Greener Journal of Agricultural Sciences
Vol. 11(1), pp. 6-18, 2021
ISSN: 2276-7770

https://gjournals.org/GJAS

Characterization, Classification and Management of Soils of Obosi in Anambra State, Nigeria

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ARTICLE INFO

Article No.: *011321006*
Type**:** *Research*

Accepted: *15/01/2021*
Published: *03/02/2021*

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Keywords: *Characterization; classification; management; landscape; morphology; land degradation; land suitability*

ABSTRACT

Soil Survey and Evaluation of an approximately total area of 25.58km2 of Obosi land was carried out, using the map of the area. The aims of the research were to map out the soils of Obosi, classify and evaluate them for suitability and sustainability for agricultural production and other land use development projects, and to inventory the causes of the prevalent soil erosion and the general land degradation of the area. Auger samples and profile pits samples were collected and examined based on the morphology and the relief of the surveyed area three mapping units: MUI – Lowland areas, MUII – Upland areas and MU III – Gullied areas were established. From the results obtained it was found out that the lowland areas and the upland areas were suitable for arable crops. Their major shortfall for agricultural production is low fertility. The Gullied areas, MUIII is physically found within the uplands and low-land areas. They are referred to as badlands. The prominent limitation of this unit is erosion hazard. The area cannot be used in their present state without serious reclamation activity. The soils are generally Iso-thermic udult (ultisols) by USDA classification and correlated as Eutric Ferralsols by FAO - WRB classification. Efforts made through interviews and consultations to inventory the causes of the prevailing land degradation and soil erosion in Obosi revealed that so many factors such as massive and sudden deforestation of the area, the topography and relief of the area, the erodibility of Obosi soils and the poor government intervention, all contributed immensely to the land degradation problems of the area, and appropriate recommendations were made.

INTRODUCTION

Soil is the ultimate foundation of existence for all creation, and man depends on soil for his livelihood. However, man tremendously influence soils within his immediate environment and as such good soils are dependent upon man and the use he makes them. Man's standard of living is generally driven by the quality of plants and animals grown on the soil.

Soil is a natural filter to many contaminants and toxic elements that might be harmful to crops, animals and man supplies the crop root with plant nutrients;

water and air for crop development and a natural medium for waste disposal. The teething problems emanating from soil erosion is enormous and effort to combat and reduce it to the barest minimum is more often than not man's greatest challenges in controlling his environment. Soil is a non-renewable resource from which we exercise our agricultural activities for food production and source of petroleum, cement, gold tin etc. Hence it is important for man to treat soil especially top soil as a living entity. Else we pay dearly for it as a time may come when life will become impossible on earth. The greatest threat to the environmental settings of southeast, Nigeria is the progressive cutting into pieces the natural scenery or land arrangement by water erosion. Environmental factors such as vegetation, geology, geomorphology precipitation which is usually torrential in the area and fragile nature of the soil according to Igwe (2012) all enhance the erosion problems and their development.

Obosi is among the towns in Anambra State devastated by gully erosion that have caused severe damages on many people's residence rendering them homeless. Many farm lands and crop were destroyed and many schools, houses, and churches are badly affected in Obosi community. In fact many have being chased out from their patrimonial land and became a foreigner in their own father land all due to erosion menace. The depth of the gully erosion site in Obosi, Nanka, Oba and Ekwulobia all in Anambra State were more than one and a half kilometers (Nweke, 2015). Hydro-geologic investigation carried out by Nwabineli and Oti (2012) at Obosi, Nnaka, Umuchu, Amenyi, Nnewi and Oyi revealed that the soils have low to moderate swelling and shrinking potentials and so will more influenced by agents of erosion. Presently the town is been faced with the problem of urbanization, the problem of providing land for waste disposals, land for the establishment of infrastructures such as schools, markets, accommodation for government offices and workers and farm land for citizens.

Soil characterization describes and measures a wide range of soil properties like physical, chemical, mineralogical and microbiological properties. An assessment of soil particles and aggregates that provide estimate of soil horizons describe the properties of these soils with regards to colour, texture, structure, consistence, pH, root and pores distribution, boundary characteristics and horizon continuity (Schoenderger et al., 2002, Esu, 2004). Therefore soil classification is the arrangement of soils into groups or categories according to their characteristics. Soil characterization and classification tend to build a synergy between the soil users and scientist of different discipline for understanding the soil. Hence, soil characterization, soil classification and there spatial distributions are necessary for sustainable use and management of the resources while at the same time protecting and improving the natural environment. Understanding of this sort enables useful protection to be made whenever such soil occur, therefore, the information should be organized in systematic and concise manner to make for better understanding of soils and improved management hence the need for effective soil characterization cum classification. Thus, in the face of modern land use planning for land use sustainability the objective of the study is to characterize and classify the soils of Obosi for different uses.

MATERIALS AND METHODS

Study area

Obosi is in Idemili-North Local Government Area of Anambra State. It is located approximately by longitude 06^0 38^I and 06^0 50^IE and latitude 05^0 50^I and 06^0 12^I N (Duze and Afolabi 1981). It is bounded in the east by Nkpor and Umuoji, in the North by Nkwelle –Ezunaka and Onitsha, in the west by Ogbaru and in south by Ojoto (Figure 1).

