CC BY NC SA

International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

Influence of Land Use Types on Soil Carbon Sequestration in Climate Change Era in Ikwo, Ebonyi State, Nigeria

Jephter Orji, E.

Department of Soil Science, Alex-Ekwueme Federal University, Ndufu-Alike, Ebonyi State, Nigeria

Corresponding author: revjeph@gmail.com

ABSTRACT

Background: The increasing threat of climate change has heightened the importance of soil carbon sequestration as a vital ecosystem service. Land use types significantly influence soil carbon storage, yet the magnitude and direction of this impact remain poorly understood in many regions, particularly in sub-Saharan African communities such as Ikwo.
Objective: The objective of the study was to determine the influence of land use types on soil carbon sequestration in soils under different land use types in Ikwo, Ebonyi state, South-East, Nigeria.
Method: The experimental design is 4*3*2 factorial laid out in a randomized complete block design (RCBD). Four different land use types viz; forest, fallow, grass land and continuously cultivated soils) were randomly selected. Soil samples were randomly collected from each land use type at the depths of 0-15 cm and 15-30 cm using auger but undisturbed samples for determination of bulk density were collected with core samplers. Small portions of the samples were air dried, crushed and sieved using a 2-mm sieve in preparation for laboratory analyses. Data obtained were subjected to ANOVA.
Result: The results obtained showed that the soil in the study area is predominantly sandy and sandy loam in texture and slightly acidic. The soil textural fractions of sand, silt and clay contents at 0-15cm ranged from 61.30 – 69.30 gkg^{-1}, 13.50 – 23.50 gkg^{-1}, and 15.20 – 23.20 gkg^{-1} in the four different land use types. The proportions of sand, silt and clay contents of 15-30cm ranged from 55.30 – 61.30 gkg^{-1}, 15.50 – 25.40cm gkg^{-1} and 19.20 – 25.23 gkg^{-1} across all the land use types studied. The carbon storage at 0-15 cm was as follows; Forest Land = 2735gC/ha, Fallow land = 2713gC/ha, Grass land =1886gC/ha and continuous cultivated land =1368gC/ha. **Conclusion:** In conclusion, the land use types have significant influence on soil properties and carbon sequestration. Forest, fallow and grass lands had higher quantities of carbon when compared with continuously cultivated lands, therefore should be encouraged and practiced while continuously cultivated land should only be practiced with organic amendment for sustainable soil productivity.
Unique Contribution: The study has shown that different land use types have capacity to store nutrients especially soil organic carbon which help to improve soil physicochemical properties which sustain the production of agri-food. It showed the need to encourage forestry, fallow, grassland especially in this climate change. The nutrients storage was more in rainy season than in dry season. Farmers are encouraged to adopt such land use types practices to improve soil productivity and mitigate climate change effects.
Key recommendation: The study recommended that the various land use types should be practiced in this climate change era only that the continuously cultivated land should be practiced with regular organic matter amendments for sustainable soil productivity.

Keywords: land use types, soil carbon, sequestration, climate change

CC BY NC SA

INTRODUCTION

Carbon sequestration is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide (CO2) in soil or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change (https.//en.m.wikipedia.org, 2016) Soils are important reservoirs of active organic components (such as carbon, nitrogen) and play a major role in the global cycle of these elements. As such, soil can be either a source or sink for atmospheric carbon dioxide (CO2) depending on land use and management of soil and vegetation (Lal, 2005). Changes in agricultural management can increase or decrease soil organic carbon (SOC) and increasing SOC is beneficial for mitigating and improving soil structural conditions. Carbon enters the soil as roots, litter, harvest residue and animal manure which is stored primarily as soil organic matter (SOM) (Anikwe, 2010). Organic carbon in agricultural soils contributes positively to soil fertility which is a major factor determining soil productivity (Anikwe, 2010). The conversion of native ecosystems such as forests, grasslands and wetlands to agricultural uses, and the continuous harvesting of plant materials, have led to significant losses of plant biomass and carbon (Davidson and Ackerman, 1993), thereby increasing the carbon dioxide (CO2) level in the atmosphere. Thus, a part of carbon increase in the atmosphere is thought to have come from agriculture, affecting not just climate change but also productivity and sustainability of agriculture and natural resources (Robbins, 2004). The value of soil for agricultural and other uses is majorly determined by the concentration of organic components of the soil and parent materials from which the soils are formed.

