to the coarse nature of the soils.

The exchangeable bases were low as a result of the nature of the underlying parent materials, the intensity of weathering, leaching, low activity clay, low OM, erosion, and lateral translocation of bases. Ca was the most dominant cations with values ranging between 1.38cmolkg^{-1} and 4.94cmolkg^{-1}in the exchange complex. It may be linked to the occurrence of exchange sites which have a specific affinity to Ca (Idoga, 1985) or maybe because Ca is least easily lost from exchange site or has high displacement ability over other cation in exchange reaction. The Mg values ranged between 0.82cmolkg^{-1} and 2.64cmolkg^{-1}while that of K and Na ranged from 0.35cmolkg^{-1}to 1.86cmolkg^{-1}and 0.29cmolKg^{-1}and 0.98cmolkg^{-1}respectively. These values confirmed the predominance of Ca follow by Mg over K and Na as observed by Idoga, (1985) and Ogunkunle, (1989). The CEC of the soils were low to moderate with values ranging between 3.75cmolkg^{-1} and 8.34cmolkg^{-1}. The low CEC values indicate that the soils had a low potential for retaining plant nutrient. It may also be attributed to the nature of clay minerals (kaolinite) and low OC level of the soils. The B.S values (53% to 98%) were moderately high to very high. The high BS is probably associated with the presence of weathered minerals which release nutrients into the soil and their alluvial nature. A general correlation exists between the B.S and its pH. As the BS is reduced owing to the loss in drainage of Ca and other metallic constituents, the pH is also lowered in a more or less definite proportion (Table 2).

3.3 Suitability Ratings for Rainfed Rice (Oryza sativa) Production

Land suitability evaluation is the process of assessing the suitability of land for specific kinds of use (Ufot, 2012; Brady and Weil, 2014). According to FAO (2016), land suitability rating involves matching of crop requirements with the land qualities. It is the fitness of given traits of soil for a specific kind of land use. It is the effects of individual land qualities on the particular use. The suitability rating of Obukiyo wetland soils was carried out by comparing the qualities of the soil with the requirements of rice. The chemical characteristics of the soils such as pH, organic carbon, CEC, exchangeable bases, exchange acidity, available P and total N were found to be either conducive to rice production or can be amended by individual farmers and therefore cannot be considered to be permanent limitations.
One of the most important requirements of the rice crop is the availability of water throughout the growing period (Idoga, 2005). Water is, therefore, the most important limiting factor in rainfed rice production. Soil depth, drainage, slope, porosity, texture, and structure are essential physical characteristics that influence water retention. Soil units II, III, and IV were low-lying with 1% to 2% slope. They allow for water accumulation from surrounding areas leading to aquic soil conditions. This high clay content and the good structural development of the soil positively influence the water retention for plant use. Also, these soils were highly influenced by ground/ perched water table as observed in the grayed colour (2.5Y) of the soils. Apart from rainfall, flooding and underground seepage constitute an additional source of water to the soils of Obukiyo area.

The relatively low content of soil organic matter, total N, available P, CEC, and exchangeable bases indicated the low nutrient status of the wetland (Table 2). For soil unit 1, the significant limitations were low WHC, high porosity due to its sandy nature, low nutrient status of the soil, and the ustic moisture regime. Although the moderate clay content and the good structural development of the soil positively influence water retention for some period of cropping season for rice use. It is therefore grouped as S_3(Table 3), which is marginally suitable for rice production and may require organic or inorganic fertilizer application, irrigation when there is a drought of one to two months for sustainable rice production. The marginally suitable soils of the area account for about 12% of the study area. This implies that the individual farmer who cultivates the whole wetland needs little human manipulation to have a maximum yield of rice. Soil units III and IV were considered moderately suitable (S_2) for rice production on account of water availability and nutrient status. The moderately suitable soils of the area account for about 66% of the study area. The soils occupied the lower elevation in the area. They are therefore considered as moderately suitable (S_2) to rainfed rice production. Unit II soils occupied the lowest elevation in the area and had endo saturation with the high water level. They were poorly drained with drainage mottles noticed as from the topsoil to the subsoil horizons. Besides, the high clay content of the soil and the low-lying or depressional landscape do not permit the soils to lose water as fast as they received.