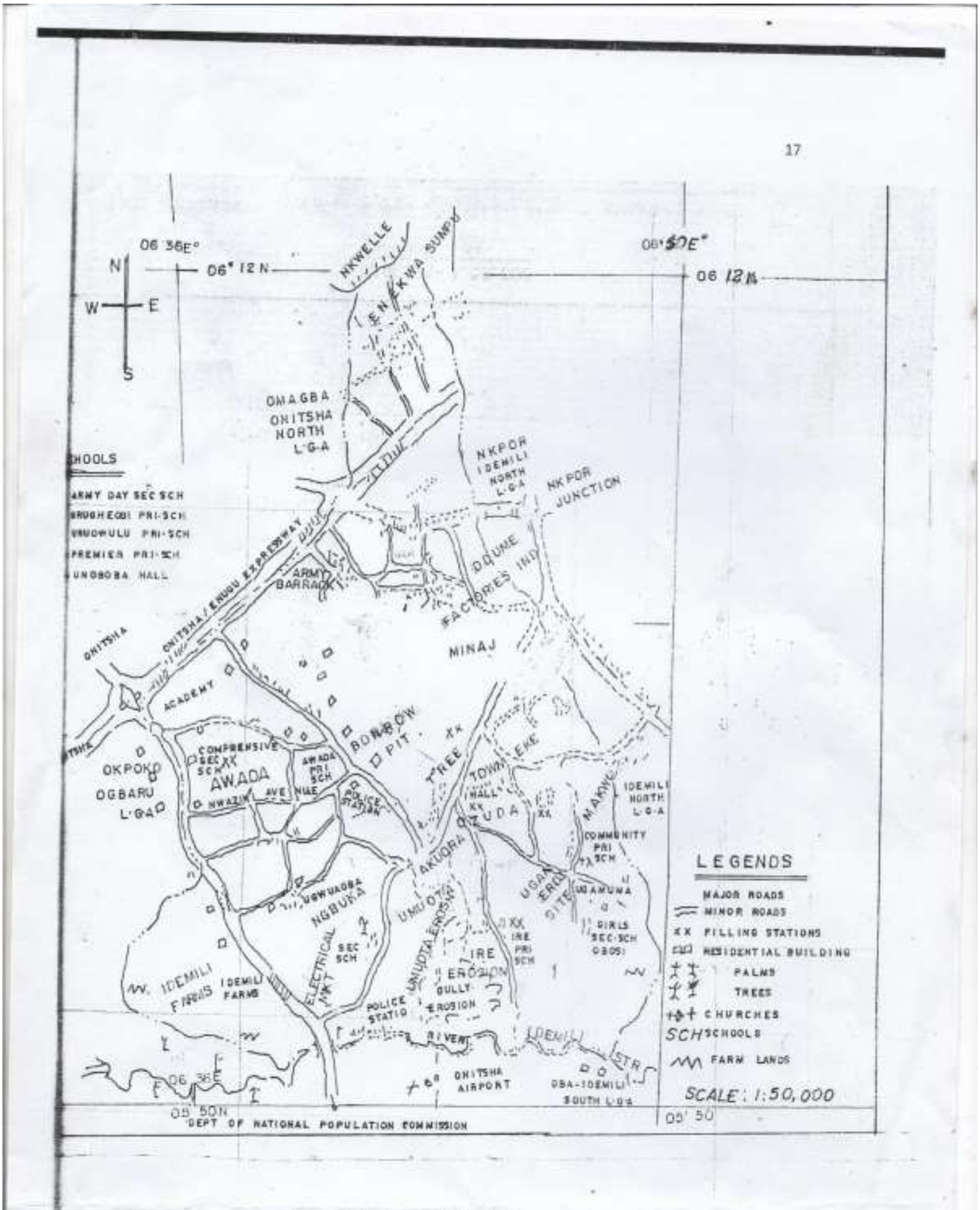

Fig 1 : Map of Obosi Community

Climate

Obosi has two climatic seasons in a year, the rainy season and the dry season the rainy season last from April to October with about 2000 – 3000mm average per annum, while the dry season is from November to March with an average amount of rainfall, 375mm. There is usually a break in August (the August break). Generally, the mean annual rainfall amount is over 2000mm. The relative humidity of this area in January and July respectively falls between 75% and 95% with the mean annual temperature fluctuating between 25^0 – 27.5^0 (Oboli, 1980).

Topography, Vegetation and Soil

Obosi has an uneven landform, which rise in elevation as one enters the town either through Nkpor junction, or Idemili bridge end off Owerri road. This gives an impression that most parts of Obosi land are located on plateau or on a hilly area. However, the entire land configuration of the area lies within an average elevation of below 200m (Duze and Afolabi 1981).The town falls within the rain forest agro ecology of south eastern Nigeria. Most tropical crops, with the exception of those that require flooding thrive well in the area. The soil of the area is predominantly sedimentary, and belongs to the red – yellow ferralitic soils of the humid tropic (Duze and Afolabi 1981).

Soil Sampling

Out of an approximated total area of $39.78km^2$ of Obosi land, $25.58km^2$ (about 65% of the entire area) was covered by the survey work. The entire north east to south east of Obosi land comprising of Odume, army Barracks, Awada, Umuota, Ire, Ugamuma, Urowulu and Nmakwum was covered. A conventional soil survey approach using flexible grid survey type was employed. The transverse used were the major roads and footpaths. The sampling points were sited at the areas where there appeared to be difference in the soil. As a result of the physical similarities of the soils, the land form and the congested activities on the land observed during the field work, four profile pits were dogged and seven auger points was established and sampled. A total of sixty samples were collected for analysis. The samples from the profile pits were subjected to a routine analysis, while soil samples collected from auger boring points were subjected to soil pH and mechanical analysis only.

Laboratory Analysis

All the samples collected were air dried, sieved with 2mm sieve and then subjected to standard methods of soil analysis at the Department of Soil Science Laboratory University of Nigeria Nsukka as indicated below.

Soil pH Determination: The pH values were determined in both distilled water and in 0.1N potassium chloride solution using a soil/liquid ratio of 1:2.5. The pH values were read using a Beckman Zerometic pH meter (Peech, 1965).

Particle size Analysis: This was carried out using the hydrometer method of Bouyoucous (1951).

Organic matter: This was determined by Walkley and Black method (1934). The percentage organic matter content was calculated by multiplying the organic carbon value by the conventional "Van Bernmeler" factor of 1.724.

Total nitrogen: Total nitrogen was determined by macro kjeldatic method of Bremmer and Mulvancy (1982), using sodium sulphate catalyst mixture.

Exchangeable Bases (Ca, Na, Mg, and K): Calcium and Magnesium were determined by the complexiometrix titration method (Jackson, 1958), while sodium and potassium were determined in IN ammonium acetate leachate using the flame photometer.

