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ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF FLOODPLAINS SOILS FOR RICE AND YAM CULTIVATION IN OBUBRA LOCAL GOVERNMENT AREA OF CROSS RIVER, NIGERIA.

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Abstract

The Assessment of physico-chemical properties of floodplains' soils for rice and yam cultivation using the standard routine methods were done. The result showed that Soil properties differed according to various sample locations under study. Bulk density was favourable (<1.8Mgm^3). The Moisture levels were low (<50%). The particle size distribution (sand, silt and clay) were moderate in all the sample locations. The pH was moderate (5-6.00) and was within the limit for optimum growth for plants. Organic carbon was also moderate across the study locations (2.00-4.20gkg^{-1}) Total nitrogen and available phosphorus were low (0.10 gkg^{-1} and <10mg/kg), exchangeable bases (Exch Ca, Mg, Na and K) varied from low - high in the study locations. Exchangeable acidity was high while CEC was moderate (6-10cmol/kg). It is within the limit for the cultivation of the crops. Base saturation was very high (>50%) in all the sample locations of the study. The soils were classified as clay loam and sandy clay. The deficiency in total nitrogen and available phosphorus should be remediated using fertilizer, which is high with these elements.

Key words: assessment, Physical, chemical, properties, floodplain soil

1.0 Introduction

The physicochemical properties of the soil play a very important role in the development of vegetation anywhere in the world. The soil as a complex system is made up of several minerals such as organic matter, water and air (Hector, 2011, Vishal et al., 2009). The associated interaction of the physicochemical and biological properties, which affect many processes in the soil that makes it, fit for agricultural practices and other purposes cannot be over emphasized (Rakesh et al., 2012). The soil texture, soil structure and acidic contents affect the accumulation and absorption of mineral elements by plants and this play a vital role in vegetation establishment of development in sch areas (Mamun et al., 2011, Triphati and Misra, 2012 in Turkura, 2013). Alloyway, (1997), Tukura et al, (2009) and Snober et al, (2011) opined that soil pH is the Hydrogen ions (H^+ ions) in the soil pore which is in a changing state with the predominantly charged surfaces of the soil particles. On the other hand, Michael and Agub, (2010) suggested that the value of pH of any soil is influenced by the type of parent material from which the soil was formed and is affected by the amount of rainfall due to leaching of some nutrients such as calcium and manganese from the soil and their replacement by the acidic content of aluminum ion ($Al^{3+)}$ and ferrous ion (Fe^{2+}) (Michael and Agub, 2010). The trace metal complexation is greatly affected by pH either through solubility equilibria or because of complexation by soluble and surface ligands (Tukura et al, 2012). Soil organic matter is very active in binding native traced materials and is of great importance in the movement of metallic ions in the soil, sediments and water and in providing these ions to the plants in soils (Robin and James, 2003, Motuzova et al, 2008 and Rash et al., 2012). Stackhouse and Benson (1988) reported that soil organic matter is about 2.5% of the total soil mass and that it plays a significant role in checking the water holding capacity of the soil and its exchange – ion capacity. Connell; 1997, Alina and Henyk, (2000) also advanced that lignin is the main components of plant that add to soil organic matter in the form of humic substances which are classified as humin acids, humic, fulvic. Cation exchange capacity (CEC) is a measure of the amount of cations, which the soil can take or hold (Ayidnlp and Mannava, 2003). The CEC in most of the soil varied from 5-3cmolkg^{-1} depending on the type of soil and amount of the combinations of clay minerals (Kabata, 2004). Mamun et al, (2011) showed that soils with higher CEC generally have higher levels of clay and organic matter and that CEC is responsible for exchangeable cations such as calcium ion (Ca^{2+}), magnesium ion (Mg^{2+}) and K: which is always available for plant uptake and further reported that cations adsorbed to exchange sites are more resistant to leaching or downward movement in soils with water, calcium ion (Ca^{2+}) and magnesium ion (Mg^{2+}) though secondary nutrients are required in relatively smaller but in appropriate quantities. The deficiencies in calcium ion are always very rare when the pH in the soil is adequate (Snober, et al., 2011). Optimum magnesium ion levels in the soil varied from 100 – 250ppm (Mamun et al., 2011).