Consequently, water remains at or near the soil surface for

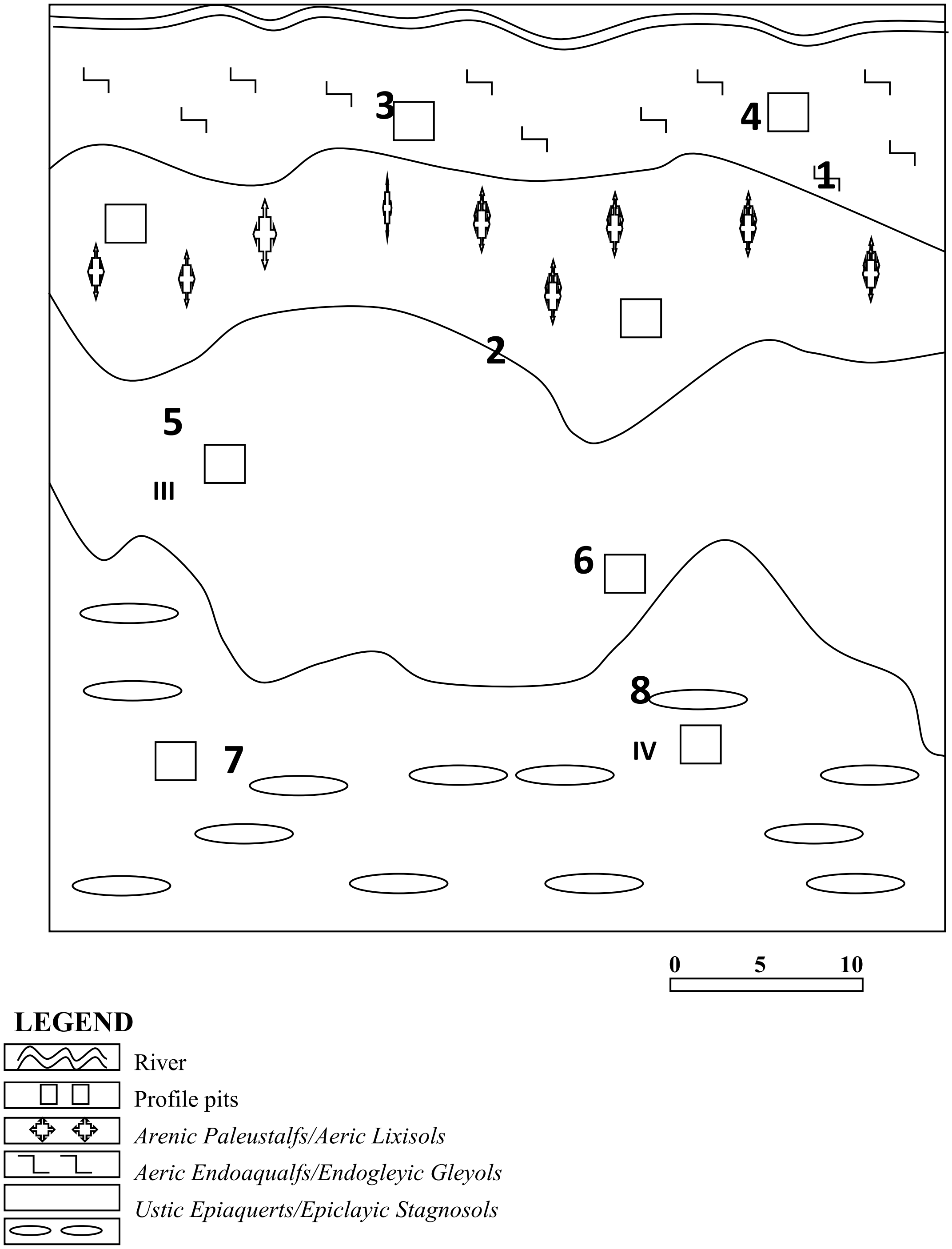

Figure 1: Soil Map of the Study Area

Table 1a: Morphological Description of the wetland Showing Pedon 1 - Pedon 4

Horizon	Depth (cm)	Colour (Moisture	Mottling	Mottling details	Texture	Structure	Consistence	Inclusion	Boundary
Unit I Pedon 1: Arenic Paleustalfs/Aeric Lixisols									
A	0-40	7.5YR4/3			Sandy clay loam	3MSBK	SSW	Few Medium Roots	c5
B	40-60	5YR6/6			Sandy loam	2MSBK	SSW	Few Fine Roots	ds
BC	60-110	5YR7/6			Sandy loam	2MSBK	SSW	Few Fine Roots	ds
C	110-120				Sandy clay loam	2MSBK	SSW	Few Fine Roots/ hard coherent rock at 170cm	-
Unit I Pedon 2: Arenic Paleustalfs/Aeric Lixisols									
Ap	0-28	10YR5/3			Sandy clay loam	3CSBK	SSW	Medium Common Roots	ds
A	28-78	10YR5/2			Sandy clay loam	3CSBK	SSW	Few fine roots	cs
AB	76-105	10YR5/6			Sandy loam	2MSBK	SSW	Few fine roots	gs