Exchangeable Acidity: The exchangeable hydrogen and aluminium were determined by titrimetric method using potassium chloride extract (Mclean, 1982)

Base Saturation: This was calculated by dividing the sum of bases (Ca, Mg, Na and K) by the cation exchange capacity (CEC) and multiplying the quotient by 100.

$$\text{Base saturation} = \frac{\text{Total exchangeable bases}}{\text{Cation exchange capacity}} \times \frac{100}{1}$$

Available phosphorus: This was determined by using Bray II method (Bray and Kurtz, 1945).

Cation exchange capacity (CEC): The apparent cation exchange capacity was determined using the ammonium acetate method (Jackson, 1958) and the exchangeable acidity determined from IN KCl extract.

Sodium adsorption ratio (SAR): This was determined by dividing the value of sodium in $cmolkg^{-1}$ by the square root of the sum of calcium and magnesium divided by two.

$$SAR = \frac{Na}{\sqrt{(ca + mg) / 2}}$$

Exchangeable sodium percentage (ESP): This was obtained by dividing the value of exchangeable sodium (ES) with the actual cation exchange capacity (ACEC) and multiplying it with 100

$$ESP = \frac{ES - Value}{ACEC} \times \frac{100}{1}$$

Total exchangeable acidity (TEA): This was calculated by summing up the values of exchangeable aluminium and that of the exchangeable hydrogen.

TEA = Exch. Al^{3+} + Exch. H^+

RESULT

The survey area was grouped into three mapping units based on the criteria of relief, drainage and morphological properties. And this units were; MUI - Lowland Area, MUII -Upland Area, MUIII -Gullied Land Area (Bad Lands). The soil mapping units are explained in figure 2.

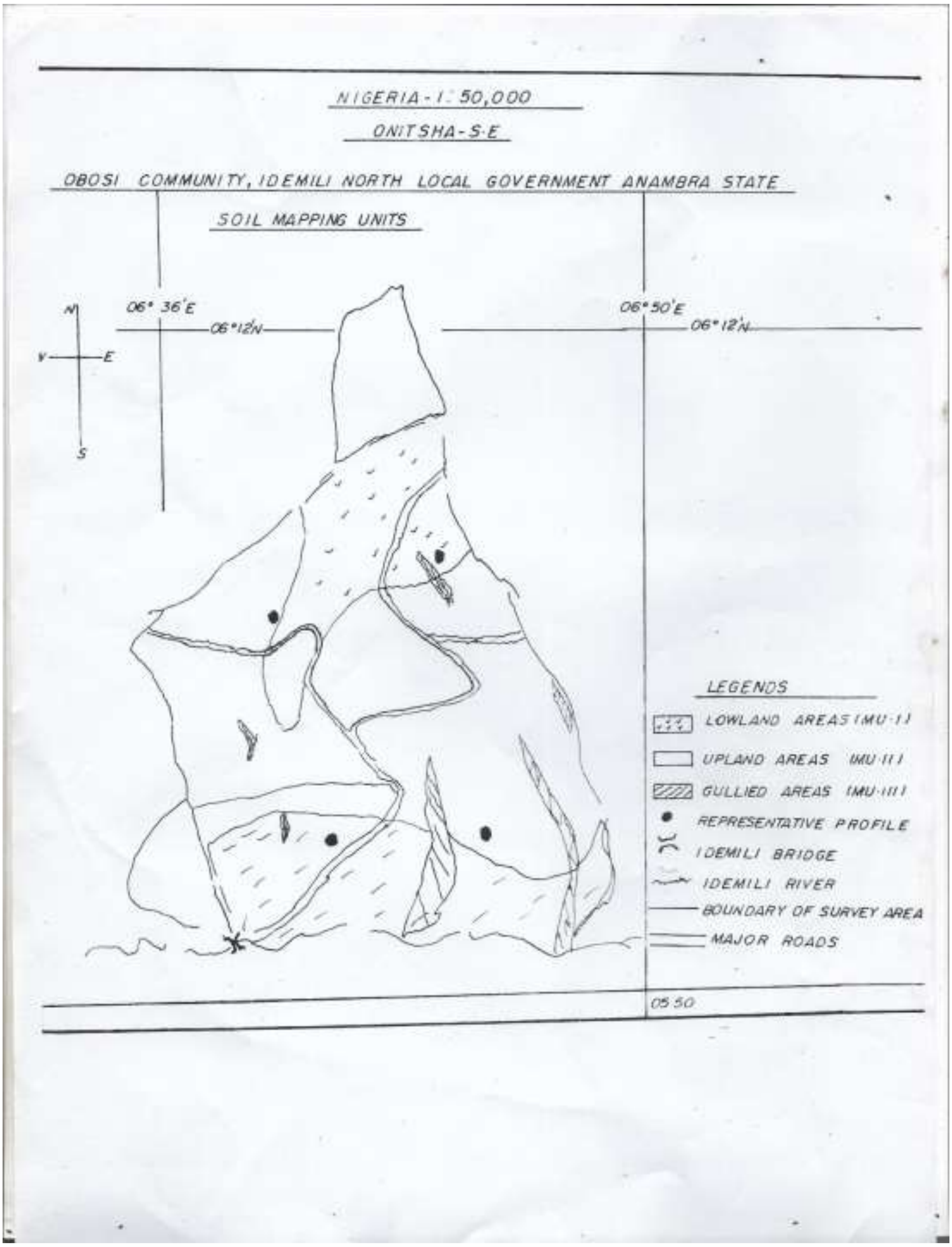

Figure 2 Soil mapping units of Obosi

Morphological and Physical Characteristics of Lowland Areas (MUI)

The low land Areas (MUI) covers part of Odume, Awada, Owelle Aja, Ugwuagba, Umuru, Umuota, Ire, Ugamuma and Urowulu. Most of the farming activities within this surveyed area take place within this unit. It harbours the Odume-Isiowulu industrial layout. The Lowland areas are less densely populated and have more undeveloped lands for both agricultural and Industrial development of the area. The surface soils of this mapping unit is dark reddish brown (2.5 YR – $^{3/}{}_{4}$) and generally reddish brown in sub soil (2.5 YR – $^{4/}{}_{6}$). The soils have no lithic or paralithic layer, no cutan and no form of stone outcrop, the unit soils are sandy loam, well drained, friable and have weak structure. The area is represented by Augers I, II, III, and IV (Table 1) and profile pits A at community secondary school Obosi (CSSO) and profile pit B at Urowulu in Table 2. The texture of the soils of this unit were mainly sandy loam, with the following ranges in particle sizes, clay 90 – 160gkg^{-1}, Silt 50 – 110gkg^{-1} and sand 730 – 860gkg^{-1}. Generally, the silt content of the soil is very low, followed by the clay content. However, their distribution in the soil is relatively constant across the horizons. The grams per kilogram of fine sand forms the least of the total sand content with value range of 130 – 420gkg^{-1}, while the coarse sand has a value range of 420 – 650gkg^{-1} (Tables I). There was a general decrease in the total sand particle and an irregular decrease in sand fractions with increasing soil depths.