Carbon sequestration involves the process of transferring atmospheric CO_2 into the soil through crop residues and other organic solids, and storing it securely so it is not immediately reemitted into the atmosphere (Lal, 2004). Thus, soil carbon sequestration means increasing soil organic carbon (SOC) and soil inorganic carbon (SIC) stocks through judicious land use and recommended management practices (Akamigbo, 2010a). This transfer or ―sequestering of carbon helps off-set emission from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity. Soil carbon sequestration can be accomplished by management systems that add high amounts of biomass to the soil, cause minimal soil disturbance, conserve soil and water, improve soil structure, and enhance soil fauna activity.

The rapidity of soil carbon decline in tropical soils is worrisome as it is a principal factor in soil quality of the biome which results to soil structural deterioration. Poor carbon sequestration has been attributed to shortened fallow cycles, poor management practices, changes in microbial chemistry, bush burning, deforestation, conventional tillage, mining, climate change and poverty (Onweremadu*etal*., 2008a). Of all the causes of poor carbon sequestration in the soil, deforestation takes a great toll in sub-Saharan Africa, and indeed the tropical world. In Southeastern Nigeria, there is increased deforestation and resultant erosion damages of soil resources (Oti, 2007). However, in the tropics, erosive activities have led to a decline in organic matter (Egwu et al., 2023;Mbagwu and Obi, 2003), resulting to adverse changes in physical properties of the soils, low nutrient status and build-up of toxicities such as excessive concentration of heavy m*etal*s in soils. In the light of the above, several soil fertility enhancing

[CC BY NC SA]
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

practices such as prolonged fallow, conservation tillage and improved agro-forestry systems have been suggested with little success due to increasing population and poverty which consequently result to pronounced degradation of soil resources.

A major challenge facing scientists and policy makers is how to increase the amount of carbon sequestered in soil in order to mitigate climate change. According to Wu (2011), there is need to understand the impact of land use management on soil carbon stocks regionally and globally, because this stock is not only twice the total amount of CO_2-C in the atmosphere, but it is also sensitive to land use changes. Therefore, restoration of soil quality through soil organic carbon management has remained a major concern for tropical soils. Several studies (Nwite et al., 2018; Gebeyaw, 2007; Hacisalihoglu, 2007) have been done on the effect of different land use types on soil properties and carbon storage but studies on the influence of land use types on soil carbon sequestration in climate change era in Ikwo, Ebonyi state is scanty hence the need for the study. The objective of the study therefore is to determine the influence of land use types on soil carbon sequestration in climate change era in Ikwo, Ebonyi state, south-east Nigeria.

Materials and Methods

Site location

The study was carried out at the Teaching and Research Farm of Faculty Agriculture of Alex Ekwueme Federal University Ndufu Alike, Ebonyi state, South-Eastern Nigeria. The area lies between latitude 06^o 8.29N and Longitude 08^{o}8.63E and altitude 55m in the derived savanna zone of southeastern Nigeria. The rainfall ranges from 1700 to 2000mm with mean annual rainfall of 1800mm (Anyadike 2002). The mean annual temperature ranges from 27^{o}C to 31^{o}C throughout the year. The relative humidity is 80% during rainy season but declines to 65% in the dry season (FDALR, 1990). The field work was carried out in four selected land use types within the university namely; Forest Land, Grass Land, Fallow land and Continuously Cultivated Land and and their description are as follows;