B	105-115	7.5YR6/4			Sandy clay loam	2MSBK	SSW	Few fine roots	dt
Bt_1	115-180	5YR5/4			Sandy clay loam	2MSBK	VSW	Few Fine roots/ hard Coherent rock at 180cm	-
Unit II Pedon 3: Aeric Endoaqualfs/EndogleyicGleysols									
Ap	0-20	10YR5/6	2.5YR5/6	F3P	Sandy clay loam	3CCr	SSW	Many coarse roots	cs
Bt_1	20-80	2.5YR5/2	10R5/6	M2P	Clay loam	2MSBK	VSW	Many coarse roots	ds
Bt_2	80-110	2.5YR4/2	10R7/6	F2D	Clay loam	2MSBK	VSW	Common medium roots	ds
Bt_3	110-180	2.5YR5/4	10R5/2	F2D	Clay loam	2MSBK	VSW	Few medium roots	-
Unit II Pedon 4: Aeric Endoaqualfs/Endogleyic Gleysols									
	0-24	10YR8/6	10R3/2	C2D	Clay loam	3CCr	VSW	Many coarse roots	ds
	24-86	5YR5/3	10R3/3	F2P	Sandy clay loam	2MSBK	VSW	Few fine roots	ds
	86-118	2.5YR5/2	5YR4/3	M2P	Clay loam	2MSBK	VSW	Few fine roots	ds
	118-190	2.5YR5/6	5YR7/	M3P	Sandy clay loam	2MSBK	VSW	Few fine roots	-