Table 1 Physical Properties of Low-land Areas (mapping Unit I) – Auger Samples

Description	Depth (cm)	Clay	Silt →	Fine Sand gkg^{-1}	Coarse Sand ←	Total Sand	Textural Class
Aug. I	0 – 20	90	50	350	510	860	Sandy loam
	20 – 40	110	50	330	510	840	Sandy loam
	40 – 60	110	50	420	420	840	Sandy loam
	60 – 80	190	50	290	470	760	Sandy loam
	80 – 100	190	70	290	450	740	Sandy loam
	100 – 120	190	70	320	420	740	Sandy loam
Aug. II	0 – 20	140	90	290	480	770	Sandy loam
	20 – 40	140	90	190	580	770	Sandy loam
	40 – 60	140	70	210	580	790	Sandy loam
	60 – 80	140	90	160	610	770	Sandy loam
	80 – 100	120	90	130	640	770	Sandy loam
	100 – 120	120	70	160	650	810	Sandy loam
Aug. III	0 – 20	140	70	210	560	770	Sandy loam
	20 – 40	140	70	200	590	790	Sandy loam
	40 – 60	140	70	220	570	790	Sandy loam
	60 – 80	140	90	180	590	770	Sandy loam
	80 – 100	140	90	220	550	770	Sandy loam
	100 – 120	160	70	240	530	770	Sandy loam
Aug. IV	0 – 20	150	90	360	400	760	Sandy loam
	20 – 40	150	90	340	420	760	Sandy loam
	40 – 60	150	90	340	420	760	Sandy loam
	60 – 80	170	90	340	400	740	Sandy loam
	80 – 100	170	90	370	370	740	Sandy loam
	100 – 120	170	70	330	410	740	Sandy loam

Chemical Characteristics

The chemical characteristics of the soils studied are presented in Table 2. The soil pH show that the soils of this unit is extremely acidic to slightly alkaline, with a pH range of 4.8 to 7.7 in water, and 4.0 to 7.1 in 0.1N KCl. The pH is fairly constant or uniform through the profile depth. The organic matter (OM) content of the soils of the mapping unit is generally low and it tends to decrease with depth, with the highest value found at the surface. The values vary from 1.03mg kg^{-1} at the top to 0.32mg kg^{-1} at 200cm depth. The nitrogen content varies from 0.004 to 0.042mg kg^{-1}. The carbon: nitrogen ratio (C/N) ranges from 3.4 to 14.29 with an exceptional high value of 54.055 at profile pit B, horizon AB (35 – 90cm). The exchangeable sodium is moderate throughout the profile its value is fairly constant, and ranges from 0.11 to 0.14, while the exchangeable sodium percentage (ESP) ranges from 1.83 to 3.89 %. The potassium content of the soil is very low throughout the mapping unit. It is fairly constant through the profile depth, and ranges from 0.02 to 0.07 cmolkg^{-1} of soil. The calcium content of the soil is high. It ranges from 0.08 to 1.6 cmolkg^{-1} of soil in an irregular manner and forms the bulk of the exchangeable bases in the soil. The magnesium value is high in the soil and it range from 0.1to 2.4cmolkg^{-1}. Magnesium distribution throughout the studied profile horizons is also not well defined. Both calcium and magnesium forms the bulk of the exchangeable bases. The Base saturation is generally high, but its distribution is irregular throughout the studied profiles. It ranges from 37.50 to 99.21% across the entire area. The CEC of the soil is low. The values range from 3.2 to 6.0 cmolKg^{-1}. The value of aluminium varies from 0.4 to 1.6cmolKg^{-1}. The available phosphorus is completely absent or fixed in the lowland areas.

Table 2 Chemical Properties of Low-land Areas (mapping Unit I) – Profile Pits Samples

Description	Depth (cm)	Horizon	pH H_2O	pH KCl	OM %	N %	C/N Ratio	Exch. Bases Na^+ (cmolkg^{-1})	K^+	Ca^{2+}	Mg^{2+}	CEC	Base Sat. %	Exch. Acidity Al^{3+} (cmolkg^{-1})	H^+	P MgKg^{-1}	SAR	ESP %	TEA cmolkg^{-1}
Profile A	0 – 40	A	4.8	4.0	0.49	0.004	10.91	0.11	0.05	1.2	1.6	3.2	80.00	0.8	1.2	-	0.10	3.44	2.00
(CSSO)	40 – 80	AB	4.9	4.2	0.39	0.026	3.21	0.11	0.02	1.0	0.1	4.0	69.00	1.6	1.6	-	0.11	2.75	3.20
	80 – 130	Bt_1	4.9	4.1	0.47	0.028	9.64	0.14	0.06	0.8	1.1	5.6	37.50	0.8	2.8	-	0.14	2.50	3.20
	130 – 200	Bt_2	4.8	4.1	0.40	0.028	8.21	0.11	0.07	0.8	2.4	6.0	56.33	0.8	1.6	-	0.09	1.83	2.40
Profile B	0 – 35	A	5.3	4.4	1.03	0.042	14.29	0.11	0.06	1.4	1.8	4.0	84.24	-	0.6	-	0.09	2.75	0.6
(Urowulu)	35 – 90	AB	4.9	4.0	0.47	0.042	54.05	0.11	0.06	1.2	2.4	3.8	99.21	0.4	1.6	-	0.08	2.89	2.0
	90 – 130	Bt_1	5.1	4.2	0.40	0.028	9.21	0.14	0.06	1.2	1.2	3.6	72.22	0.4	1.2	-	0.13	3.89	1.6
	130 – 200	Bt_2	5.2	4.3	0.32	0.014	12.86	0.11	0.05	1.6	1.2	4.0	74.25	0.6	1.0	-	0.09	2.75	1.6

