International Journal of Agriculture Innovations and Research
Volume 3, Issue 4, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 27/01/2015 | Accepted on : 10/02/2015 | Published : 28/02/2015

Hydraulic Properties of Soil Under Different Management Practices in Owerri Southeastern Nigeria

L.C Agim
email: agimleonard@yahoo.com

G.U Njoku
email:ugoify2007@yahoo.com.

C.M Ahukaemere
email:mildredshine@yahoo.com

L.C Okoro
email:linus52@yahoo.com

S.U Onwudike
email:onwudikestanley@yahoo.com

Osisi A.F
email:uadaku@yahoo.co.uk

Abstract: **This work investigated hydraulic properties of soil under different management practices in Owerri Imo State. Soil samples were randomly collected from five land use types namely continuous cultivated soil (CCS), bush fallow soil (BFS), pineapple orchard soil (POS), Grassland soils (GLS) and bare soil (BS) respectively in three replicates with soil auger. Collected samples were air dried, sieved with 2 mm mesh, and were analyzed in the laboratory with standard methods. Hydraulic properties were determined indirectly using particle size analyses result. The experiment was arranged in randomized complete block design with the five land uses serving as treatments. Data were analyzed using analyses of variance and significant means were separated using least significant means (LSD) at 5% probability levels. Hydraulic conductivity was correlated with selected soil properties. Result showed that all studied soils were sandy loam in texture. Bulk density followed the order: POS (1.46 g/cm^3) > BS (1.43 g/cm^3) > GLS (1.42 g/cm^3) > CCS (1.36 g/cm^3) > BFS (1.27 g/cm^3). Hydraulic conductivity was higher in bush fallow 4.90 cm^3/water/cm^3 of soil and was least in pineapple orchard soil 2.77 cm^3/water/cm^3 of soil compared to others and related negatively with bulk density (r^2 = - 0.79), positively with sand fraction, r^2 = (0.35) and Soil organic matter (r^2 = 0.45) respectively. Field capacity Field capacity ranged from 0.16 – 0.27 cm^{3}water/cm^{3}soil. The highest value occurred in continuously cultivated soil. Soil organic matter was higher in continuously cultivated soil (1.33 g kg^{-1}) and least in grass land soil (0.88 g kg^{-1}). Hydraulic conductivity, field capacity, wilting point and plant available water all varied minimally in all the studied land use with the coefficient of variability (CV) ranging from 1.6 - 2.6 %.**

Keywords: **Hydraulic Properties, Landuse, Organic Matter Soil, Southeasthern Nigeria.**

1. Introduction

Soil as a natural body has both physical and chemical properties which determine its behavior and functions in terms of nutrient availability to crop, medium for plant growth, regulator of water supply, habitat for soil organism, retention of farm buildings, recycles of wastes and raw materials etc [1]. Hydraulic properties are those soil characteristics that change with availability of water [2]. Hydraulic conductivity of soil, in a similar manner as the particle size distribution is used for a textural classification. Knowledge of basic hydraulic properties such as field capacity or plant available water is important for simulation of water movement (infiltration, conductivity, storage and plant-water relationships) using different physical equations. Information on hydraulic properties of agricultural soils is also very important for better water management.

Hydraulic properties of soil can be determined by both direct and indirect means. Several indirect methods which have been documented include inverse method [3], pedo transfer functions,[4]. Direct methods for the determination of soil hydraulic parameters are limited to accuracy, measurement range, tedious to carry out, and demand for time and capital. To overcome these problems, indirect methods on the other hand are used to estimate hydraulic properties from more easily measured data, using particle size analyses,[2, 5]. [6], opined that indirect methods are often appropriate for soil hydraulic properties related to erosion such as available water.

Information relating to hydraulic properties of the studied sites is dearth. Based on the above therefore, the major objective of this work was to determine hydraulic properties of soil under different management practices through indirect method in Owerri South Eastern Nigeria. Other specific objectives include to: Determine selected physico- chemical properties of the soils. To correlate hydraulic properties with other physico-chemical properties of studied soil.

2. Materials and Methods

Study Area:

The study was carried out at the teaching and research farm of Federal University of Technology, Owerri located on latitude 5^{0}17‘N and longitude 6^{0}54‘E [7].