Table 1b: Morphological Description of the wetland Showing Pedon 5 - Pedon 8

Horizon	Depth (cm)	Colour (Moisture	Mottling	Mottling details	Texture	Structure	Consistence	Inclusion	Boundary
Unit III Pedon 5: Ustic Epiaquerts/Epiclayic Stagnosols									
Ap	0-30	10YR5/6	10YR5/2	F1F	Sandy clay	3CSBK	SSW	Many medium roots	cs
AB	30-60	10YR5/8	10YR5/2	E2D	Sandy clay	3MSBK	VSW	Common Fine Roots	cs
B	60-75	10YR5/4	2.5Y7/6	C2P	Sandy clay	2MSBK	VSW	Few Fine Roots	ds
Bt_1	75-115	7.5YR5/4	5YR5/3	C2D		2MSBK	VSW	Few Fine Roots	ds
Bt_2	115-150	7.5YR7/4	5YR7/1	C2P	Sandy clay	2MSBK	VSW	Few Fine Roots	ds
Btn	150-180	7.5YR5/6	2.5Y7/2	C2D	Sandy clay	2MSBK	VSW	-	-
Unit III Pedon 6: Ustic Epiaquerts/Epiclayic Stagnosols									
Ap	0-20	10YR5/4	10YR6/8	C2P	Sandy clay	3CSBK	SSW	Many fine root	cs
B	20-50	2.5Y4/4	7.5YR6/3	F1D	Clay	3CSBK	SSW	Common Fine Roots	ds
Bt_1	50-100	2.5YR/6	5YR5/4	C2D	Clay	2MSBK	SSW	Few fine roots	ds
Bt_2	100-160	2.5Y5/4	7.5YR7/1	M3P	Clay	2MSBK	SSW	Few fine roots	ds
Btn	160-180	2.5Y5/0	10YR4/2	M3P	Clay	2MSBK	VSW	Few medium concretions	-
Unit IV Pedon 7: Ustic Epiaquerts/Epiclayic Stagnosols									
Ap	0-34	10YR3/3	10YR5/6	F1D	Sandy clay	3CSBK	SW	Many coarse roots	cs
B	34-74	10YR4/3	10YR6/6	F1D	Sandy clay	3MSBK	VSW	Many coarse roots	ds
Bt_1	74-98	7.5YR5/4	10YR5/4	F2D	Sandy clay	2MSBK	VSW	Few coarse roots	ds
Bt_2	98-133	5YR6/3	10YR4/2	M2P	Sandy clay	2MSBK	SPW	Few coarse roots	ds
Bt_3	133-180	2.5Y5/2	5YR4/2	M3P	Sandy clay	2MSBK	SPW	Few coarse roots	-
Unit IV Pedon 8: Ustic Epiaquerts/Epiclayic Stagnosols									
Ap	0-24	10YR3/4	5YR3/2	F1D	Sandy clay	3CCr	VSW	Many medium roots	cs
Bt_1	24-86	10YR4/4	2.5YR6/2	F1D	Sandy clay	3CSBK	VSW	Common medium roots	cs
Bt_2	86-118	7.5YR5/0	5YR5/2	C2P	Sandy clay	3CSBK	SPW	Few fine roots	ds
Bt_3	118-190	5YR4/8	5YR5/2	C2D	Sandy clay	2MSBK	PW	Few fine roots	-

Mottling Details:
F1F=Few fine faint, C2D=Few Common medium distinct, M3P=Many coarse prominent, C3P=Common coarse prominent
Texture
S= Sandy, C= Clay, SL= Sandy loam, SCL= Sandy clay loam, SC= Sandy clay
Structure
3CCr = Strong coarse crumbs, 2CCr = Moderate coarse crumb, 2MCr = Moderate medium crumb, 2MSBK = Moderate medium subangular blocky, 2MFBK = Moderate fine subangular blocky, 3CSBK = Strong coarse subangular blocky, 3MSBK = Strong medi-

um subangular blocky

Consistence

SSW = Slightly sticky wet, VSW = Very sticky wet, VPW = Very sticky wet, SW = Sticky wet, nSW = Non-sticky wet, Npw = Non -plastic wet

Inclusion

C2F= Common medium faint, M2d= Many medium distinct, F1f= Few fine faint, C3d= Common coarse distinct

Boundary

ds = diffuse smooth, gs = gradual smooth, cs = clear smooth, as = abrupt smooth.

Table 2a: *Physical and Chemical Properties of the Inland Wetland Soils of Obukiyo of Oju Local Government Area, Showing Pedon 1– Pedon 5*