CEC = Cation Exchange Capacity (Cmol.Kg^{-1}), SAR = Sodium Adsorption Ratio ESP = Exchangeable Sodium Percentage (%)

Morphological and Physical Characteristics of Upland Area (MU II)

The upland area covers part of Urowulu, the entire Nmakwum, Okpuno Umuota, parts of Ugamuma, Ire, Umuota, Ugwuagba, Awada and Odume. This unit is the most densely populated area of the surveyed site, accommodating both the rural and the urban population of Obosi. The surface soil of the mapping unit is dark reddish brown (2.5 YR – $^{3/}{}_{4}$) with generally dull reddish brown (2.5 YR – $^{4/}{}_{4}$) subsoil. The soils are sandy loam to loamy in texture. Mottles, cutan, lithic or paralithic layers and stone outcrops were completely absent. The soils are well drained and have a weak structure. They were represented by augers V, VI and VII (Table 3) and profile pits C (at Ire) and Profile D (at Awada Borrow pit) in Table 4. The texture of this unit's soils ranges from loamy sand to sandy loam. Their particle sizes ranges as follows; clay 40 to 190g kg^{-1}, silt 50 to 90g kg^{-1} and sand 720 to 900g kg^{-1} fractions. The silt is the least in the soil's mineral constituent followed by clay, while sand forms the bulk and hence determine most of the soil behaviour and characteristics. The coarse sand fraction ranges from 310 to 610g kg^{-1}, while the fine sand fraction ranges is 220 to 590g kg^{-1} of soil (Table 3).

Table 3 Physical Properties of Upland Areas (Mapping Unit II) – Auger Samples

Description	Depth (cm)	Clay (gKg^{-1})	Silt	Fine Sand	Coarse Sand (gKg^{-1})	Total Sand	Textural Class
Aug. V	0 – 20	100	70	340	490	830	Loamy Sand
	20 – 40	140	90	220	550	770	Sandy Loam
	40 – 60	80	50	330	540	870	Loamy Sand
	60 – 80	100	70	290	540	830	Loamy Sand
	80 – 100	100	70	320	510	830	Loamy Sand
	100 – 120	120	50	320	510	830	Loamy Sand
Aug. VI	0 – 20	50	50	590	310	900	Sandy loam
	20 – 40	150	70	320	460	780	Sandy loam
	40 – 60	190	70	320	420	740	Sandy loam
	60 – 80	150	90	250	510	760	Sandy loam
	80 – 100	190	50	310	450	760	Sandy loam
	100 – 120	190	50	270	490	760	Sandy loam
Aug. VII	0 – 20	190	90	340	380	720	Sandy loam
	20 – 40	110	70	300	520	800	Sandy loam
	40 – 60	190	50	290	470	760	Sandy loam
	60 – 80	190	70	290	450	740	Sandy loam
	80 – 100	190	70	300	440	740	Sandy loam
	100 – 120	190	90	270	450	720	Sandy loam

Chemical Characteristics

The results of chemical characteristics of the soils studied were recorded in Table 4. The soil pH values of the area, shows that the soil is extremely acidic to slightly alkaline, with the pH ranges in water and 0.1N KCl being 5.2 to 8.0 and 4.4 to 7.4 respectively. It is fairly constant through the soil profile. The organic matter content of the soil unit is generally very low, and the values decreases with depth down the profile horizon. It ranges from 0.40 to 1.34mgkg^{-1}. The nitrogen content is fairly constant and it decreases down the profile horizons with value range of 0.0028 to 0.014mgkg^{-1}. The carbon – Nitrogen (C/N) ranges from 2.14 to 29.29. The exchangeable sodium is relatively uniform through the soil profile horizons and ranges from 0.10 to 0.11 cmolkg^{-1} of soil. The sodium adsorption ratio (SAR) ranges from 0.06 – 0.10, while the exchangeable sodium percentage (ESP) ranges from 0.98 to 1.41%. The potassium content of the mapping unit is very low and ranges from 0.03 to 0.11 cmolkg^{-1} of soil. And its distribution is irregular. The calcium content of the soil unit is low to moderate. Its values range from 1.2 to 5.6 cmolkg^{-1}. It is irregularly distributed. Calcium forms the bulk of the exchangeable bases in the soil. Magnesium is high in the soil unit, but its distribution is irregular in pattern. It ranges from 0.4 to 3.6cmolkg^{-1}. The percentage base saturation ranges from 22.38 to 96.54%. It is very high but its distribution through the horizons is irregular. The Cation exchange capacity is low and it ranges from 7.4 to 11.20 cmolkg^{-1} of soil. The exchangeable hydrogen ranges from 0.4 to 1.2cmolkg^{-1}, while the exchangeable aluminium ranges from 0.2 to 0.8 cmolkg^{-1} of soil. However, aluminium is completely absent in horizons AP, Bt1, Bt2 and Bt3 of profile pit C, and horizons AP and Bt2 of profile pit D. The available phosphorus ranges from 0.94 to 14.93mgkg^{-1} and it is completely absent in profile pit C, horizons AP and Bt3; and profile pit D, horizons AP, Bt2 and Bt3. Generally, it is very low in value (Table 4).

