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THE AGRICULTURAL POTENTIALS OF FLOOD PLAIN SOILS ALONG THE BANK OF WARRI RIVER FOR DRY SEASON CROPPIN

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ABSTRACT

This research work was carried out to assess the potentials of flood plain soils on agricultural productivity in Warri River, in the Niger-Delta area of Nigeria. Soil samples were collected from plots of 10 meters by 10meters along the river bank. In all ten (10) sample plots were established and the simple random technique was employed in the collection of the soils. Soils were collected from 0-15, 15-30cm soil depth and a total of 30 samples were collected for laboratory analysis. The soil elements considered include, particle size for the proportion of sand, silt and clay. The status of organic matter, total Nitrogen, exchangeable calcium, magnesium, potassium and sodium were also analyzed. Other elements considered are effective cation exchangeable (CEC), available phosphorous, iron and the soil pH. Results from the study showed that the soil ofRiver Warri flood plain has high soil productivity if put into proper use. This is evident from the high cation exchangeable capacity recorded as both the 0-15cm and 15-30cm soil layers. It is therefore recommended that farmers should be encouraged by agriculture extension workers to take advantage of the soil to cultivate large amount of vegetables such as okro, fluted pumpkin, cucumber and sugar cane etc along the bank of the river especially during the 3rd and 4th months of the dry season to utilize the abundant mineral and organic nutrients and moisture content of the soil.

Keywords: Agricultural potentials, Warri, Flood plain soils, cation exchange capacity.

1. INTRODUCTION

The Warri River flood plain at Udu, Aladja and some other parts of Warri South of Delta State in Nigeria is nearly a flat plain with small in-filled channels that bifurcates from the main river and empty their water into Warri river valley. These extensive flood plain that is drained by the numerous tributaries are seasonally flooded for about three months when the Warri River overflows its banks. The soils formed on this flood plain exhibits different physical, chemical characteristics and also in mineralogical composition (Hossain, Khan, Hussain, and Macumder 2011).

According to Agbola, (1979) there are three main types of flood plain soils of some significance to agriculture in Nigeria. Perhaps the least important for farming purposes are alluvials on marine deposits found in mangrove areas along the coast which are only suitable for coconut growing. He further stated that, flood plain soils nearer to the coast have a high sulphide content this usually have high acidic content when it is drained, thus limiting their use for agriculture. The flood plain soils found in lacustrine and riverine deposits are found to be more useful under

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conditions of controlled drainage. The fertility of these soils are at its peak during the dry season when the flood water of the rivers recede.

Soil characteristics are very important as they go a long way to determine crop yields and productivity (Aroegodore, 2004). Also, soil equally influences the management strategies to be adopted by farmers so as to ensure that soil maintains a high level of fertility (Bekunda; Sanginga and Woomer, 2010)

However, it has been observed that series of studies carried out on soil characteristics and its properties, in the rain and swamp forest ecological zone dealt with inland soils and have made no attempts on flood plain soils. Although some authors have made attempts to examine the characteristics of alluvialsoils in the coastal parts of Nigeria, but failed to consider the potentials of Agricultural production of this soils (Areola, 1984, Aghimien, Udo, and Ataga 1985 and Obiefuna, 1989).

It is for this reason that this research effort is made towards examining the nutrient status of flood plain soils along the bank of Warri River with a view of determining its potentiality for agricultural crop production at whatever scale.

2. MATERIALS AND METHODS

2.1 Study Area

Warri River transverses six Local Government areas of Delta State in Nigeria. However, for the purpose of this research the study wascarried out at the mid-session which stretches from Agbarho area to Warri central. The Warri River is one of thecoastal riversin the Niger-Delta area of Nigeria with an outlet through the forcardos estuary to the Atlantic Ocean. It lies between Latitude $5^0 21'$ and $6^0 00'$North and Longitudes $5^0 24'$ and $6^0 21'$East (See Figure 1.1). The River lies in the Northern outskirts of the mangrove saline zone in the Niger Delta of Nigeria. The river takes its source from Utagba-Uno and flows South-West for about 80km through Amai, Othoro-Abraka, Otokutu and main Warri town before emptying its water into the Atlantic Ocean through the Forcados estuary.