Sodium ion, the degree at which the soil exchange sites are saturated with sodium as greater than 2.5%, may cause adverse effect on the physicochemical conditions of the soil, which may retardate development in the soil that may prevent plant growth. High levels of exchangeable sodium affect soil permeability, which may cause toxicity to sensitive plants (McCauley et al., 2005). There are three basic nutrients that are needed in large quantities by plants to grow well; such as nitrogen, Potassium and phosphorus as postulated by Rai et al., 2012). The presence of phosphorus in the soil depends on the soil pH. Sometime potassium exists in soil as unavailable, slowly available and in available form (Ijaz et al, 2006). Rakesh et al. (2011) advanced that physicochemical properties of the soil are complex and often non-linearly related, spatially and temporally in a changing state. For the optimal production of rice and yam, the physicochemical conditions of the soil must be maintained at a favourabe levels such as soil type, soil nutrient, and soil mineral. Rice and yam are two of the major crops cultivated in Obubra local Government Area that needed soil with rich soil nutrients to growth well. Many research works have been done on soil physical and chemical properties worldwide but an absolute work on the requirement of each of the elements of the soil physical and chemical properties of the soil for crop production is not sufficient in literature, hence the need for this study. The objective of this study is to assess the physical and chemical properties of soil samples from the flood plain soils of Obubra environs for rice and yam cultivation.

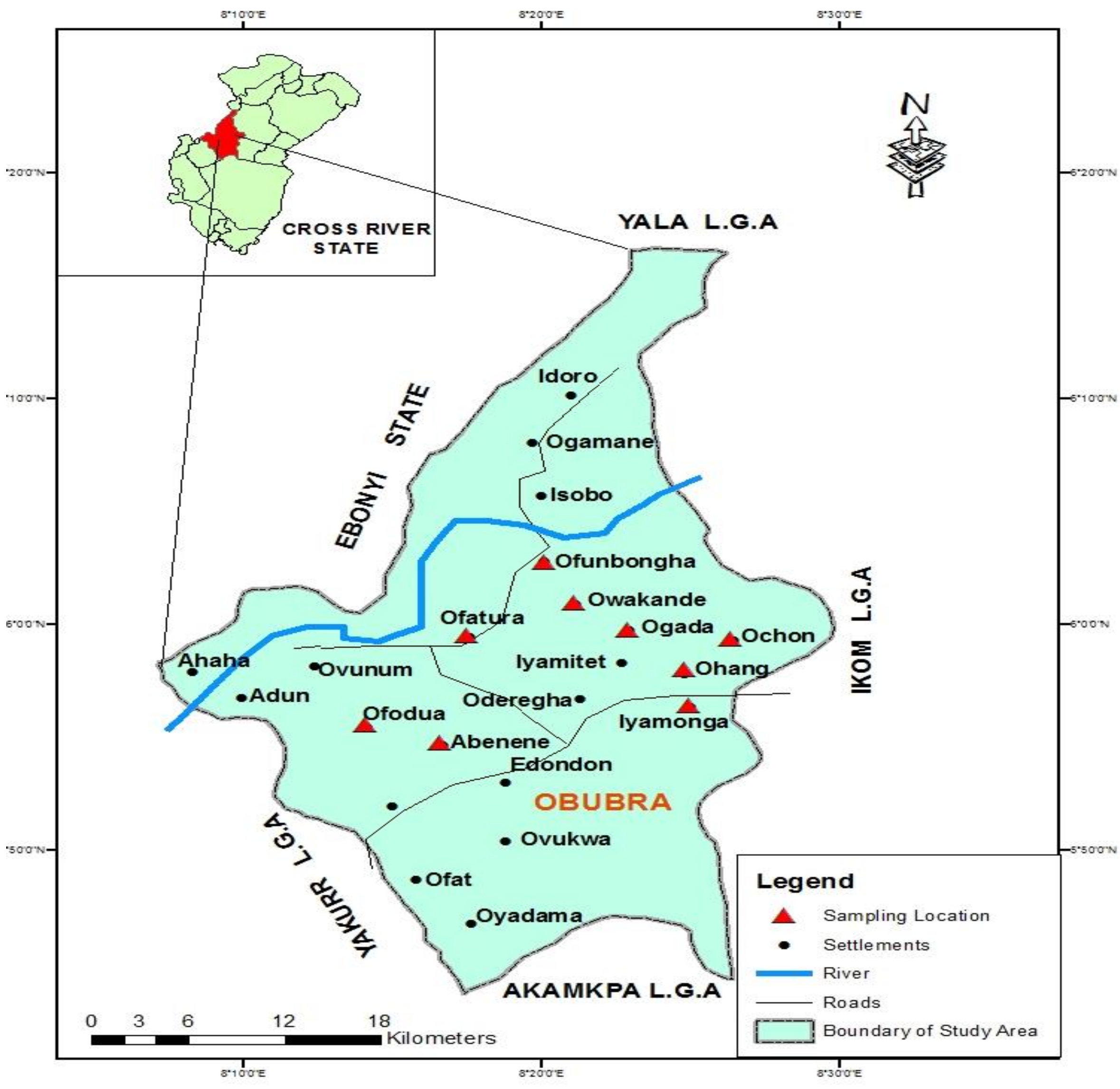

Fig 1: Map of Obubra L.G.A showing study area and sampling locations

Source: Geographic Information System (GIS) Laboratory Department of Geography and Environmental Science, University of Calabar, Calabar.