Table 4 Chemical Properties of Upland Areas (Mapping Unit II) – Profile Pits Samples

Description	Depth	Horizon	pH		0M	N	C/N	Exch. Bases				CEC	Base Sat.	Exch. Acidity		P	SAR	ESP	TEA
	cm		H_20	KCL	%	%		Na^+	K^+	Ca^{2+}	Mg^{2+}		%	Al^{3+}	H^+	$MgKg^{-1}$		%	$cmolkg^{-1}$
								← cmokg-1 →						$cmolkg^{-1}$					
Profile C	0 – 35	A_p	7.8	7.2	1.03	0.028	2.14	0.11	0.08	5.6	1.6	8.0	22.38	-	-	-	0.06	1.38	1.0
(at Ire)	35 – 65	AB	7.1	6.7	1.34	0.028	27.86	0.10	0.05	2.6	2.0	7.8	60.90	0.2	0.4	3.74	0.07	1.28	0.6
	65 – 98	Bt_1	7.8	7.3	0.55	0.028	11.43	0.11	0.07	2.4	3.6	7.8	79.23	-	0.8	4.64	0.06	1.41	0.8
	98 – 133	Bt_2	7.9	7.3	0.55	0.014	22.86	0.11	0.09	5.3	2.0	8.2	91.46	-	0.6	2.80	0.06	1.34	0.6
	133 – 200	Bt_3	8.0	7.4	0.40	0.014	22.86	0.11	0.11	5.2	2.4	8.1	96.54	-	0.6	-	0.06	1.36	0.6
Profile D	0 – 15	A_p	6.9	6.5	1.19	0.028	24.64	0.11	0.06	3.6	2.0	11.2	51.24	-	0.8	-	0.07	0.98	0.8
(Borrow Pit)	15 – 40	AB	5.3	4.4	1.11	0.028	22.86	0.10	0.04	2.0	0.4	8.4	30.24	0.8	1.0	14.93	0.09	1.19	1.8
Awada	40 – 80	Bt_1	5.2	4.3	0.63	0.014	26.43	0.10	0.05	1.2	1.0	7.8	30.13	0.6	1.2	0.94	0.10	1.28	1.8
	80 – 115	Bt_2	5.3	4.4	0.71	0.014	29.29	0.11	0.05	2.4	0.6	7.4	42.70	-	0.8	-	0.09	1.49	0.8
	115 – 200	Bt_3	6.3	5.5	0.47	0.014	19.29	0.11	0.03	2.4	1.8	8.5	51.06	0.2	0.8	-	0.08	1.29	1.0

GULLIED LAND AREA (MUIII)

The soil mapping unit III is the erosion affected parts of the surveyed area. The mapping unit caught across parts of the lowland area (MUI) and the upland area (MUII); it is represented in this work by Ugamuma Gully site, Ire-Umuota Gully site, Odume-Gully site and Owell aja-Awada Gully site.

Ugamuma Gully Erosion

This gully site caught across the residential areas of the people and has engulfed many houses, and claimed many farmlands. Common vegetation or plant cover seen in these area are those mainly drawn by land-slide into the gully, like oil palm trees, bambos, gmelina trees, neem, irvingia gabonensis etc. it is the most developed gully erosion site in Obosi. And people living around it, uses it as a refuse dump.

Ire – Umuota Gully Erosion

The Ire – Umuota gully site may be said to be second to the Ugamuma gully. Many hectares of land are involved, and it had led to the resettlement of many indigenes over the years. Its expanse stretches from almost the Obosi town hall to the Idemili River. Common vegetation found there are the drawn or sank trees as a result of land slide, and some bamboos planted as a measure in trying to check it like in the above case. It is commonly used by people living around it as a refuse dump.

Odume Gully Erosion

This gully site is not as developed and extensive as the two sites already described above. One can rightly describe it as gully at its medium stage. Bamboo trees are planted extensively and seen growing wild in it. People also dump refuse there.

Owelle Aja-Awada Gully Erosion

This is the least developed of the four sites described. It is not as deep as others and all kinds of plants are seen growing wild in it. It also forms the major refuse dump of the people living around there.

Soil classification

Obosi soils has a base saturation of 50 percent or more in the major part between 20 and 100cm from the soil surface, hence it is Eutric in nature by WRB for soil resources (2006) standard. It has a weak structure, udi moisture regime and an isothermic temperature regime (Table 5). The soils are deeply weathered red to yellowish brown soils as we move down through the profile horizons with a dominating low activity clay mineral, kaolinite and some argilic horizons.

The soils were classified based on the USDA soil Taxonomy as ultisol (iso – thermic udult) and correlated to FAO-UNESCO soil classification system as ferralsols (Eutric ferralsols).

Table 5 Classification of Obosi Soils

Mapping Units	Soil series	Classification USDA	FAO-UNESCO (WRB)
Lowland Area (MUI)	Obosi	Iso-thermic udult	Eutric Ferralsols
Upland Area (MUII)	Obosi	Iso-thermic udult	Eutric Ferralsols
Gullied Land (MUIII)	Obosi	Iso-thermic udult	Eutric Ferralsols.

DISCUSSION

Result of the study revealed that Obosi land have soils of sedimentary parent material. The entire area was under the influence of common climate and supports similar vegetation. However, the area varies significantly in their morphology and relief (topography). The soils of the units were highly weathered and very deep. This agrees with the observation made by Akamigbo and Asadu (1983) about soils of south-eastern Nigeria that profiles on soils derived from false-bedded sandstones (sedimentary origin) are deep to very deep. The soils have no cutan, lithic or paralithic layer(s). The variation in sand content could suggest differences in the intensity of weathering and composition of the saprolite. The dominance of total sand indicates fragility and low content of colloidal materials like clay giving rise to the susceptibility of the soil to erosion. The higher clay content observed in the subsurface horizon in the pedons probable may be due to illuviation and faunal activities taking place in the area. The three mapping unit soils were highly permeable, well drained and lack mottles in their horizons. Their soil colour varies from brownish to reddish probable due to the high iron compound oxidation in the area.

In the lowland areas (MUI), the soils were mainly sandy loam in texture and there is a little evidence of clay translocation from the top soil to the sub-soil, as can be seen in profile A horizon A, 0-40cm depth which is 120gkg^{-1} and AB, 40-80cm that is 140gKg^{-1}. However, in the Upland Areas (MUII), which is mainly loamy sand to sandy loam, there is a clear evidence of increase in clay content along the vertical cross section of all pedons, except horizon Bt, in both profile C and profile D, hence there is the existence of argillic horizons (Soil Survey Division Staff 2018). The clay bulge noticed in all pedon may be attributed to humidity and amount of water percolation as they are very important in clay dispersion.