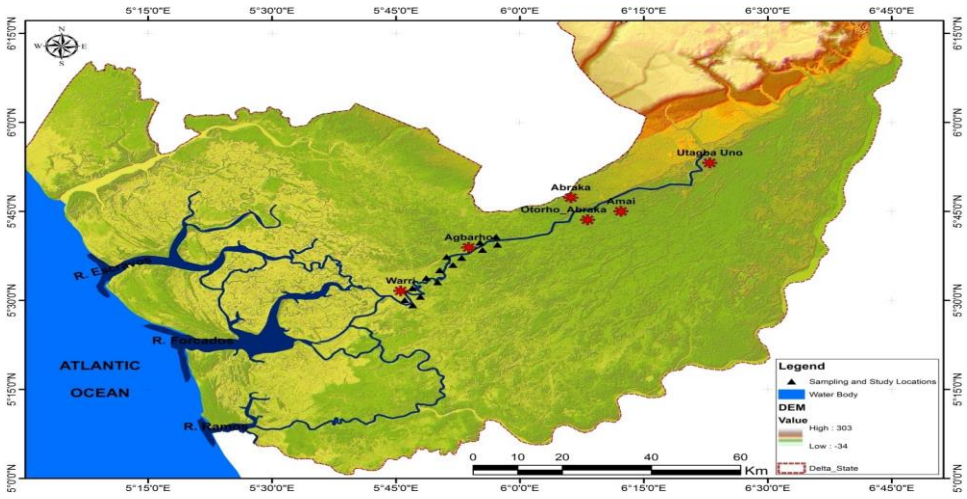

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Fig 1. Warri River indicating study area

Warri River basin is situated within the Niger Delta region which is made up of the Agbada-Akata and Benin formations in terms of geology. Today, over 12 kilometers of sediments have accumulated since the Eocene period in the basin starting with the bottom marine clays (i.e. Akata formation) overlain by Paralic Oligocene-Miocene Sediments (i.e. the Agbada formation) and capped by continental gravels and sands of the Benin formation (Short, and Stauble, 1967, Assez, 1989). The formation is a deep water marine deposit and over pressured by the overlying accumulation of deposits. According to Asseez(1989), thin sandstone lenses separate it from the overlying Agbada formation. The upper facies of Agbada formation contain mostly sands that are coarsening upward with minor shale intercalations, whereas the lower portion consisted of alternating layers of sand and shale deposited in equal proportions (Doust and Omatsola, 1989). Generally, the study area is flat and low-laying with no path rising above 8 meters above sea level. The whole area is consequently liable to heavy flooding.

The area is characterized by hydromorphic soils which are made up of the Sambreiro plain soils derived from the coastal plain deposits (FEPA, 2001). This soil type consists of well-drained sandy loam over coarse sandy clay loam subsoil. There is also the second group of hydromorphic soils known as the mud flat type derived from the coastal plains of alluvium. They are characterized by cat clay with mottles in the grey clay sub soils. These three types of soil are found along the flood plain of the Warri river (Mogborukor, 2007).

As a result of its location, the study area experiences a slightly modified equatorial climate with its characteristically high temperatures and rainfall all the year round. This is an area where the influences of the Tropical Maritime airmas (mT) are felt for most of the year. This airmas is warm and moist and blows across the Bight of Benin, bringing much rain to this area. The rainy season lasts for about nine months (March to November). The rainfall regime is clearly that of a double maxima with an August break. The dry season is short and occurs from December to February. During this period, the influences of the Tropical Maritime airmass are largely replaced by those of the Tropical Continental airmas – a cool dry airmass blowing from the north, resulting in a short harmattan season. Even in the dry season, heavy downpours often occur.

Warri has a mean annual rainfall of 2873.8mm, which is quit high when compared with other stations such as Port Harcourt (2423.8mm) and Lagos (1829.8mm). Frequent incidences of flood within the city are, therefore, not uncommon. Much of the rain is conventional in nature and falls mostly in the afternoons. It is characterized by violent storms and lightning. During these thunderstorms, as much as 25.4mm of rain may be recorded in less than one hour. The relative humidity is quite high (exceeding 90%) for most of the year.

The temperatures are rather constantly high, with monthly mean of about 34^0C. Annual range of temperature is considerably small 3.0^0C. This slight contrast between the warmest and the coolest months is determined not so much by its position of the sun as by the amount of cloudiness and precipitation. Lowest mean temperatures occur between June and September,

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when the study area experiences the heaviest rains of the year. High temperatures are recorded during the period of lowest rain and clearest skies.

The Warri metropolis is located on the zone of contact between the mangrove swamps and the freshwater swamps. The mangrove swamps are characteirised by numerous crreks and swamplands inaccessible by direct road links. Extensive swamp forest tracts with a variety of species such as *Rhizohoraracemosa, R. mangle,R. harrisonia* and *Avicenniaafricana* which occur in almost every part of the study area. The oil palm and rubber trees are also very common.