2.0 Methods of Study

2.1 Study area

2. 1.1 Location

Obubra Local Government Area is a riverine area which lies between latitude 6º 15' and 4^0 25'N and longitude 8º 12' and 3^0 29'E and 109 metres elevation above the sea level. It is boardered at the north by Yala Local Government Area, Yakurr Local Government Area at the south, and Ebonyi State at the West and Ikom Local Government Area at the east. It is situated within the central sectorial district of Cross River State (Fig 1). The study area covers a land mass of 431sqm (1,115m^2) with a population of 172, 443 (National Population Census at the2006) population census with a projection of 199,470 in 2011 population projection (National population commission, 2006, National population commission of Nigeria (web), 2011, Cross River State Ministry of Land & survey, 2012). Obubra Local Government Area soils are mostly sandy loam and clay in texture and consist of hydromorphic soils of the lower deltaic coastal plains that are usually flooded during the rains (Datta & Joshi, 2004).

The soils are fragile in some areas and prone to erosion due to lack of good vegetative cover; except in the interior parts, where vegetation is lush. The soils are mainly used for farming activities. The rich top soils are laced underneath with unfathomable and extensive beds of limestone and quartz, pyrite, salt, iron ore, clay lead, and gravel (Okey, 2015). Obubra lies within the rich fringes of the tropical rainforest zone of South Eastern Nigeria with abundant natural resource, including agricultural forest (Okey, 2015). The Soil is highly variable and strongly correlated with fluvial landforms (Okey, 2015). The soil texture is sandy loam to loam, silt loam; with silty clay loam to clay-textured in the floodplains. The floodplain vegetation of the area consists of many small patches of vegetation with different species composition, and successional stages often correlated with fluvial landforms. Within a floodplain vegetation of the area, vegetation varies along a gradient of flooding frequency and duration. In addition to local variation in species composition and structure within the floodplain of the study area the dominant trees in the area are tree species such as Mahogany (Turraeanthus Africana), Obeche, Opepe, Cedar with several leguminous plants and shrubs (Ovai, 2019). Vegetation type of the upland is characterized by tall trees such Iroko, Mahogany, Obeche, Opepe, Cedar and Gmelana. However much of the original vegetation has been cleared such that the prevalent vegetation is becoming derived savannah consisting of grasses and forbs, small broad leaved plants.

Traditionally the people of Obubra Local Government Area are predominantly farmers and the land use of the area is agriculture. About 95 percent of the people of Obubra Local Government Area are engaged in agricultural activities with cultivation of annual crops like cassava (Manihot Spp), yam (Dioscorea spp) and rice (Oryza sativa).

2.2 Data collection

Thirty six (36) Samples of soils were randomly collected from sample plots of the floodplains from the three zones of the study area (Osopong, Okum and Adun clans) and three villages with abundant floodplains were also randomly selected from each zone, and in each of the villages (Ofunbongha, Owakande & Ogada for Osopong clan, Ochon, Ohana & Iyamoyong for Okum clam while Ofatura, Ofudua & Abenene was for Adun clan), 4 samples plots were mapped (100 X 100m) out and soil samples were collected using soil auger. The soil samples were collected from 0 – 30 cm. This depth is ideal for rice and yam since the roots goes deep below the surface. This depth incorporated the top and subsoil, (top soil from 0 - 15cm and subsoil 15 – 30cm) which is relevant for yam and rice cultivation. Twelve (12) soil samples were collected from each study location. The soils were subjected to physico-chemical analyses in the laboratory to obtain the following parameters: Particle size distribution, soil pH, organic carbon, total nitrogen, cation exchange capacity (CEC), exchangeable bases (Ca, Mg, Na, and P & K), base saturation, total available phosphorus, exchangeable acidity and electrical conductivity, also, core sampling bulk density rings were used to collect undisturbed soil core samples for bulk density determination at 0 -5cm depth.

2.3 Laboratory analysis

The soil samples collected from the sample plots were air- dried and analyzed at the Soil Science Laboratory, University of Uyo; except bulk density, that was determined in the University of Calabar Soil Science Laboratory using the standard routine laboratory procedures, as described by Page, Miller and Keeney, (1982); Jou (1983) and Klute (1986).

3.0 Result and Discussion

3.1 Physical properties of the floodplain soils in the Obubra Local Government Area

Bulk density values vary among the soils in the three clans as seen in Table 1. The results showed that the soils within the Osopong ranged from 0.89-1.45Mg/M^3 with mean values of 1.11Mg/m3, whereas those of Okum ranged from 0.89-1.67 with mean values of 1.47Mg/m^3 while the Adun soils varied between 1.1 – 1.7Mg/m^3 with mean value of 1.14Mg/m^3. The bulk density mean values on Obubra soils as observed were agronomically less than 1.8Mgm^3 considered optimum for sustainable rice and yam production. This is because for bulk density to be considered unfavourable for sustainable crop production when the dominant values should be 1.8Mg/m^3 and above (Zimermann and Kardos 1961). Therefore soils with bulk density values >1.8Mg/m^3 will hinder root penetration because aeration and water movement will be too low for development and good crop growth (De Geus, 1973; Lombin, 1999;& Essoka, 2008).