Geology:

The soils are derived from coastal plain sand otherwise known as Benin formation [8].

Climatic Conditions:

The vegetation of the area is dominated by secondary forest [9]. The rainy season starts from March / April-Sep-October with a mean annual rainfall of about 1500-2500mm and temperature ranging from 27^0-28^{0}C[7].

Economic Activities:

The major economic activities of the people are farming. Also trading hunting are also practiced

Experimental Design:

The experiment was arranged in a randomized complete block design (RCBD) with five treatment replicated three (3) times. The treatments include: Continuous cultivated soil (CCS), Bush fallow soil (BFS), Pineapple orchard soil (POS), Grass land soil (GLS) and bare soil (BS) all replicated three times.

International Journal of Agriculture Innovations and Research
Volume 3, Issue 4, ISSN (Online) 2319-1473

Field Studies:

Random sampling technique was used to select sampling points such that all soil groups were adequately represented. Soil samples were collected with soil auger in three replicates from each land use at a depth of 0-15 cm. Core samplers were used to collect soil samples insitu for bulk density determinations. Collected soil samples were put into a polythene bag, property labeled, air dried, crushed and sieved using 2mm sieve in readiness for various laboratory analysis on selected chemical proper.

Laboratory Analyses:

Hydraulic properties namely saturated hydraulic conductivity, available water holding capacity, permanent wilting point and field capacity were determined through the soil hydraulic properties model of Saxton [2]. Particle size analyses were determined by hydrometer method according to the procedure of [10] using sodium hexameta phosphate (calgon) as dispersant. Bulk density (eb) was measured by core methods as [11] recommended. Total porosity was determined by calculation as was described by [12].

Soil pH was determined in water and 0.1KCl using the pH meter in soil/liquid suspension of 1:2:5 as was described by [13]. Soil organic carbon was determined by the Walkly and Black chromic wet oxidation method. Soil organic matter was subsequently obtained by multiplying with a factor of 1.724 [14]. This was extracted with Bray solution determined by the molybdenum blue method [15]. Potassium (k^+) and sodium (Na^+) were extracted wit neutral ammonium acetate NH_4OAC and determined photometrically using flame photometer [16]. Magnesium (mg^{2+}) and calcium (ca^{2+}) were determined using acethylene diamine titra-acetic acid (EDTA) [16]. Effective cation exchange capacity(ECEC) was calculated as the sum of exchangeable acidity and exchangeable acidity [1].

Data Analyses:

Generated data were analyzed using analysis of variance (ANOVA), and significant means were separated using LSD at 5% probability level. Data were also subjected to correlation and regression analysis and coefficient of variability determined according to [17].

3.Results and Discussion.

The result in Table 1, shows that textural class of the soil is loamy sand irrespective landuse type. This supports the fact that texture is an inherent soil property that does not change easily[1]. The result show a dominance of sand fraction in all the five land use, which is significantly higher in bare soil .The result followed the order: Bare soil (834.33 g/kg) > Bush fallow soil (830.33 g/kg) > Continuous cultivated soil (812.00 g/kg) > Grassland soil (808.67 g/kg) > Pineapple orchard soil (788.33 g/kg) respectively (Table 1). The sandy nature of the soils reflects the parent material from which they were formed, and land use [18] which influence pedogenesis and properties of soils [19; 20]. [21], found similar result. The reason for high sand fraction in bare soil could be attributed to action of rainfall directly on the soil, which has leached out basic cations out of the soil. Sand fraction seldom moves away after rainfall because of its in active nature. Silt and clay fraction were not significant but ranged from 71.00 g/kg – 112.67 g/kg and 90.66- 104.00 g/kg respectively (Table 1). The result of the silt clay ratio was in the range of 0.97-1.05 (Table 1). This result is very low indicating high weather ebility and age of soil.[22, 23]. Similarly, [24], documented that the higher the silt clay ratio the younger the soils and that higher silt clay ratio are associated with landscape devastated by erosion. It follows that grass land soil is the youngest of all studied soils and could be degrading faster than others. Variability in silt clay ratio was moderate (C.V= 21.30%) (Table 1.). This result is similar to the documentation of [25] and [26].