2.2 Soil Sampling and Laboratory Techniques

Data for this study was obtained from soil samples which were collected plots of 10 metres by 10 metres which are in consonance with Aweto and Ogurie (1992) specification. In all, ten sample plots were established along the river Warri flood plain. Within each of the sample plots, simple random technique was employed to sample soils from the spots in each of the plot using a core samples. For each of the sample spots, soils were collected from 0-15cm and 15cm – 30cm in depth. The choice for the different depths was to check whether there is any significant variation in soil element in the different depths. By this exercise, a total of 30 soil samples were collected for laboratory analyses.

The soil samples were first air-dried and sieved through a 2mm sieve. They were analysed for the following particle size distribution so as to establish the proportion of sand, silt and clay using hydrometer method (Bouyoucos, 1926). Organic matter in the soil was determined using the Walkley-Black Method and available phosphorous using the methods of Bray and Kutz (1945). Total Nitrogen were determined by the Kjeldahl method. The soils were leached with 1m-ammonium acetate in order to obtain the leachates used for determining soil exchangeable cations. Soil exchangeable calcium, potassium and sodium were determined by means of flame photometry and exchangeable magnesium by atomic absorption spectrophotometry. Soil effective cation exchange capacity was determined by the summation method (Chapman, 1965). The concentration of extractable iron was determined by using an atomic absorption spectrophotometer (Aweto and Oyegunwa, 2000). Soil pH was determined potentiometrically in distilled water using a soil to water ratio of 1:1.

3. RESULTS AND DISCUSSION

3.1 Nutrient Status of Alluvial Soil along River Warri

Soil analysis and nutrient status of the coastal soil along Warri River is presented below:

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Table 1: The mean physical and chemical analyses of the 0-15cm and 15-30cm soil layers along the sampled area of Warri River

Soil Physical and Chemical Properties	Units of Measurement	0-15cm mean values	15-30cm mean values
Sand	%	65	62.3
Silt	%	11.5	12.0
Clay	%	23.5	25.7
Organic matter	g/kg	3.05	3.02
Total Nitrogen	g/kg	0.12	0.12
Exchangeable calcium	Meg/100g	1.85	1.80
Exchangeable magnesium	Meg/100g	1.31	1.42
Exchangeable potassium	Meg/100g	4.00	4.10
Exchangeable sodium	Meg/100g	0.14	0.64
Cationexchangeable capacity (CEC)	Meg/100g	12.68	12.00
Available phosphorus	mg/kg	420.00	380.00
Iron	mg/kg	118.24	118.24
pH		5.7	5.7

Source: Author's Fieldwork, 2019

The physical composition of particle size of soil was determined along the River and showed that sand is the dominant mineral fragment in both 0-15cm and 15-30cm soil layers (Table 1). This is evident from the mean proportions of sand in the 0-15cm and 15-30cm soil layers, which are 65% and 62.3% respectively. The dominance of sand at the topsoil layer could be traced to accumulation of loose sediments that are more at the top soil layer than the sub soil layer. The mean silt proportion gave figures of 11.5% for the depth of 0-15cm, while it was 12% for 15-30cm depth. The mean proportion of clay in both 0-15cm and 15-30cm are 19.5% and 23.3% respectively. The higher silt and clay content recorded is presumably due to the removal by surface water run-off of the fine soil fragments from the upland. But the mean organic matter of the 0-15cm and 15-30cm soil layers are 3.05g/kg and 3.02g/kg respectively. The high organic matter demands some explanations because of the values of 1.83k/kg recorded by Alakpodia(2000), which is lower than this current study. Thus, the soils along the coastal areas are constantly under vegetation because of the all year round availability of water from River Warri. Therefore, the process of mineralization which stimulates the biochemical breakdown of

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dead plants tissue by microorganisms to produce simple structured soluble organic matter (Knapp, 1979) is highly effective. Also, high organic matter could be attributed to the effective regrouping of the soluble organic substances into layer molecules (polymerisation), which then become poorly soluble and stabilizes as a major point of soil humus due to constant supply of underground water which keep the land cover evergreen.

In both the 0-15cm and 15-30cm soil layers, there is no significant difference with respect to the level of total Nitrogen. The levels of total nitrogen at the top and sub-soil layers are 0.12% and 0.12% respectively and this could be attributed to the non-application of nitrogenous fertilizers on the soil which would have concentrated the nitrogenous substances on the top soil than the sub-soil. The situation could be traced to the fact that no major farming activity is taking place along the river-bank. However, the river Warri total Nitrogen is higher than that obtained by Alakpodia (2000) in an area which is constantly under gas-flare heat and lower than that obtained by Aweto and Ogurie (1992) and Alexander (1988) for hydromorphic soil under market gardens in the Ojo area of Lagos metropolis and for well-drained soil used for intensive market gardening in Jos Plateau area of Northern Nigeria.