The moisture content of soils around the Osopong varied from 9.56-14.00% with mean value of 12.25% while the of Okum varied from 10.22-18.31% with mean value of 13.26% and Adun soils varied from 11.86-15.26% with mean value of 12.99% with Cv value of 14%, 20% and 10% respectively. The moisture contents were generally adequate for the production of both crops (Lombin, 1999) in the study area being <50%. The particle size analysis of the soils in the study area showed that the proportion of sand was seen to be relatively higher than the values of silt and clay. The sand content ranged from 31.72-67.66% with mean value of 52.13% for soils around the Osopong clan whereas soils around Okum ranged from

27.66-67.00% with mean value of 47.72% and within the Adun axis the soils varied from 26.80-74.72% with mean value of 52.82%. Silt on the other hand ranged from 14.54-36.62% with mean value of 24.58% for soils around the Ospong clan, 17.70-46.54% with a mean value of 31.28% for soils of Okum area while the soils within the Adun area ranged from 19.90-39-40% with mean value 26.79%. The clay content in Osopong clan has a mean value of 23.29%, Okum has a mean value of 21.42% while that of Adun has a mean value of 29%. The clay in the Osopong area was higher than that of Okum and Adun, which indicated that there is illuviation and perturbation (Malgwi et al., 2000; Ogunwole et al, 2000). The soils in the area were generally seen to be moderately variable. The soils in the floodplains of the area were more of clay loam in texture in Osopong and Okum clans and silt clay loam in Adun clan. These textural classes of the floodplain soils suggest that the soils can support the production of yam and rice (Ahmed; et al., 2017)

3.2. Chemical properties of the floodplain soils of Obubra Local Government Area

The pH of soils over the Osonpong clan varied from 5.00-6.00 with mean value of 5.6, whereas those of Okum varied from pH 5.00-5.90 with mean value of 5.28 while those ones over the Adun clan ranged from pH 5.00-6.00 with mean value of pH 5.39 (Table 2). The soils in the area are moderately acidic in nature. The moderate nature of soil pH observed in the area indicates that the available nutrients in the soil are balanced (Tale & Ingole, 2016). Okorie (2013) and Njoku et al., (2013), Tabi et al, (2012), also confirmed this. This result also was in conformity with Ponnamperruma (1977), when he opined in his study that the optimum conditions for nutrient uptake by yam and rice from soil solution of pH is about 5.6.

The electrical conductivity in soils of Osopong, Okum and Adun have mean values of 0.08, 0.07, 0.08 dSm^{-1} respectively. The EC (Electrical Conductivity) of the soils are highly variable with highest variability seen in the soils of Okum area (CV=71 percent). The organic carbon values ranged from 1.70 – 5.74gkg^{-1} for the soils at Osopong, 1.36-3.91gkg^{--1} for the soils of Okum and 1.02-4.20gkg^{-1} for the soils of Adun with mean values of 3.30, 2.83gkg^{-1} and 2.75gkg^{-1} respectively. The organic carbon content is moderate; seen to be between 2.00- 4.20% (Enwezor et al., 1989). These values were within the critical level or limits. The mean values of total nitrogen in all the soils were generally very low; being <0.10 gkg^{-1} (Enwezor et al, 1989: Udo et al., 2009) the low total nitrogen may be attributed to continuous cultivation of the soils year in and out for yam and rice production, which led to a rapid reduction of total nitrogen due to crop uptake (Maniyunda and Malgwi, 2011). The available phosphorus content ranged from 1.03-3.74mg/kg for Osopong soils, whereas the soils of Okum varied from 1.10-8.95mg/kg and soils of Adun varied from 1.00-7.28mg/kg with mean values of 2.65, 3.14 and 3.22mg/kg (Table 2). The element is rated very low and below the critical limit of 10 mg/kg (Enwezor et al., 1989; Uponi & Adeoye, 2000).