Forest Land (FL): The Forest land is located at the back of the old female hostel at the University (Alex Ekwueme Federal Univeristy Ndufu Alike, Ebonyi State). The land was said to have existed for over 100years as the villagers also mentioned that the heart of the forest is also a dangerous place for anyone to enter therefore it is prohibited for hunting and farming activities in it. The land possess trees, grasses, herbs and shrubs such as wire grass (*Sporobulus pyramidalis*), tridax (*Tridax procumbens*), giant star grass (*imperata cylindrical*), guinea grass (*Panicum maximum*), oil palm (*Elaeis guincensis*), mango (*Magnifera indica*), etc.

Grass Land (GL): The Grass land is located close to the Male Hostel regarded as the University (Alex Ekwueme Federal University Ndufu Alike, Ebonyi State) football field. The grass land is periodically under-cut especially the area that serves as field for games. Some parts of the land is use to graze animals. The grass land has existed over 13years. The land is grown with herbs but dominated by grasses such as Tridax (*Tridax procumbens),* giant star grass (*Imperata cylindrical*), Guinea grass (*Panicum maximum*). The land area for the purpose of the study is measured 50 m x 50 m (0.5 ha).

CC BY NC SA

International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

Fallow Land (FL): The Fallow land is located close to the Engineering Faculty. The fallow has lasted for more than 13 years. There are different types of vegetation covering the land but among major ones are scattered trees, herbs, shrubs and grasses like guinea grass (*Panicum maximum),* wire grass *(Sporobulus pyramidalis*), goat weed (*Ageratum conyzoides*),stubborn weed *(Sida acuta)*. The land area of 50 m x 50 m (0.5ha).

Continuously Cultivated Land (CCL): Otherwise known as arable land located close to the Faculty of Agriculture Alex Ekwueme Federal University Ndufu Alike, Ebonyi State. The arable land is the research/experimental farm of the Faculty of Agriculture. The area has been under yearly cultivation for more than six years by students and staff of the Department. It has been subjected to conventional tillage operations, use of chemicals (like fertilizers, herbicides and pesticides), organic amendments and other cultural practices. Common crops grown in rotation include yam (*Dioscorea spp),* cassava (*Manihot spp)*,maize (*Zea mays* L*)*, vegetables, cucumber and leguminous crops. The selection of the four land use types above is to have better representation of the various land use practice in AE-FUNAI, South Eastern Nigeria.

Soil Sampling

Soil samples were collected from the selected four land use types at two depths (0 – 15 cm and15 – 30 cm) using core samplers and soil auger for soil physical and chemical determinations. Within each land use type, three (3) core and auger samples each were collected from the three soil depths and replicated three times. The undisturbed samples collected with core samplers of 6 cm height and 5 cm of diameter were used for bulk density determination. The auger soil samples were air – dried, gently crushed and passed through 2mm-sieve to obtain fine earth separates for soil particle size distribution and chemical analysis.

Laboratory methods

Particle size distribution of the less than 2mm fine earth fractions was determined using Bouyoucous hydrometer method as described by Gee and Bauder (1986). Bulk Density was determined using core sampling method after oven drying the soil samples to a constant weight at temperature of 105°C for 24hours (Blake and Hartage, 1986; Grossman and Reinsch, 2002). The Total Porosity was calculated from soil bulk density using us assumed particle density of 2.70gcm^3 . TP= (1-Bd/Pd) X 100/1

Soil pH was determined using glass-electrode pH meter. The pH was determined on a 1:2.5 soil: solution ratio in both water and 0.01M $CaCl_2$ solution (Mc Lean, 1982). Available phosphorus was obtained by the Bray-2 method (Bray and Kurtz, 1945). Organic carbon was determined by Walkley – Black dichromate wet oxidation method (Nelson and Sommer, 1982), Total Nitrogen was extracted using the mico-kjeldahl technique (Bremner and Mulvaney, 1982). Exchangeable $H^+$and Al^{3+} were determined by tritrimetric method using KCl (Mcleean, 1965). Exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were extracted with 1N neutral ammonium acetate (NH_4OAC) solution, Ca^{2+} and Mg^{2+} were determined by titration, while K^+ and Na^+ were measured by flame photometry (Grant, 1982). Cation exchange capacity was obtained by ammonium acetate

BY NC SA

displacement method. Base saturation was obtained using the appropriate formula: % BS = TEB/ECEC x 100/1.