Soil moisture content and bulk density results presented in Table 1 were not significant but followed the order: BFS 134.10g/kg > POS 132.60g/kg > CCS 131.1 g/kg > GSL 101.90 g/kg > BS 69.0 g/kg while bulk density followed the trend POS 1.46 g/cm^3> BS 1.43 g/cm^3 > GLS 1.42 g/cm^3> CCS 1.36 g/cm^3> BFS 1.27 g/cm^3 respectively. The higher moisture in bush fallow could be due to lesser evaporation of water from the soil brought about by vegetation cover, presence of organic materials covering the soil surface while the lower percentage in bare soil could be attributed to poor structural stability as indicated by dominance of sand fraction and due to exposure of the soil to sunshine. The highest mean value of bulk density found in pineapple orchard soil and bare soil could be due to poor vegetal cover and soil compaction due to raindrop impact [27,1]. Moisture content and bulk density varied moderately in the study with their respective CV's as 21.3 % and 14.2%. (Table 1) Similar results were found in Ibadan Nigeria [29]. Variability in soil moisture content is attributed to variations in vegetation, water uptake and root system distribution [30]. [28], attributed variation in bulk density to variation in particle size and method adopted in sampling.

Bush fallow had significant ($P < 0.05$) highest hydraulic conductivity followed by continuous cultivated soil and grass land soil. The values range from 2.77 to 4.82 cm^3/water/cm^3 of soil (Fig.1). Higher hydraulic conductivity result found in bush fallow soil is attributed to decaying organic material, thus higher organic matter content of the soils. The result also reflects the texture of the soil under study. The implication of higher hydraulic conductivity in soils under bush fallow is that the soil will have low runoff, and less erosion. Hydraulic conductivity found in the study is in line with the ranges for sand and loamy sand textures of [1]. [30], had reported, that the initial moisture content condition of the soil surface, porosity, structure, degree of swelling and organic matter *etcetera* affecthydraulic conductivity.

Hydraulic conductivity had significant positive relations with sand fraction Fig. 3. The r^2 value of 0.35 signifying that about 32 % of its value was contributed by sand fraction. Hydraulic conductivity increases with decreasing bulk density (r^2= - 0.79) (Fig. 4) and increases with an increase in soil organic matter (r^2 = 0.45) (Table 3) respectively. Since organic matter content, the porosity of the soil and the soil structure are factors that influence hydraulic conductivity, these implies that the factors are more favorable to bush fallow soil compared to others.

Field capacity ranged from 0.16 – 0.27cm^3 water/cm^3 soil. Their mean values were as follows, continuous cultivated soil, 0.33 cm^{3}water/cm^{3}soil, bush follow soil 0.16 cm^3 water/cm^3 soil, pineapple orchard soil, 0.17cm^3 water/cm^3 soil, grass land soil, 0.28cm^3 water/ cm^{3}soil and bare soil, 0.23cm^{3}water/cm^{3}soil (Fig 2). Soil water contents at field capacity and wilting point are used to calculate the water depth that should be applied by irrigation [31], and to determine water availability, whichis a crucial factor in assessing the suitability of a land area for producing a given crop [32]. This implies that within the soils under study, continuous cultivated soil and soil under grass will make water readily available to the soil than others. This could be related to litter decomposition on the soils. Permanent wilting point and plant available water ranged from 0.08-0.09 cm in all the studied land use. They varied as follows; continuous cultivated soil, 0.09 cm3 water/cm^3 soil, bush follows soil, 0.08 cm3water/cm^{3}soil, pineapple orchard soil, 0.09 cm3water/cm^{3}soil , grass land soil, 0.08 cm3water/cm^{3}soil and bare soil, 0.08 cm3water/cm^{3}soil respectively. The mean values of wilting point of the landuse are almost the same with plant available water (Fig. 2) signifying that in the absence of water, plant witnesses drought. The result are as follows: continuous cultivated soil, 0.09, bush follow soil, 0.11 grass land soil, 0.08 cm3water/cm^{3}soil bare soil, 0.08 cm3water/cm^{3}soil respectively. [33] stated that soil with higher available water content are generally more conducive to high biomass productivity because they can supply adequate moisture to plants during time when rainfall does not occur. This implies that pineapple orchard soil, grass land soil and bare soil has the same range of plant available water, while continuous cultivated soil is likely the same. The bush fallow soil has the highest mean value which signifies that it is more readily available to plant root system than others and will produce larger biomass.