The extreme acid to slightly alkaline nature of the soils pH 5.2 – 8.0 in water and 4.4 – 7.4 in 0.1 NKCl, could be attributed to their parent material, and the high leaching prevailing in the area. The low organic matter content of the soils may be attributed to high temperature and relative humidity of the area which favours rapid mineralisation of organic matter. The OM and CEC content of the soils were found to be low. Asadu and Akamigbo, (1990) noted that organic matter content contribute an average of 70% of the CEC of the ultisols and oxisols. Greenland et al. (1975) observed that to obtain good crop yield where soil organic carbon is below 1% is not possible and that soils having below 2% organic carbon are characterized by lack of cohesion and instability. The low total exchangeable bases and the low CEC of the soils may be due to the inherent composition of the parent materials and their weathered environment. The low available phosphorous of the entire area may be due to phosphate fixation, which according to Townsend (1973) is not restricted to any particular soil kind. It occurs in all types of soil at all levels of soil pH. World Reference Base for Soil Resources (2006), under management and uses of ferralsols, observed that strong retention (fixing) of phosphorus is a characteristic problem of ferralsols. The soils have high percentage base saturation (BS) > 64% according to FAO (1988), soil having less than 20% BS is rated low, while 20 – 60% is medium and above 60% high. The high base saturation may be associated with the weatherable minerals in soils. The aluminium value of this soils are very low, and it is completely absent in some horizons. Hydrogen provides the bulk of the exchangeable acidity. The calcium and magnesium content of the soils were relatively high throughout the entire study area both form the bulk of the exchangeable cation.

From the interview conducted across various stake – holders in Obosi, it was gathered that the causes of gully erosion in the area caught across both the orthodox and the un-orthodox believes. The traditionalists like Inyom Nwanyi – Ugo Chijindu and Ogbuefi Nwaolisah Animadu (2010) believed that the emergence of erosion menace in the town is as a result of wrong doings and evils committed on the land by the people, particularly the youths. They counted those evils and wrong doings to include: the people's failure to pay tribute to the town's oracles ("Okwu Agadi Nwanyi", "OKwu Idemili" etc), and the peoples frequent introduction of foreign gods from other lands into Obosi, without due process. To this class of people, erosion problem in Obosi is a punishment from gods, as a result of disrespect or wrong-doing. Ikenna Ekwulugo (2013), a member of Obosi works Committee, observed that the Obosi gully erosion problem is associated to the town's location and the type of soils in Obosi. He said that there is no part anybody will enter Obosi without ascending hill and that Obosi soils are generally loose and lack the strength to withstand decantation by erosive agent (water). Adding to the above Ekwulugo pointed out that the people are not helping enough in the fight to check the menace, because they have often been interrupted by individuals, who felt that their lands are being encroached in the course of carrying out the control work.

Other members of the works committee and opinions across the surveyed area believed that the massive erosion devastation in the area is a result of two or more of the following factors;

i. Poverty of the general masses, which resulted in their failure or inability to check the menace at the on-set.
ii. Untimely government intervention to check and rescue the people from the problem.
iii. The clustered or congested settlement habit of the people which resulted in poor channelling of run-off, massive wild water float and reduced soil water percolation.
iv. Individualistic and selfish attitude of many people in the area, which resulted in lack of trust and co-operation among them in checking the menace at the onset.

Management of Obosi land for sustainable land use

Fertility and agronomic measure

The decline in soil fertility of Obosi land, which is highly attributed to leaching and erosion of top soil by intense rainfall of the humid tropical region can be replenished through the timely combined use of organic and inorganic fertilizers. The soils of this area need to be amended with organic matters like compost manure, crop residues, poultry droppings, cow dung, farm-yard manure etc to improve on the soils cohesion, its colloids, its water holding capacity, its soil nutrients, as well as to improve on the soil aggregation to resist erosion. Bayu et al. (2006), Nweke et al. (2013), Nweke and Nsoanya (2015) Okoli and Nweke (2015) noted that complementary use of organic and mineral fertilizers has been proved to be a sound soil fertility management strategy for soil productivity, increase in crop yield and environmental health. Also FAO (2006) and Nweke (2020) recommend under ferralsols management, that there is the need for maintaining its soil fertility by manure addition, mulching, alley cropping practices to prevent surface soil erosion. FAO (2006) however, went further to point out that fertilizer selection and the mode and timing of fertilizer application determines to a great extent the success of agriculture on ferralsols. The combination of mineral fertilizer and organic manure is highly recommended for any farming venture in the area. In addition to the traditionally grown crops in the area (yam, cassava, cocoyam, pumpkin, amaranthus, pepper etc), an intensified cultivation of groundnut, beans, soya beans and crop rotation system are advised in their farming to ensure steady vegetation cover of the land. This will assist greatly in replacing lost nutrients checking leaching and reducing soil erosion menace.

Land conservative and reclamation measures

To manage the soils of this area sustainably, it is recommended that; the people should embark on a massive agro forestry programme, afforesting and planting cover in their immediate environment and the already gullied areas as a way of naturally checking the land degradation. The people should provide catchment pits around their houses, as a way of reducing the amount of water that gets outs to the public drains or flow out unchecked. The massive construction of underground concrete water storage tracks within households or compounds in Obosi is advised. This will help in harvesting rainfall and reducing its degradation effects. A situation where open drains are made on bare ground should be discouraged. This is one of the observed common practices, which hastens gully formation in the area. There is the need to construct at least three main central drainage channels, into which smaller lateral drains will be connected to across the surveyed areas. The recommended run-off channels were as follows;

a. Eke – Obosi - Ugamuma down to idemili River
b. Obosi Town Hall – Ire – Umuota down to Idemili River
c. Odume – Owelle aja – Ugwuagba – Umuru down to Idemili River.