Horizon	Depth (cm)	Particle size dist			Texture	pH H2O	Org C	Total N	Avail P	Exchangeable Bases				TEB	EA	CEC	BS
		Sand	Silt	Clay		→	(%) ←		Mg/SCL	Ca →	Mg	K cmol/kg-1	Na	←			(%)
Unit I Pedon 1: Arenic Paleustalfs/Aeric Lixisols																	
A	0-40	70.40	7.84	21.76	SCL	7.2	1.30	0.05	3.36	1.97	1.66	0.98	0.64	5.25	0.76	5.36	87
B	40-60	72.40	7.84	19.76	SL	6.8	0.30	0.06	1.62	2.68	2.38	0.64	0.49	680	110	6.29	85
BC	60-110	79.76	0.00	20.24	SL	6.8	0.60	0.05	3.52	3.70	2.62	0.72	0.48	7.52	2.07	7.53	78
C	110-120	72.12	5.54	23.04	SCL	6.0	0.71	0.06	3.57	3.73	1.08	0.54	0.37	5.72	2.02	5.72	74
Unit I Pedon 2: Arenic Paleustalfs/Aeric Lixisols																	
Ap	0-28	74.40	4.56	21.04	SCL	6.1	1.19	0.05	3.27	1.69	1.38	0.82	0.79	4.68	1.02	4.78	82
A	28-78	70.40	6.84	22.76	SCL	6.5	0.32	0.06	1.56	2.47	1.86	0.54	0.46	5.33	1.07	5.35	83
AB	76-105	72.40	8.54	19.06	SL	5.6	1.54	0.05	2.46	3.93	2.41	0.54	0.48	7.36	2.16	7.47	77
B	105-115	69.12	4.84	26.04	SCL	5.7	1.30	0.08	4.67	2.01	1.76	0.64	0.93	5.34	2.18	5.35	71
Bt_1	115-180	62.40	5.56	32.04	SCL	5.6	0.40	0.42	4.47	1.38	2.43	0.35	0.29	4.45	2.62	4.58	63
Unit II Pedon 3: Aeric Endoaqualfs/EndogleyicGleysols																	
Ap	0-20	50.40	28.56	21.04	SCL	4.8	2.00	0.05	3.41	2.05	2.03	0.84	0.44	5.35	3.05	5.38	64
Bt_1	20-80	43.12	27.84	29.04	CL	4.4	1.52	0.05	3.13	1.93	1.75	0.72	0.54	4.94	3.61	4.98	58
Bt_2	80-110	43.12	27.84	29.04	CL	5.6	1.50	0.04	1.45	2.07	2.04	0.75	0.54	5.06	0.76	5.73	88
Bt_3	110-180	42.42	24.54	33.04	CCL	5.1	1.26	0.04	2.77	2.13	1.84	0.69	0.43	5.09	0.68	5.12	88
Unit II Pedon 4: Aeric Endoaqualfs/Endogleyic Gleysols																	
Ap	0-24	42.40	24.56	33.04	CL	4.1	2.00	0.05	2.10	2.60	2.34	0.82	0.53	6.29	3.62	6.34	63
Bt_1	24-86	48.40	20.56	31.04	SCL	4.6	1.42	0.05	1.93	1.98	0.96	0.76	0.58	4.28	3.68	4.39	54
Bt_2	86-118	40.40	24.56	35.04	CL	5.0	2.13	0.06	3.73	3.36	2.73	0.52	0.64	7.25	0.77	7.34	90
Bt_3	118-190	74.40	0.56	25.04	SCL	5.0	0.40	0.08	2.84	2.69	2.48	0.73	0.64	6.54	0.68	6.72	91
Unit III Pedon 5: Ustic Epiaquerts/Epiclayic Stagnosols																	
Ap	0-30	58.40	3.54	38.06	SC	5.7	1.38	0.06	1.42	1.99	0.84	0.76	0.58	4.17	3.63	4.37	53
AB	30-60	60.24	0.44	39.32	SC	7.5	0.88	0.11	1.52	1.98	1.42	0.82	0.58	4.80	2.62	4.85	65
B	60-75	53.04	6.36	40.60	SC	6.7	0.74	0.05	1.44	1.98	2.64	1.03	0.94	7.59	0.71	7.68	91
Bt_1	75-115	51.68	7.20	41.12	SC	7.0	0.97	0.06	1.26	2.99	2.32	0.94	0.82	7.07	2.24	7.07	76
Bt_2	115-150	56.40	1.50	42.10	SC	6.0	1.97	0.06	1.21	1.82	0.98	0.73	0.64	4.17	2.02	4.28	67
Btn	150-180	55.68	0.78	43.54	SC	6.3	1.56	0.04	1.26	3.38	2.41	0.84	0.58	7.21	0.76	7.22	90