Soil pH (water) ranged from 5.86 – 6.27 and spread as follows; Continuous cultivated soil, 5.86, Bush follow soil 6.27, Pineapple orchard soil, 5.44 , grass land soil, 6.07 bare soil, 5.36 (Table 2.). These values shows that both bush fallow soil and grass land soil will release nutrients more to the plant than other land use even though all were in the acidic ranges which is ideal for tropical soils. Soil pH is a major factor influencing the availability of element in the soil for plant uptake [34]. Soil organic matter ranged from 0.9- 1.33. These values were low a result that is similar to tropical soils [12]. Soil organic matter did not show any significant (P< 0.05) among the studied land use. However it's distribution followed the trend CCS> POS> BS >GLS > BS respectively. Continuous cultivated soil has the highest soil organic matter content and is attributed to higher decomposition and oxidation rate of organic materials in the soil. Cation exchangeable capacity:-Cation exchange capacity was significantly lower in bare soil. It followed the trend BS> POS>GLS> BF> CCS. This result deviated from normal. It could be attributed to past land use history.

Table1. Physical properties of studied soil

Landuse	Sand	Silt	clay	TC	SCR	MC	BD	TP	HC	FC	WP	PAW
	g/kg	g.kg	g.kg			g/kg	g.cm^3	%	Cm3water//cm^3 soil			
CCS	812.00	104.66	75.66	LS	0.89	131.2	1.36	46.36	4.82	0.33	0.09	0.09
BFS	830.33	73.67	96.33	LS	0.86	134.1	1.27	52.02	4.90	0.16	0.08	0.11
POS	788.33	112.67	104.00	LS	0.87	132.6	1.46	44.74	2.77	0.17	0.09	0.08
GLS	808.67	98.00	93.37		1.05	101.9	1.42	46.36	3.84	0.28	0.09	0.08
BS	834.33	71.00	90.66	LS	0.97	69.0	1.42	54.55	3.61	0.23	0.08	0.08
LSD (P<0.05)	0.04	NS	NS		NS	NS	0.02	0.34	0.01	0.001	NS	NS
C.V(%)	3.40	8.60	21.30		21.30	21.30	14.20	2.40	2.60	1.80	1.20	1.33
Ranking	LV	LV	MV		MV	MV	LV	LV	LV	LV	LV	LV

HC=Hydraulic conductivity, FC= Field capacity, WP = Wilting point, PAW= Plant available water, M.C= Moisture content,, TC=Textural class, SCR= Silt clay ratio,, B.D= Bulk density, T.P=Total porosity, LSD=Least significant difference, C.V=Coefficient of variation, L.V=Little variation, MV=High variation, NS= Not significant.

Table 2. Chemical properties of studied soil

Landuse	pH	pH	SOM	TN	P	CEC	TEB	TEA	PBS
	H_20	Kcl	gkg^{-1}	%	mg/kg	cmol/kg^{-1}			%
CCS	5.86	6.43	1.33	0.08	7.87	1.36	1.36	0.17	63.20
BFS	6.27	6.47	1.20	0.08	7.69	1.64	0.97	0.22	45.62
POS	5.44	4.64	1.04	0.07	5.83	2.98	0.61	0.16	38.70
GLS	6.07	5.82	0.88	0.15	6.32	2.02	1.17	1.16	61.42
BS	5.36	6.19	0.90	0.10	5.85	3.01	1.00	0.13	40.16
LSD (P=0.05)	NS	NS	NS	0.02	0.46*	0.04*	0.06*	0.06*	41.48*
CV %	7.3	20.7	21	15.13	3.7	1.80	4.1	0.40	46.6
Ranking	LV	HV	HV	LV	LV	LV	LV	LV	HV

LSD==Least significant difference, C.V=Coefficient of variation, NS=Not significant,*=significant, P.BS=Percentage base saturation, TE.B=Total exchangeable bases, TE.A =Total exchangeable acidity, T.N=Total nitrogen, SO.M =Soil organic matter.