CONCLUSION

The soils of Obosi series encountered were classified into an order of the soil Taxonomy iso – thermic udult (Ultisol) and correlated to the FAO/UNESCO units as Eutric Ferralsols (Ferralsols). The lowland area (MU I) and the upland area (MU II) were found to be good for arable crops production. Their major challenge for agricultural production is low fertility. The gullied lands (MU III) were physically found within the upland areas and the lowland areas. The prominent limitation of this unit is erosion hazard. The areas cannot be used in their present state without serious reclamation activities. In all the mapping units generally, the texture were sandy loam to loamy sand. The soils of the area have low organic matter content, low nitrogen and carbon percentage, low to medium cation exchange capacity, high calcium and magnesium content and a high base saturation. Phosphorus fixation is very high in this area, it is found only in trace amount in few horizons and hydrogen ions form the bulk of the exchangeable acidity.

REFERENCES

Akamigbo F. O. R. and Asadu C. L. A. (1983). Influence of parent material on the soils of south eastern Nigeria East Afri. Agriculture and Forestry Journals 48(21): 81-91

Asadu, C. L. A. and Akamigbo, F. O. R. (1990). Relative contributions of organic matter and clay fractions to cation-exchange capacity (CEC) of soils in south eastern Nigeria. Samaru Journal of Agriculture Research, 7, 17–23.

Bayu, W, Rethman, N. F. G. and Alemu, G. (2006). Effects of FYM and inorganic fertilizer on Sorghum growth, yield and Nitrogen use in semi-arid areas of Ethiopia. Journal of plant Nutrition 29 (2): 391 – 407

Bouyoucous, G. J. (1951). A recalibration of hydrometer for Mechanical Analysis of soils Agronomy Journal 43: 434 – 438.

Bray, R. H. and Kurtz, L. T. (1945). Determination of total organic and available forms of phosphorus in soils Soil Science 59: 39 – 45.

Bremmer, J. M. and Mulverney G. S. (1982). Methods of soil Analysis part II ASA No.9, Madison, Wisconsin pp 574– 624.

Duze, M. and Afolabi M. A. (1981). Senior school Atlas. Macmillan Education Ltd. Nigeria.

Ekwulugo, I. (2013). Works Dept. His Royal Majesty Igwe Iweka III palace, Eze Obosi (Oral interview).

Esu, I. E. (2004). Soil Characterization and mapping for food security and sustainable environment in Nigeria.

A key note address presented at the 23rd Annual Conference of the Soil Science Society of Nigeria held at the University of Agriculture Abeokuta Nigeria Pp 9-18

Food and Agricultural Organization (2006). World Reference Base for Soil resources, a framework for International classification, correlation and communication. World Soil Report No. 103 FAO Rome

Food and Agricultural Organization (1988). Soil map of the world revised legend by FAO UNESCO-ISRIC. World Soil Resource Report No. 60, Rome

Greenland, D. J., Rimmer, D. and Pyne D. (1975). Determination of the Structural stability class of English and

Welsh Soils, using water Coherence test J. Soil Science 26, 294 – 303

Igwe C. A. (2012). Gully erosion in south eastern Nigeria: Role of soil properties and environmental factors Intech. Open Science 8: 157-171

Inyom Nwanyi – Ugo Chijindu and Ogbuefi Nwaolisah Animadu (2010). Odinani Cultural Group members Obosi, Anambra State, Personal communication

Jackson N. L. (1958). Soil chemical analysis practice Hall inc. Englewood, Cliffs New Jersey.

Mclean, E. O. (1982). Soil pH and Time requirement. Methods of Soil analysis part II chemical and Microbial properties second edn. Agronomy series No.9 ASA Madison, W.T united States of America

Nwabineli, E. O. and Oti, V. I. (2012). Hydro geological parameters: Causative, factors of gully erosion in Anambra State (case study of Nanka and environs) Bookman International Journal of Mechanical and Civil Engineering I(2): 22-27

Nweke, I. A. (2020). Alley cropping for soil and agricultural sustainability in south eastern soils of Nigeria Sumerianz J. Agric. Veter. 3(1): 1-6

Nweke, I. A. and Nsoanya, L. N. (2015). Effect of cow dung and urea fertilization on soil properties, growth and yield of cucumber (*Cucumis Sativus L*). Journal of Agriculture and Ecology Research International, 3(2): 81-88. DOI: 10.9734/JAERI/2015/14084.

Nweke, I. A**.,** Nsoanya, L. N. and Okoli, E. C. (2013). Effect of organo- mineral fertilizer on growth and yield of maize (zea mays. L) at Igbariam south-eastern, Nigeria. Journal of Agriculture and Rural Development 16 (1): 1404-1408.

Nweke, N. (2015). South east vs Erosion menace 247ureports.com.

Oboli, H. O. N. (1980). New outline Geography of west Africa Harrap Books London in association with African universities press, Lagos.

Okoli, P. S. O. and Nweke, I. A. (2015). Effect of poultry manure and mineral fertilizer on the growth performance and quality of cucumber fruits, Journal of Experimental Biology and Agricultural Sciences 3(4): 362-367. DOI: http://dx.doi,org/10.18006/2015.

Peech, M. (1965). Hydrogen ion activity in C.A Black (ed) methods of Soil Analysis II. AM. Soc. Agron.9: 194 – 226.

Schoeneberger P.J., Wysocki D.A., Benham E.C. and Staff, S.S. (2012). Field book for describing and sampling soils version 3.0 NRCS-NSSC Lincoln NE USA Pp 300.

Soil Survey Division Staff (2018): Soil Survey Manual. Agric. Handbook. No 18. 4th edition U.S. Gov. Print Office Washington, DC.

Townsend (1973). Paper presentation on phosphate transport.

Walky, A. and Black, I. A. (1934). An Examination of the Degtiarelt method for soil organic matter determination and a proposed modification of the chromic acid titration method Soil Science 37: 29 – 38.

World Reference Base for Soil Resources (2006). A frame work for international classification, correlation and communication, 2006 edition, FAO UN Rome.

Cite this Article: Ejikeme, CS; Nweke, IA; Asadu, CLA (2021). Characterization, Classification and Management of Soils of Obosi in Anambra State, Nigeria. *Greener Journal of Agricultural Sciences* 11(1): 6-18.