Table 2b: Physical and Chemical Properties of the Inland Wetland Soils of Obukiyo of Oju Local Government Area, Showing Pedon 6– Pedon 8

Unit III Pedon 6: Ustic Epiaquerts/Epiclayic Stagnosols																	
Ap	0-20	56.40	2.62	40.98	SC	7.8	1.74	0.09	1.41	2.68	2.55	1.86	0.98	8.07	0.62	8.19	93
B	20-50	43.12	2.59	54.29	C	5.4	0.86	0.07	1.82	4.94	1.83	0.87	0.62	8.26	1.77	8.28	82
Bt_1	50-100	42.12	3.22	54.66	C	6.0	0.74	0.07	1.33	3.93	2.34	1.04	0.94	8.25	2.08	8.34	80
Bt_2	100-160	40.40	2.89	56.71	C	5.6	1.26	0.14	2.19	3.24	2.38	0.82	0.62	7.06	2.04	7.16	78
Btn	160-180	39.12	2.62	58.26	C	7.7	0.78	0.01	1.50	2.98	1.87	0.98	0.96	6.52	0.63	6.58	91
Unit IV Pedon 7: Ustic Epiaquerts/Epiclayic Stagnosols																	
Ap	0-34	58.40	2.60	39.00	SC	5.4	2.25	0.05	3.36	1.82	1.34	0.86	0.77	4.79	1.82	4.89	72
B	34-74	59.68	0.32	40.00	SC	6.5	1.02	0.05	1.57	2.94	1.86	0.93	0.56	6.29	1.74	6.29	78
Bt_1	74-98	61.12	1.65	37.23	SC	6.2	0.36	0.04	2.14	3.67	2.48	0.89	0.03	7.97	0.75	7.98	91
Bt_2	98-133	59.70	1.14	39.70	SC	5.8	1.59	0.06	6.51	2.47	1.65	0.42	0.84	5.38	2.11	5.49	72
Bt_3	133-180	35.12	7.45	39.43	SC	5.7	1.73	0.06	1.97	1.64	1.34	0.64	0.53	4.15	2.19	4.26	65
Unit IV Pedon 8: Ustic Epiaquerts/Epiclayic Stagnosols																	
Ap	0-56	57.40	2.40	40.20	SC	5.5	1.45	0.07	2.33	2.34	1.86	0.95	0.82	5.97	2.18	5.98	73
Bt_1	56-96	53.12	2.34	44.59	SC	4.9	1.45	0.06	1.66	2.78	2.02	0.41	0.36	5.55	3.02	5.67	65
Bt_2	96-126	53.40	0.61	45.99	SC	6.1	0.48	0.04	1.94	3.37	2.62	0.82	0.72	7.53	0.76	7.33	91
Bt_3	126-160	52.12	2.62	45.26	SC	5.8	0.46	0.06	2.48	3.43	2.14	1.58	0.42	7.57	2.22	7.69	77

Table 3: Summary of Soil Suitability Ratings of the Study Area

Soil Units	**Profiles**	**Suitable rating**
I	1and 2	S_3
II	3 and 4	S_1
III	5 and6	S_2
IV	7 and 8	S_2

Table 5: *Suitability Class Scores of the Pedons in the Study Area for Wetland Rice*