International Journal of Agriculture Innovations and Research
Volume 3, Issue 4, ISSN (Online) 2319-1473

Table 3.Correlation of hydraulic conductivity with selected soil properties.

Soil property	Correlation coefficient (r^2)	Reamark
Moisture content	0.63	Significant
Sand	0.35	Significant
BD	0.799	Significant
TN	0.78	Highly significant
SOM	0.45	Significant
WP	0.73	Significant
Av.P	0.62	Significant
PAW	0.32	Significant
Ca	0.69	Highly significant
Na	0.57	Significant
AI	0.58	Significant
H	0.77	Significant
CEC	0.32	Not significant

SOM = Soil organic matter, Mg = Magnesium, Na = Sodium, H = Hydrogen, AI = Aluminum, A. vp = Available phosphorus, Ca = Calcium, K = Potassium B.s = Base saturation, WP = Wilting point, F.C = field capacity, PAW = Plant available water, CEC = Cation exchange capacity.

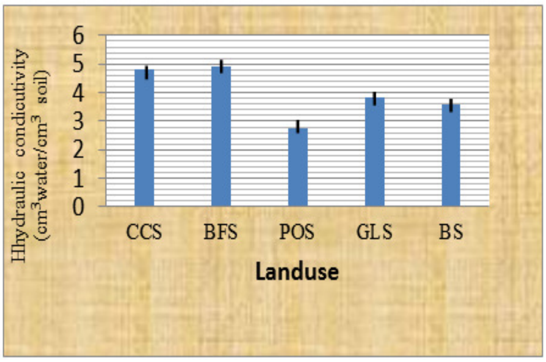

Fig. 1.Hydraulic conductivity of the studied landuse types.

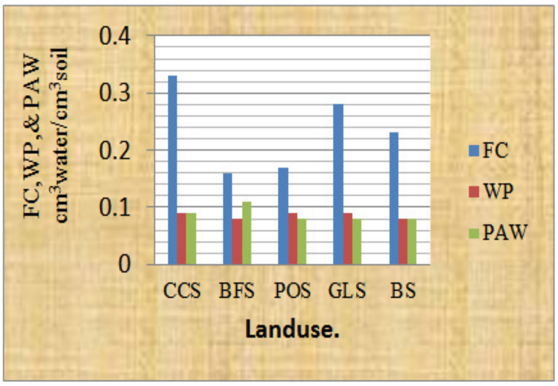

Fig.2 . Field capacity, wilting point, and plant available water

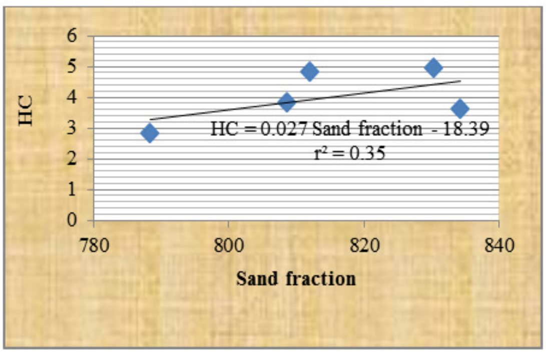

Fig.3. Relationship between hydraulic conductivity and sand fraction.

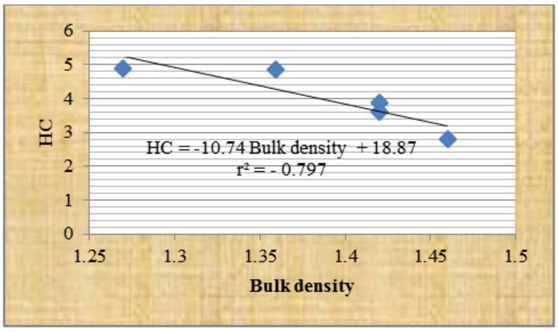

Fig. 4.Relationship between hydraulic conductivity and bulk density.