The low available phosphorus could be due to the fixation of phosphorus by iron (Fe) and Algon (Al) sesquioxides and pH status of the soil as opined by Adegbenro et al.; (2011). For rice to yield well it requires available phosphorus content of 13.35 mg/kg while yam requires 10 - 15 mg/kg (Aondoakaa & Agbakwuru, 2012). Nevertheless, this cannot be used to judge the level of phosphorus in view of the fact that Grant (1964) discovered that phosphorus is improved in waterlogged soils such as the floodplains. Exchangeable Ca showed a mean value of 8.65cmol/kg, for Osopong soils, 6.70cmol/kg for soils of Okum and 7.28cmol/kg. Exchangeable Mg has a mean value of 0.11cmol/kg for Osopong, whereas that of Okum showed a mean value of 1.73 Cmol/kg, while the soils of Adun shows a mean of 1.87 Cmol/kg. The mean value for exchangeable Na over the soils at Osopong in large quantity for its growth and better yield (Balogun, 2001). The low to high variation observed can be due to the biological materials from which the soils where formed (Omotoso & Akinbola, 2007). Variability in soils is a numerical representation that determines the degree of how soils properties are spread in the soil or how they vary from each other. Exchangeable acidity varied between 1.28-3.34cmol/kg for the soils of Osopong with mean value of 2.84cmol/kg, 1.30-8.00 cmol/kg for soils at Okum with mean value of 2.69 cmol/kg and 1.60-3.84 for Adun soils with mean value of 2.40cmol/kg. These exchangeable values over some of the soils in the area are considered high and reflect the acidic content of the soils and this indicated that acidic cations are significantly present in the exchangeable sites of the soils (Malgwi, 2011). The CEC at Osopong soils ranged from 9.48-19.90cmol/kg whereas the soils at was 0.11cmol/kg, 0.08cmol/kg for the soils over Okum and 0.09Cmol/kg for Adun, while Exchangeable K indicated the mean value of 0.26Cmol/kg for Osopong soils, 0.15Cmol/kg for Okum soils and 0.16 Cmol/kg for the Adun soils. The values were within the critical limit of being between 5-10cmol/kg.

The exchangeable Mg is moderate and was within the critical limit for rice cultivation. The exchangeable Na was generally low and exchangeable K was also low, being between 1.0-0.3cmol/kg (Udo et al., 2009, Tabi et a,., 2012), The low exchangeable Na and K were detrimental to yam and rice cultivation since these are macro-nutrients that they required

Okum ranged from 7.57-14.38 cmol/kg and soils at the Adun region varied 9.11 - 17.14 with the mean values of 17.74, 10.89 and11.86 cmol/kg respectively. These values were said to be moderate for yam and rice production; being between 6-40 cmol/kg (Tabi et al, 2012). The percentage base saturation in soils of Osopong varied between 66.43-92.28% while Okum soils ranged from 71.29-89.81 and varied between 58.89-88.022% for soils at the Adun area, with mean values of 81.58% for Osopong, 78.81% for Okum soils and 78.94% for Adun soils. The soils were generally high in base saturation being, greater than 50 percent. The high base saturation could be attributed to the relatively moderate amounts of exchangeable Ca and Mg. However, the high base saturation percentage could also be explained in part; by the presence of weatherable minerals in soils of the study area (Holland et al., 1989).

Table 1: Descriptive summary Statistics of Physical Properties of Soils in Obubra L.G.A

Sample Area	Bulk Density Mg/m^3	porosity %	MC %	particle size Analysis sand%	silt%	clay %	Textural class
Osopong clan							
Range	0.89-1.45	19-53	9.56-14.0	31.72-67.66	14.54-36.62	17.40-33.66	
Mean (number of cases = 12)	1.11	38.75	12.25	52.13	24.58	23.29	CL
Standard Deviation	0.18	9.85	1.72	9.88	6.93	4.38	
C.V %	16	25	14	19	28	19	
Okum clan							
Range	0.89-1.67	9-51	22-8.31	27.66-67.00	17.70-46.54	13.30-25.30	
Mean (number of cases = 12)	1.47	18.83	3.26	47.72	31.28	21.42	
Standard Deviation	0.02	11.47	2.69	11.18	9.11	3.94	CL
C.V %	14	61	20	23	29	18	
Adun Clan							
Range	1.1-1.74	14-39	11.86-15.26	26.80-74.72	19.90-39.40	9.66-33.30	
Mean (number of cases = 12)	1.41	24.42	12.99	52.82	26.79	20.55	SL
Standard Deviation	0.22	10.51	1.24	12.15	7.13	5.88	
C.V %	16	43	10	23	27	29	

Source: Fieldwork, 2019.