Soil carbon stock/pool (g C/ha) was quantified as the product of fractional mass of carbon, soil depth (m), soil bulk density (g/cm^3) and land area/ha (m^2/ha) thus.
gC ha^{-1} = [% C x BD x d x 10^{4}m^2] /100 (Lal *et al.,* 1998).
Where gC ha^{-1} = gram carbon per hectare
% C = percentage of carbon given by laboratory result
Bd = Soil bulk density (g/cm^3) d = depth in meters.

Data Analysis

Data were analysed using analysis of variance (ANOVA) Obi (2002). Separation of treatment means for significant effect was done using Fisher's –Least significance difference (F-LSD).

RESULTS AND DISCUSSION

The results of the physical parameters of the various land use types studied are presented in Table 1. The soil physical properties in the study area were significantly different by (p<0.01) among the various land use types. The study area had the sand fraction across the two soil depths ranging from 55.30 to 69.30 %, silt fraction ranging from 13.30 to 25.40% and clay fraction ranging from 15.20 to 25.23 %. Thus, the soils in the study area were predominantly sandy loam and sandy clay loam and was significantly (p < 0.01) affected by land use (Table 1). The textural variation across the land use types might be attributed to the selective removal of soil particles from one location to another by agents of soil erosion and variation in weathering intensity (Kolo, 2019). The sand fraction decreased generally with depth in all land use types. The general decrease in sand fraction with depth could be attributed to the sorting through eluviation-illuviation process as was reported by Egwu et al. (2023) Amenkhienan et al. (2021) and Thomas and Oke (2018) . The distribution of silt fraction was irregular with depth across the land use types. The clay fraction increased generally with depth in all land use types. From the results, it can be observed that the values of sand are greater than clay and silt. The same is clay value over silt. This is in tandem with the general trend in particle size distribution which is sand > clay > silt, this was also observed by Asadu and Akamigbo (1983) in most soils of southeastern, Nigeria.

"Across the depths (0-30 cm),the value of bulk density was significantly different (p<0.01) among the land use types and ranged from 1.29-1.70 gcm^{-3}. The value of bulk density range between 1.29 and 1.69gcm-3 with CV of 4.3% at 0-15cm soil depth and 1.30 - 1.70 gcm^{-3} with CV of 0.3% at 15 – 30 cm soil depth (Table 1). The highest (1.70 gcm^{-3}) and lowest (1.29 gcm^{-3}) bulk density values at 0 – 15 cm soil depth were recorded at continuously cultivated land and forest land respectively (Table 1). The low bulk density observed in soils of forest land has advantage of increased porosity (Egwu et al., 2023; Vogelmann *et al*., 2010) with accompanied adequate aeration. The increase in bulk density with depth may be attributed to compaction caused by the weight of the overlying horizons and decrease in organic matter with depth. This agrees with the reports of Mba *et al.* (2023a) and Fedaku *et al.* (2018) as they reported

CC BY NC SA
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

increasing bulk density with depth due to changes in organic matter content, porosity and compaction. "

Total porosity values of the soils were significantly different (P < 0.01) among the land use types. Total porosity varied from 34 to 51.33% across the soil depths of the various land use types. Forest land consistently recorded the highest values (51.7% and 51.3%) while continuously cultivated recorded the lowest values (34% and 34%) across the soil depths and among the land use types (Table 1). The decrease in total porosities with depth might be attributed to the decrease in organic matter content with depth (Mba *et al.*, 2023a;Hassan and Shuaibu, 2006)."