Land qualities	Land characteristics	Unit	S1	S2	S3	N1	N2
Factors Rating		%	100-85	84-60	59-40	39-20	19-0
Climate (c)	Annual Rain	Mm	>1400	1200-1400	950-1100	850-900	<850
	Solar radiation	$Cal.cm^{-2} day^{-1}$	>300	300-200	200-100	<100	Any
Growing period	LPG+	Days	120-180	70-120	>70	<70	<70
Soil physical characteristics	Soil Depth 14	Cm	>20	10-20	5-10	<5	Any
	Clay	%	40-25	25-15	15-5	≤15; ≥5	Any
Wetness (w)4	Drainage	-	1-3	1-3	3	Any	Any
	S. W. D	Cm	10-20	20-40	40-60	>60; >10	Any
	F. D	Months	<4	3-4	2-3	>2; >4	Any
	G. W. T	Cm	0-15	15-30	30-60	>60	Any
Fertility Status (f)	PH[19]	-	5.5-7.5	5.2-5.5	≤5.2; ≤8.2	≤5.2; 8.2	Any
	Total N[20]	%	>0.2	0.1-0.2	0.05-0.1	<0.05	Any
	Organic carbon[20]	%	2.3	1-2	3-4	>4; ≤1	Any
	P(Bray)[18]	Mg-Kg-1	>20	15-20	10-15	<10	Any
	P(Olsen)[20]	Mg.Kg-1	>10	7.5-10	5-7.5	<5	Any
	K[20]	Cmol.kg-1	>0.2	0.1-0.2	<0.1	<0.1	Any
	Ca[20]	Cmol.kg-1	10-15	5-10	1-5	<1; >5	Any
	Mg[20]	Cmol.kg-1	2-5	1-2	<1	<1; >5	Any
	CEC (soil)[20]		>16	10-16	5-10	<5	Any
Toxicity (t)	Active- Fe[22]	%	<0.75	0.75-1.0	1-1.25	>1.25	Any

Table 5: *Suitability Class Scores of the Pedons in the Study Area for Wetland Rice*

Land quality and characteristics	Pedon I	Pedon II	Pedon III	Pedon IV	Pedon V	Pedon VI	Pedon VII	Pedon VIII
1. Climate (c): Annual rainfall (mm)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)	S_2(84)	S_2(84)
2. Growing PG+ (days)	`	S2(74)	S1(100)	S1(100)	S1(85)	S1(85)	S1(85)	S1(850
3. Soil physical characteristics soil depth (cm) Clay(%)	S1(100) S2(84)	S1(100) S1(95)	S11(100) S1(95)	S1(100) S1(95)	S1(100) S1(95)	S1(100) S1(95)	S1(100) S1(95)	S1(100) S1(95)
4. Wetness (w): Drainage	S3(59)	S3(59)	S1(95)	S1(98)	S1(195)	S1(95)	S1(95)	S1(95)
5. Fertility (f): pH	S1(100)	S1(100)	S2(84)	S2(84)	S1(95)	S1(95)	S2(84)	S2(84)
6. Total N (%)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)
7. Organic carbon (%)	S2(84)	S2984)	S1(85)	S1(85)	S2(80)	S2(80)	S1(95)	S2(83)
8. P(Bray) (mg.kg-1)	N1(20)	N1(20)	N1(20)	N1(20)	N1(20)	N1(20)	N1(20)	N1(20)
9. K (cmolgk-1)	S1(95)	S1(95)	S1(95)	S1(95)	S1(90)	S1(90)	S1(95)	S1(95)
10. Ca (cmolgk^{-}1)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40	S3(40)	S3(40)	S3(40)
11. Mg (cmolgk^{-}1)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)	S2(84)
12. CEC (soil) (cmolgk^{-}1)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)	S3(40)
13. Mean value	49	95	95	95	84	84	84	83
14. Aggregate suitability class	S3	S3	S1	S1	S2	S2	S2	S2
15. Limited characteristics	d, n	d, n	N	N	N	N	N	N

Aggregate suitability class scores:

100-75=S1, 74-50=S2, 49-25=S3, 24-0=N1

one to two months in most rice-growing seasons. Based on these features these soils can be described as wetland soils. (Idoga and Azagaku, 2005). Usman *et al. (*2017) had recommended the utilization of these types of soils for rice production based on their aquic condition. In terms of water supply; therefore, the soils can be considered to have little or no limitations to rice production. The strongly to slightly acidic reaction (4.1-5.6)of this unit and the high base status are also favourable for rice production. Consequently, these soils were considered highly suitable (S_1) for swamp rice production. These soils occupy about 22% of the study area.