Table 2: Descriptive summary results of Chemical Properties of Soils in Obubra L.G.A

	pH	EC	OC%	TN%	Aval P (Mg/kg)	Exchangeable Bases (Cmol/kg) Ca	Mg	Na	K	EA (Cmol/kg)	CEC (Cmol/Kg)	BS%
Osopong Clan												
Mean (number of cases = 12)	5.0-6.0	0.072-0.104	1.70-5.74	0.04-0.18	1.03-3.74	5.0-14.0	1.20-3.00	0.07-0.17	0.12-0.64	1.28-3.84	9.48-19.90	66.43-92.28
Mean (number of cases = 12)	5.6	0.08	3.30	0.08	2.65	8.65	2.20	0.11	0.26	2.34	17.74	81.58
Satandard Deviation	0.34	0.04	1.24	0.04	1.23	2.44	0.64	0.03	0.17	0.72	5.01	8.4
C.V %	6	48	38	49	46	28	29	24	65	31	28	10
Okum Clan												
Range	5.00-5.90	0.044-0.103	1.36-3.91	0.04-0.11	1.10-8.95	4.30-10.00	1.20-2.40	0.05-0.10	0.10-0.22	1.30-8.00	7.59-14.88	71.29-89.93
Mean (number of cases = 12)	5.28	0.07	2.83	0.07	3.14	6.70	1.73	0.08	0.15	2.69	10.89	78.81
Satandard Deviation	0.28	0.05	0.93	0.02	2.41	1.78	0.4	0.01	0.03	1.75	2.26	5.76
C.V %	5	71	33	28	77	27	23	18	20	65	21	7
Adun Clan												
Range	5.00-6.00	0.036-0.136	1.02-4.20	0.05-0.11	1.00-7.28	4.10-11.20	1.10-2.80	0.07-0.11	0.11-0.23	1.60-3.84	9.11-17.44	58.89-88.02
Mean (number of cases = 12)	5.39	0.08	2.75	0.07	3.22	7.28	1.87	0.09	0.16	2.40	11.86	78.94
Satandard Deviation	0.28	0.05	0.91	0.02	1.95	2.43	0.53	0.01	0.04	0.73	2.54	7.93
C.V %	5	59	33	29	61	33	28	14	25	30	21	10

Key: EC, electrical conductivity, OC= organic cabon, TN= total nitrogen, CEC= cation exchange capacity, BS=base saturation
Source: Fieldwork, 2017

3.3 Comparison of the established land quality and the current soil quality of Obubra Local Government Area rice and yam production

Table 3 displayed the established land quality for rice and yam cultivation and the current soil quality of the soils of Obubra Local Government Area. The result indicated that soil pH (5.6, 5.28 & 5.39), organic carbon (3.30, 2.83 & 2.75%), Exchangeable Ca (8.65, 6.70, 7.28 Cmol/kg), exchangeable Mg (2.20, 1.73, 1.87l Cmol/kg), Cation exchange capacity (CEC) (17.74, 10.89 & 11.86 Cmol/Kg) and base saturation (81.58, 78.81 & 78.94%t) in the soil of the three clans of Obubra Local Government Area met the land quality requirement for rice production in the area; except total nitrogen (0.08, 0.07 & 0.07%), available phosphorus (2.65, 3.14 & 3.22Mg/Kg) and exchangeable K (0.26, 0.15 & 0.16Cmol/Kg) that were below the critical limit for rice production in the study area. For yam production soil pH, organic carbon, available phosphorus and CEC were moderate for yam production in the area, while total nitrogen and exchangeable k were low whereas base saturation was extremely high. From this comparison, the result showed that soils of Osopong clan were richer in terms of the chemical properties for yam and rice production than the other Okum and Adun clans. Some of the properties were above the critical limit; such as exchangeable Ca, Mg, cation exchange capacity (CEC) and base saturation respectively.

Table 3:Comparison of the established land quality and current soil quality for rice production in Obubra Local Government Area

Established land quality	Yam	Rice	Current soil quality in the study area		
Chemical properties	Rang of values	Rang of values	Osopong clan	Okum clan	Adun clan
Soil pH	6.0-6.5	3.1 - 6.00	5.6	5.28	5.39
Organic carbon (%)	>2.0	0.20 - 21.0	3.30	2.83	2.75
Total nitrogen (%)	>0.15%	0.10 - 0.2	0.08	0.07	0.07
Avail. Phosphorus (Mg/Kg	1-15	8.60 - 83.00	2.65	3.14	3.22
Exchangeable Ca (Cmol/kg)		2.70 - 0.85	8.65	6.70	7.28
Exchangeable Mg (cmol/kg)		0.84 - 1.0	2.20	1.73	1.87
Exchangeable K (Cmol/kg)	0.5-0.7	0.84 - 1.0	0.26	0.15	0.16
CEC (Cmol/kg)	>2.0	2.12 - 11.39	17.74	10.89	11.86
Base saturation (%)	>35%	30 - 80	81.58	78.81	78.94

Source: Aondoakaa and Agbakwuru, (2012)

4. Conclusion

The Assessment of physico-chemical properties of floodplains' soils for rice and yam cultivation was done. The result showed that the physical and chemical properties of soils of the study area differed according to various sample locations under study. The Bulk density was favourable for rice and yam cultivation in the area. The particle size distribution (sand, silt and clay) were moderate in all the sample locations. The pH was moderate and was within the limit for optimum production of the crops. Organic carbon was also moderate across the study locations. Total nitrogen and available phosphorus were observed to be low. Exchangeable bases (Exch. Ca, Mg, Na and K) varied from low - high in the study locations. Exchangeable acidity was high while CEC was seen to be moderate and it is within the limit for the cultivation of the crops. The soils were classified as clay loam and sandy clay. Total nitrogen and available phosphorus were seen to be deficient in all the sample locations. The deficiency in total nitrogen and available phosphorus should be remediated using fertilizer, which is high with these elements for maximum production of yam and rice in the study area.