Table 1: Effect of Land Used System and Soil Depth on the Physical Properties of Soil

Land Use types (LUT)	% Sand	% Silt	% Clay	Bulk density.	Total porosity
			0 – 15cm		
C. Cultivation	63.30b	13.50d	23.20a	1.69a	34.00c
Fallow Land	63.30b	21.50b	15.20b	1.32b	49.00a
Forest Land	61.30c	23.50a	15.20bb	1.29b	51.67a
Grassland	69.30a	15.50c	15.20b	1.38b	41.00b
Mean	64.30	18.50	17.20	1.42	43.92
SE±	0.25	0.16	0.25	0.05	1.11
CV (%)	0.5	1.00	1.70	4.30	3.10
FLSD (0.05)	0.602**	0.383**	0.599**	0.121**	2.718**
			15 – 30cm		
C. Cultivation	59.21b	15.50d	25.23a	1.70a	34.00a
Fallow Land	55.30c	21.50b	23.20b	1.40c	44.00b
Forest Land	55.30c	25.40a	19.20d	1.30d	51.33a
Grassland	61.30a	17.50c	21.20c	1.60b	39.30c
Mean	57.78	19.97	22.21	1.50	42.16
SE±	0.4	0.122	0.024	0.004	0.375
CV (%)	0.80	0.80	0.10	0.30	1.10
FLSD (0.05)	0.979**	0.300**	0.058**	0.010**	0.917**

CV = Coefficient of variation

cc BY NC SA
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

The results of the chemical properties of the land use types are presented in Tables 2. The soils of the studied area were significantly different ($p < 0.05$). The results showed that soil from Forest land had the highest values for total nitrogen (TN), organic carbon, available phosphorus, exchangeable calcium (Ca), exchangeable sodium (Na) and exchangeable potassium (K) while the lowest values were recorded by the soil from continuously cultivated land. In all the land use types, the soils were slightly acidic and increased with soil depths. The soil pH was lowest in the top soils of continuously cultivated land (5.0) and the highest at the forest land (6.0).

The total nitrogen (TN) content decreased significantly with soil depths in all the land use types. The values of total nitrogen were observed to decrease significantly with soil depths in all land use types and were rated very low to low in all the land use types based on the scale by Enwezor *et al.* (1989) and Kayode *et al*. (2018). The low values of TN might be linked to low organic matter content of the soils as OM accounts for 93 to 97% of total nitrogen (Meysner *et al*., 2006)." According to Nsor and Adesemuyi (2018) low TN could be attributed to the volatilization of gaseous forms of nitrogen during burning and agreed with Uzoho *et al*. (2014) who observed low nitrogen values in areas degraded by bush burning. The lower TN observed at the lower depth might be linked to the higher water table which contributes immensely to leaching of nitrogen usually the nitrate form (Adegbite *et al*., 2019).

The highest value of organic carbon content was obtained at the Forest land (0.92%) while the lowest value was obtained at the continuously cultivated land (0.66%) at 0 – 15 cm and across the soil depths. Organic carbon was observed to be in the following order: Forest land > Fallow land > Grass land > Continuously cultivated land. Therefore, high nutrient recycling occurs in the forest land due to the high litter falls (Chokor and Egborah, 2018).