Cation exchange capacity (CEC) is the ability of clays and humus to yield cations for plants use and this is measured in milli-equivalents per 100g of soil.

The mean exchangeable calcium, magnesium, potassium, sodium at the 0-15cm and 15-30cm are 1.85meg/100g,1.80meg/100g, 4.00meg/100g and 4.10meg/100g and 4.00meg/100g, 4.10meg/100g, 0.14meg/100g and 0.64meg/100g respectively (See Table 1). The cation exchangeable capacity of the Warri Riverflood plain could be considered high at 0-15cm and 15-30cm soil layers considering the values of Aweto and Ogurie (1992) and Alakpodia (2000). The high value of CEC (premised on the fact that the soil of the Warri River is constantly regenerating. The cation exchangeable capacity (CEC) of the soils could be said to be very high due to the fact that it is higher than the values obtained by Sanchez (1976), Aweto and Ogurie (1992), Ewhrudjakpor (1996) and Alakpodia (1998, 2000), in both flood plain soil sand upland soils with values of calcium (0.25meg/100g), magnesium (0.22meg/100g), potassium (0.08meg/100g) and sodium (0.04meg/100g). The mean available phosphorous and Iron in the 0-15cm and 15-30cm soil layers along the river Warri are 420.00mg/kg and 380.00mg/kg respectively.

The level of available phosphorous and Iron are much in the soils of the study area because they do not differ much from the values obtained by Nwoboshi (1979) and Adesoye (1979) in the rainforest zone of southern Nigeria. The reason for high level of available phosphorous and Iron in the soil of river Warri could be attributed to the fact that the study area is left uncultivated and as such, all the mineralization processes that promote the availability of phosphorous and iron in the soil is effectively done. The pH value is 5.7 at both the 0-15cm soil layers. This showed that soil of the study area could be considered as being neutral, which can possibly support many crops.

3.2 The Suitability of alluvial soils for agricultural Productivity

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In order to determine the potentials of the alluvial soils along the bank of Warri river for crop production, several root crops such as (yam, cassava, potatoes, cocoyam) and cereals like maize and rice were planted during the farming seasons from the month of February – April, 2019. Also planted were vegetables such as fluted pumpkins, spinach, cucumbers, cabbage,okro and sugar cane, only swamp rice is planted all the year round because it can tolerate and thrive during the short spell of dry season November – March and in the wet season (April - November).

At the end of the planting season and harvesting, evaluation and assessment was made for each crops' level of productivity. It was observed that the tuber crops as yam, cassava and potatoes and cocoyam did not thrive well under the alluvial bank soils.This could be due to excess wetness and anaerobic condition deficiency in oxygen content. However, post-harvest for maize and rice was very encouraging especially rice which are harvested in large quantity for local consumption.

Most of the vegetables that were planted during the short period of dry season along the River valley such as fluted pumpkins, okro, spinach, cucumbers, cabbage and sugarcane do exceedingly well in the alluvial soils. This is buttressed by the findings of Aweto and Ogurie (1992) for hydromorphic soils under market gardens in Ojo area of Lagos metropolis. Okro and pumpkin leaves which are staple vegetables in most homes in the area of study and beyond,were specially discovered to have thrived best in this flood plain soil.

4. CONCLUSION AND RECOMMENDATIONS

This study examines the agricultural potentials of alluvial soils and its productive capacity along river Warri. 30 soil samples was collected from 10m by 10m sampled plots and subsequently analysed. The soil elements considered include, particle size for the proportion of sand, silt and clay. The status of organic content, total Nitrogen, exchangeable calcium, magnesium, potassium and sodium were also analyzed. Other elements considered are Cation Exchangeable Capacity (CEC), available phosphorous, iron and the soil pH. Results from the study showed that the soil ofRiver Warri has high soil productivity if put into proper use. This is evident from the high cation exchangeable capacity recorded as both on the 0-15cm and 15-30cm soil layers. It is therefore recommended from the findings that farmers should be encouraged by agriculture extension workers to take advantage of this soil to cultivate large amount of vegetables such as okro, fluted pumpkin, cucumber and sugar cane along the bank of the river especially during the 3-4 months of the dry season to utilize the abundant mineral,organic nutrients and moisture content of the soil.

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