Reference

Alina, P. and Henyk, P. (2000):.Trace elements in soils and plants" (3rd Ed C.R.C Press, Amazon, U.K. pp.345-382.

Aondoakaa, S. C., &Agbakwuru, P. C. (2012):. "An assessment of land suitability for rice cultivation in Dobi, Gwagwalada area council" FCT Nigeria. Ethiopian Journal of Environmental Studies and Management *EJESM, 5(4), 444-451*.

Adegbenro, R.O, Ojetade, J.O &Amusan, (2011): A.A 'Effect of topography on phosphorus forms and distribution in soils formed in schist in Ife area". *Journal of Agriculture and veterinary Sciences 5(1):86-105*():

Ahmed, A Xu, S Yu, U & Wang, V (2017): "Comparative study on factors influencing Rice yield in Niger State and Hainan of China", *International journal of Agricultural and Food Research Vol 6 No 1 Pp 15-25*(

Balogun, A (2001): "The federal capital Territory of Nigeria: Geography of its Development", University of Ibadan: Ibadan University press.

Cross River State Ministry of land & survey, (Production of rice in Cross River State. 2012):

Datta, K .K & Joshi, P. K (2004): 'Impact of surface drainage in the improvement of crop production and income', Lagos

De Geus, J.G (1973): "Fertilizer guide for the tropics and subtropics 2nd edition centre d' elude' 1 Azote Zueich 403 pp

Enwenzor W.O, Udo B.J, Usoroh N.J, Ayotade K.A, Adepetu J.A, Chude V.A,and Udegbe

C.A (1989): "Fertilizer use and management for crops in Nigeria Series 2", Pp 163,

Essoka, P.A; (2008): "Soil variation over basement complex rocks and slopes in Cross River State". Ph.D Thesis, Ahmadu Bello University, Zaria

Grant, C.J (1964): "Soil characteristics associated with wet cultivation of rice in *Indonesia" Indonesian Food Journal 8(2)*

Holland, M.O; Allen, R.K, Barton, D & Murphy, S.T (1989): "Land evaluation and Agricultural Recommendations: Cross River National Part, Oban Division, ODNRI, WWF Nigeria and CRS Govt Pp 41-42

Juo, A, S.R (1982): "Phosphorus absorption characteristics of some bench – mark soils of West *Africa" Soc. Sci 107:214 -220*

Kabata- Pendias, A. (1983): "Soil-plant transfer of trace elements-an environmental issue" *Geoderma*, 122, 143-149 (2004).

Lombin, G): (1999) 'Production in the Nigerian Savanna region Paper presented at 15th Annual conference of score soil Science Society of Nigeria, Kaduna Nigeria 21sat – 24th Sept 1999

Maniyunda, L.M &Malgwi, M.B (2004): "Physico – chemical properties and management strategies for soil along River Galma ZariaDatta, K .K & Joshi, P. K: "Impact of surface drainage in the improvement of crop production and income," Lagos

Okorie A, &Njoku, (2013): "Comparative assessment of selected chemical properties of soils in Ivo, Ohaozara and Onicha L.G.As of Ebonyi State" Greener *Journal of Agricultural volume. 3(2), Pp 097-100*

Omotoso, S.O &Akinbola, G.E *(*1982): "Variability of soil properties at the transition zone between two parent materials in southwest Nigeria" *International Journal of soil Science 2:218-223*, 2007:

Page A. I, Miller, R H & Keeney, D. R (1977): "Methods of soil Analysis part 2 – chemical and microbiological properties" 2nd edition, *American Society of Agronomy; Wisconsin pp 1159,*

Ponnamperruma F.N, "Physical-chemical properties of submerged soil in relation to soil fertility". International Rice Research Institute Newsletter Series No. 5,

Udo E.J; Ibia, T.O; &Ogunwale, J.A (2009): "Manual of soil, plant and water analysis" Sibin Books Limited,

Uponi J.I and Adeoye, G.O (2000): Keys to soil taxonomy, United States Department of *Agriculture (USDA 9th ed) Pp 263-385.*

Zimmermann, R.P &Kardos, L.T, (1961): "Effect of bulk density on root growth" Soil Science: 280-288,