4. Conclusion

This study investigated indirect determination of hydraulic properties of soils under different land use practices in Imo State. Indirect method of Saxton *et al.,* (2006) was used in determining hydrologic properties. Results of the study revealed changes in some soil properties due to landuse types except for texture, hydraulic conductivity was higher in continuous cultivated soil and bush fallow soil compared to grass land soil and bare soil while pineapple orchard soil has little hydraulic conductivity .Plant available water is more readily available in bush fallow soil compared to others. Soil properties varied among its self. Hydraulic conductivity related negatively with bulk density, and positively with organic matter and sand fraction. Variability differed among studied soil properties with percentage base saturation exhibiting highest dispersion. Based on the findings of this study, I recommend that the studied soils should not be left bare, incorporation of organic manure will help to increase the hydraulic properties and thus reduce runoff water.

References

[1] N.C Brady, and R.R., Weil, "The nature and properties of soils (12th ed.),'. Prentice Hall Inc., New Jersey, 1999, pp. 1-6.

[2] K.E Saxton,., W.J. Rawls, J.S. Romberger, and R.I. Papendick. (1986). Estimating generalized soil water characteristics from texture. Trans. ASAE., 50:1031–1035.

[3] A. Ritter, F. Hupet, R. munoze-Carpena, S. Lambot , and M. Vanclooster (2003) " Using inverse methods for estimating soil hydraulic properties from field data as an alternative to direct methods," Agricultural water management, 59,. 77-96.

[4] K..E. Saxton and W. J. Rawls (2006). Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions. Soil & Water Management & Conservation, Soil Physics: 677 S. Segoe Rd., Madison, WI 53711 USA. Soil Sci. Soc. Am. J. 70:1569–1578. doi:10.2136/sssaj2005.0117

[5] C.L.S. Morgan, J.M. Norman and B. Lowery. (2003). Estimating plant-available water across a field with an inverse yield model. Soil Sci. Soc. Am. J. 67:620-629.

[6] M.G. Schaap "Models for indirect estimation of soil hydraulic properties", *Encyclopedia of Hydrological Sciences*, This issue.John Wiley & Sons 2005.

[7] Imo State of Nigeria:Atlas of Imo State, Ministry of Works and Transport, Department of Land Survey and Urban Development ,1984.

[8] S.O. Orajaka, "Geology. In: Nigeria in Map: Eastern States (G.E.K Ofomataed.). Ethiope publishers Benin City Nigeria, 1975, pp. 5-7.

[9] M.U. Igbozurike "Vegetation types". In: Ofomata, G.E.K. Nigeria in maps communication, 1975.

[10] G.W. Gee and D., Or (2002). Particle Size analysis. In methods of soil analysis. Dane .D.J., and G.C Topps (Eds.).Part 4.Physical methods.Soil Science Society of America Book Series No. 5, ASA and SSSA. Madison, W.I., 225-293.

[11] R.B. Grossman, and T.G Reinsch, (2002): Bulk density and linear extensibility. In: Dane, .J.H. and Topp, G.C. (Eds.). Methods of the Soil Analysis part 4. Physical methods.Soil Sci. Soc. Am. Book Series No.5, ASA and SSSA, Madison, WI. Pp 201-228.

[12] J.R. Landon, "Booker tropical soil manual": A hand book for Soil Surveyors and agricultural land evaluation in the tropics. Paper back edition, Long man Scientific and Technical .U.K. 1991..

[13] W.H. Hendershort, ,Lalande, H., and Duquette, M., (1993). Soil reaction and exchangeable acidity, In: Soil sampling and methods of soil analysis (Carter M.R., Ed.), Canadian Soc.Soil Sci. Lewis Publishers, London pp.141-145.

[14] D.N Nelson., and L.E., Sommers (1982).Total Carbon, organic carbon and matter In: methods of soil analysis part 2.(Page A.L., R.H., Miller,and D.K., Keeney Eds.).Amer. Soc. Agron. D.M.Madison, W.I. pp. 539-579.

[15] S.R , Olson,. and L.E , Sommers,. (1990). Phosphorus In: Page, A.L. (Ed.). Methods of Soil Analysis. Parts 2, Agron.,Monogr. No. 9 Madison, WI. 403-431.