This study has shown clearly that rice cultivation in the area should be concentrated in the highly suitable (S_1), (unit II) and moderately suitable (S_2) (unit III and IV). Though unit 1 soils which were marginally suitable (S_3) for rice production, can be used for upland rice production with minimal human management (application of manure, irrigation and liming) but more better suitable for other arable crops with less water requirements such as maize, sorghum, cassava and yam as already practiced by farmers in the area. These matching was done in line with the factors of land requirements for wetland rice (Table 4 and 5).

4. Conclusion

The suitability rating of Obukiyo inland wetland soils indicated a marginally suitable (S3), (unit 1), moderately suitable (S2), units III and IV and highly suitable (S1), (unit I) for rice production. Management practices such as organic matter incorporation, liming to increase soil pH, fertilizer application and time of planting have been recommended for improved rice productivity in the mapping units that are not highly suitable for rice production in the area studied.

Reference

Brady, N.C, and Weil, R.R. (2014). The Nature and Properties of Soils'14th ed. Prentice-Hall. New Jersey, USA. 960pp.

FAO (2016). Word Reference Base for Soil Resource by ISSS-ISRIC-FAO Word Resource Report No 104, FAO Rome, Italy.

Day. P.R. (1965). Particle fraction and particle size analysis. In: C.A. Black(ed), Methods of Soil Analysis, Agron.9.ASA, Madison, Wisconsin,USA, Pp547-577.

Idoga, S. (1985). The Relationship of Topography to Soil and Vegetation in Northern Guinea Ecosystem, Nigeria. Unpublished M Sc. Thesis, Department of Soil Science, ABU, Zaria 182pp.

Idoga, S., and Azagaku, E.D. (2005). Characterization and Classification of Soils of Janta Area, Plateau State, Journal of Soil Science Society of Nigeria. Vol. 15:116-122.

Idoga, S. (2002). Characterization and Effects of Hamaterm Dust on the Soils of Lower Benue Valley, Nigeria. Unpublished Ph.D. Thesis, Dept. of Soil Science UAM, Benue State, Nigeria. 130pp.

Idoga, S. (2005). Suitability rating of some depressional soils of the Lower Benue Valley for rainfed rice production. Nig. J. of Soil Res. Vol. 6:358 – 370.

Idoga, S. and Ogbu, O.J. (2012). Agricultural Potentials of the Andibilla Plateau of Benue State, Nigeria. Nigeria Journal of Soil Science. 22(2): 124-228.

IITA (2015). Selected Methods for Soil and Plant Analysis. Manual Series N0.13, IITA Ibadan, Nigeria.

Nelson, D. W., and Summers, L.E. (1996). Total Carbon. Total Organic Carbon and Organic Matter In Sparks D. I (ed). Methods of Soils Analysis, Part 3. Chemical Methods. Agronomy Monograph N0. 9, American Society of Agronomy, Medison, Pp961-1010.

Ogbu, O.J (2011).Soils and the agricultural potentials of the Andibilla Plateau of Oju LGA, Benue State of Nigeria.Unpublished MS.C.Thesis, Department of Soil Science, UAM, Benue State. 112Pp.

Ogunkunle, A. O (1989). Variation within Taxonomic Unit. The Ibadan Series Example in South-Western Nigeria, Nigeria Journal of Soil Science. 9:9 – 20

Soil Survey Staff, (2014). Key to Soil Taxonomy, USDA Soil Conservation Service, Washington D.C. 263p.

Ufot, U. O. (2012). Soils and the Environment for Colleges and Universities, Shadow Publishers Ltd, Owerri, Nigeria 1634p.

Ugwu. T. O., Ibadan, I.J., Lekwa G.and Ucheagwu,H.M. (2001). The Soils of Basement Complex Toposequence of the Jos Plateau, Nigeria Journal of Soil Science, 27:5-25.

Usman J., Idoga, S., Oyetola, S.O, andOgbu, O.J.(2017). Characterization and Suitability Assessment of the Soils of the Gboko Plain for the Production of Maize and Rice, Nigeria. Proceedings of the 41st Annual Conference of the SSSN held on March 13-17th, 2017 at ATBU, Bauchi, Nigeria, PP 267 -278.

Young A. (1976). Tropical Soils and Soil Survey. Cambridge University Press, London. 486pp.