Alloway, B. J. & Ayres, D. C. (1997): :"*Chemical principles of environmental pollution"*, Blackie Academic and professional. Pp.53-359

Aydinalp, C. &Marinova, S. (2003): "Distribution and forms of heavy metals in some agricultural soils", *Polish Journal of Environmental Studies*, 12(5), 629-633,

Connel, D. W. (1997) "*Basic Concepts of Environmental Chemistry"*. Lewis

Publications, Boca Raton. New York.pp.77-90

Maniyunde, L.M and Malgwi, M.B (2011): "Physico-chemical properties and management strategies for soil along River Galma Zaria", Nigeria" Soil Science Society of Nigeria, Proceeding is of the 435th Annual conference of the Soil Science Society of Nigeria,

Malgwi, M.B; Ojanuga, A.G; Chude, V.O; Kpwarmwang, T and Raiji, B.A, (2000): "Morphological and physical properties of some soils at Samuru, Zaria Nigeria" *Journal Research 1:58-64*

Héctor .F, Oscar R. M, Enrique M., Ma. Del Carmen O. & Ana L. B. (2011):. Heavy metals in agricultural soils and irrigation wastewater of Mixquiahuala, Hidalgo, Mexico. *African Journal of Agricultural Research.* 6(24), 5505-5511, doi: 10.5897/AJAR11.414.

Ijaz A., Farmanullah K. & Bhatti A. U. (2006):. Some physico-chemical properties of soil as influenced by surface erosion under different cropping systems on upland-sloping soil .*Soil & Environ. 25(1), 28-34*

Mamun, S. A., Rahman F., Yeasmin F. & Islam M. A. (2011):. Suitability of the Physical Properties of Soil for Crop Production: A Study in Tangail Sadar. Journal of Environmental Science and Natural Resources. 4(2), 121-125, ISSN 1999-7361.

Mc Bride, M. & Save H. W. (1997):. Solubility control of Cu, Zn, Cd and Pb in contaminated Soils. European Journal of Soil Science. 48, 327-346.

McCauley A., Jones C. & Jacobsen J. (2005):. Soil and Water Basic Soil Properties. Management Module 1.

Michael, P. & Arguin, H. (2010). Soil. In Encyclopaedia of Earth. Eds. Cutler, J. Cleveland, Washington, D.C, Environmental information coalition, National council for science and the environment .http://www.eoearth.org/article/Soil.

Motuzova, G. V., Minkina, T. M. &Nazar-Enko, O. G. (2008):. Interaction of heavy metals with organic matter. 5th International Symposium ISMOM, Pucón, Chile.

Rai S., Chopra A.K., Chakresh P., Dinesh K., Renu S.& Gupta P. M. (2012).: Comparative study of some physicochemical parameters of soil irrigated with sewage water and canal water of Dehradun city. *India International Journal of Environmental sciences.* 3(3), 318 – 325, ISSN 0975-508X.*http://scholarsresearchlibrary.com/archive.html.*

Rakesh K., Rakesh K.U., Kishan S. &Brijesh Y. (2012).Vertical Distribution of Physico-Chemical Properties under Different Topo-sequence in Soils of Jharkhand. *Journal of Agricultural Physics.*12 (1), 63- 69, ISSN 0973-032X http://www.agrophysics.in.

Robin, D., Graham, J. &Stangoulis, C. R. (2003):. Trace element uptake and distribution in plants. *Journal of Nutrition*, 13, 1502-1508.

Snober. H. B., Afshana B. D., Mohd S.D. & Masood M. G. (2011):. Correlation of soil physico-chemical factors with vam fungi distribution under different agroecological conditions. *International Journal of Pharma and BioSciences.* 2(2), 99-106, ISSN 0975-6299.

Tripathi A. &Misra D. R. (2012): . A study of physico- chemical properties and heavy metals in contaminated soils of municipal waste dumpsites at Allahabad, India. *International Journal of Environmental Sciences*. 2(4), 024-2033, doi:10.6088/ijes.00202030086

Tukura B.W., Gimba C.C. &Ndukwe I.G. (2007): .Effects of pH and total organic carbon (TOC) on the distribution of trace metals in Kubanni Dam Sediments, Zaria, Nigeria. *Science World Journal*. 3(2), 1-6,*www. sciecnce worldjournal.com.*

Tukura B.W., Gimba C. C. &Ndukwe I. G. (2009). Effects of pH and seasonal variations on dissolved and suspended heavy metals in dam surface water. *Chemclass Journal*. 6, 27-30.

Vishal D. J., Narahari N. P. &Punit R. R. (2009): Physico-Chemical properties of four farm site soils in area surrounding Rajkot, Gujarat, India. *International Journal of ChemTech Research.* (3), 709-713, SSN: 0974-4290. www.sphinxsai.com.