[16] Thomas (1982). Methods of soil analysis, part 2: Chemical and Microbiological properties, 2nded; Amer. Soc. Agro. Inc. Madison, Wisconsin, USA.

[17] A.O Aweto, "Variability of upper slope soils developed under sandstones in Southwestern Nigeria" . Nig. Geogr.J., 1982, 25: 27-37.

[18] E.U Onweremadu, E.T Eshett, G.E. Osuji, I. Unamba-Oparah, J.C. Obiefuna and C.O.E. Onwuliri (2007). Anisotropy of Edaphic Properties in slope soils of a University Farm in Owerri, Southeastern Nigeria .Journal of American Science, 3(4) :51-62.

[19] FOR Akamigbo(1999). Influence of land use on soil properties of the humid tropical agroecology of southeastern Nigeria Agric Journal, 30:59-76.

[20] J. B Wang., Fu, Y., Qui, L., Chen, (2001). Soil nutrients in relation to land use and landscape position in the semi-arid small catchment on the loess plateau in china. J. Arid Environ, 48: 537-550.

[21] L.C. Agim, C.M,, Chris-Emenyonu S.N Obasi, P, Isika, L. C Okoro, and M. Nwachukwu, (2012). Variability of selected physico-chemical properties of soils affected by different land-sse practices in Owerri Southeastern Nigeria. International Journal of Agriculture and Rural development 15 (3):1174-1182.

[22] A.V,Wambeke (1978). Criteria for characterizing tropical soils by age. J. Soil Sci.,124-132.

[23] I. Unamba-Oparah and, and W.O., Enwezor. Soil Fertility studies in the coastal plain sand areas of Bendel, Rivers, Imo and Cross Rivers States of Nigeria. Study conducted for Land Resources Division. Fed.Dept of Agric., Kaduna. 1978.

[24] C.A .Igwe,., F.O.R, Akamigbo, J.S.C Mbagwu, (1995).The use of some soil aggregates indices to access potential soil loss in soil of south eastern Nigeria. Int. Agro. Physic, 9:95-100.

[25] L.C., Agim "Seasonal variations in erodibility based on aggregate stability of soils under different land uses in Owerri Southeastern Nigeria". MSc. Thesis Submitted to Post Graduate School, Federal University of Technology Owerri, Imo State Nigeria. 2010.

[26] E.U .Onweremadu., L.C Agim and C.I. Obi, (2012). Weathering Status and Some Pedogenic Activities of Soils Formed Over Falsebedded Sandstone In Southeasthern Nigeria. Advances in Science and Technology, 6 (1) 39 -44.

[27] R. Lal., (2007). Soils and sustainable agriculture. A review. Agron. Sustain. Dev. Available online at: www.agronomy-journal.org DOI: 10.1051/agro:2007025.

[28] R. Lal. "Tropical ecology and physical edaphology", John Willy and Sons Ltd. 1987.

[29] Babalola, O., (1978). Spatial variability of soil water properties in tropical soils of Nigeria. Soil Sci.,126:269-279.

[30] R Lal, (1976).No tillage effects on soil properties under different crops in Western Nigeria. Soil Sci. Soc. o f Amer. J., 40:762-968.

[31] J. Givi, S. O Prasherb, & R. M. Patel (2004). Evaluation of pedo transfer functions in predicting the soil water contents at field capacity and wilting point. *Agricultural Water Management*, 70, 83-96.

[32] I.R. Sys,.C., Van Ranst, E. &Debaveye, Ir. J. (1991).*Land evaluation*. Part I. Principal Land evaluation and Cropproduction calculation general administration for development, Cooperation agric Pub., 1(7), 247pp.

[33] Cornell University. "Soil and water management: Competence area II. Soil hydrology". USA. 2010.

[34] H. Marschner "Mineral Nutrition of Higher Plants". 2nd edition Academic Press, San Diego, CA 1995.

AUTHOR'S PROFILE

Agim Leonard is was born on 23 rd November 1980 in Ehime Mbano L.G.A. He is currently a PhD student in Soil and Environmental Conservation of the University of Nigeria Nsukka. He holds a Masters Degree in Soil and Environmental Conservation from the Federal University of Technology Owerrilmo State in 2010 and a Bachelor of Agricultural Technology from the same University in 2005He lectured with Imo State Polytechnic for three years and taught sciences for four years at Domino International Secondary school all in Imo State. He is currently a Lecturer II in Soil Science & Technology Department of Federal University of Technology Owerri. He has to his credit some journals papers and has read several papers in Local and International conferences. He has worked on seasonal variations and landuse effects on soil erodibility and is currently working on degraded soils with organic amendments with a view to reclaiming them.
email: agimleonard@yahoo.com.

Njoku Gift Ugochi was born on 11th of January 1986 in Isiala Ngwa of Abia State. She is running a PhD programme at the Federal University of Technology Owerri. She hold a B. Agric Tech in 2007 and MSc. in Soil Physics in 2012 all from The Federal University of Technology Owerri Imo State. He has about five years of working experience and ha presented papers in both Agricultural Society of Nigeria and Soil science Society of Nigeria Conferences respectively. She is currently a Lecture II with the Federal Polytechnic Nekede under the Department of Agricultural Engineering. Her Research interest is Soil physics and Conservation.
email:ugoify2007@yahoo.com.

Ahukaemere, Chioma Mildred was born on 10th October, 1979 in Ahiazu Mbaise L.GA, Imo State. She defended her PhD thesis on 21st of January 2015 in Soil Survey and Land use Planning at Federal University of Technology Owerri. She holds a Masters Degree in Soil fertility and fertilizer Technology (2009) and a Bachelor of Agricultural Science (2005), all from Michael Okpara University of Agriculture, Umudike, Abia State. Currently, She is working on Soil carbon and nitrogen sequestration in relation to parent materials and land use types in soils of South-eastern Nigeria. She is a lecturer in the Department of Soil Science and Technology and has published several research papers in reputable local and international journals. She has also worked extensively on modified soils (earthworm casts and termite mounds) of south-eastern Nigeria.
email: mildredshine@yahoo.com.

Okoro Linus Chidi (Mr) was born on 24th of September 1970 at Ehime Mbano LGA of Imo State. Mr Linus is currently running his PhD studies with the Imo State University Owerri. He holds a Higher National Diploma in Crop production from Federal College of Agriculture Umudike in 1994, Postgraduate Diploma in Agricultural economics in 2001, and a Master of Science in Agricultural Economics all from the Prestigious University of Nigeria Nsukka in 2007.He has about 10 years working experience both in Ministry of Agriculture and with the Imo State Polytechnic Umuagwo where he is currently serving as a Lecturer. He has some journal publications to his credit and has presented papers in Agricultural Society

International Journal of Agriculture Innovations and Research
Volume 3, Issue 4, ISSN (Online) 2319-1473

of Nigeria Conferences. His research interest is Resources and Environmental economics.
email:linus52@yahoo.com.

Name:Dr. Onwudike Stanley Uchenna
Date of Birth:12/10/77
Educational background

- B. Agric. Tech., 1999, Federal University of Technology Owerri, Imo State, Nigeria
- M.Sc. (Soil fertility and fertilizer technology), 2006, Michael Okpara University of Agric. Umudike, Abia State, Nigeria
- Ph.D. (Soil fertility and fertilizer technology), 2006, Michael Okpara University of Agric. Umudike, Abia State, Nigeria

He has over the years been researching on ways of improving the fertility and productivity of a degraded Ultisol. This he has done by evaluating the efficacy of different solid wastes of both plant and animal origin on soil physicochemical properties and growth performances of some tropical crops. He is also examining the impact of organic wastes on the mitigation of climate change through carbon sequestration. He is a LECTURER II, in the Department of soil science, FUTO.
email: onwudikestanley@yahoo.com

Osisi Adaku Felicia was born on 30th of October 1972 at Orsu LGA Imo State.She holds B. Agric.in 2000 and an M.Sc in 2004 all from Micheal Okpara University of Agriculture Umudike Abia State Nigeria. She is presently an Assistant Lecturer in the Department of Soil Science and Technology of the Federal University of Technology Owerri. She has published research papers in reputable journal to her credit. Her research interest is soil Chemistry, sulphure sorption in different parent material.
email: uadaku@yahoo.co.uk.