Similarly, available phosphorus (P) decreased with soil depths. Available P was not deficient across the two depths in all the land use types when compared to the critical value of 10 – 16 mg/kg as reported by Chokor and Egborah (2018). (Table 2). Calcium (Ca) content was significantly different ($p < 0.05$) among land use types and the highest and lowest values (3.68 Cmolkg^{-1}) and (2.94 Cmolkg^{-1}) across the land use types were obtained at the Forest land and Continuously cultivated land respectively at 0 – 15 cm soil depth. The value was high for all the soils of the different land use types across the soil depths according to Enwezor *et al* (1989). This observation is in agreement with Nsor (2017) who reported high calcium content of soils in southeastern Nigeria. Magnesium (Mg) content was significantly different ($p<0.05$) among the land use types studied. The highest value was obtained in Forest land (2.45 cmolkg $^{-1}$) while the lowest was at the continuously cultivated land (2.21 cmolkg^{-1}). The results showed that the top soil had the highest values in all the land use types and decreased down the depths. The values of Mg were rated high across the depths for all the soils under different land use types when compared with the critical value of 0.2 – 0.4 cmolkg^{-1} according to Akirinde and Obigbesan (2000); Shehu *et al*. (2015); Nsor *et al*. (2018)."Mg content was not deficient in any of the four land use types (Table 2). Potassium (K) , Sodium (Na), Exchangeable Acidity (EA), cation exchange capacity (CEC) and percentage base saturation (%BS) contents were all significantly different ($p<0.05$) among the land use types studied (Table 2).

cc BY NC SA
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

The carbon storage at 0-15 cm was as follows; Forest Land = 2735 gC/ha, Fallow land = 2713 gC/ha, Grass land =1886 gC/ha and continuous cultivated land=1368 gC/ha. Similarly, at 15 – 30 cm was as follows; Forest Land = 4358 gC/ha, Fallow land = 3648 gC/ha, Grass land =3382 gC/ha and continuous cultivated land=1008 gC/ha (Table 2). Forest and fallow lands had higher quantities of carbon across the depths when compared with those of the grass land and cultivated land though 15 – 30 cm soil depths recorded higher carbon storage. This could be attributed to high quantity of organic matter from organic substances and plant residue that entered the soil which are stored primarily as soil organic matter. This corresponds with the findings of Chukwuebuka et al. (2023); Mbah and Idike (2011) and Shittu *et al*. (2018). According to Chinonso (2020) as soil depth increased, horizon thickness equally increased and this influence the amount of carbon sequestered. Soils with deeper horizon thickness, sequestered more carbon than those in the upper horizon and this contradicts the findings of Ahukaemere et al. (2017) and Ahukaemere et al. (2020) From the results, both forest land and fallow land soils stored higher quantity soil carbon than other land use types and should be encouraged especially in this era of climate change.

CC BY NC SA
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print) doi:10.5281/zenodo.17886367

Table 2: Physiochemical properties of soils of different land use types used for the study.

Land Use System (LU)	% SAND	% SILT	% CLAY	BULK D.	T. Porosity	pH (H_2O)	P mg/kg	% N	% OC	% OM	Ca	Mg	K Cmol/kg	Na	EA	ECEC	%BS	gC/ha
							0 – 15 cm											
C. Cultivation	63.30b	13.50d	23.20a	1.69a	34.00c	5.4	14.74	0.08	0.66	1.40	3.07	2.21	0.08	0.30	2.58	7.66	61.00	1818
Fallow Land	63.30b	21.50b	15.20b	1.32b	49.00a	5.8	15.87	0.20	0.87	1.51	3.07	2.43	0.14	0.28	2.76	7.71	60.58	3171
Forest Land	61.30c	23.50a	15.20bb	1.29b	51.67a	6.0	17.31	0.25	0.92	1.89	3.68	2.45	0.14	0.17	2.52	8.97	66.92	4046
Grassland	69.30a	15.50c	15.20b	1.38b	41.00b	5.9	15.56	0.18	0.73	1.46	2.94	2.40	0.12	0.25	2.62	7.44	62.83	2080
Mean	64.30	18.50	17.20	1.42	43.92	5.8	1.52	0.169	0.38	0.613	0.54	2.73	0.11	0.25	2.62	7.37	62.83	2.779
SE±	0.25	0.16	0.25	0.05	0.11	0.18	1.52	0.14	0.18	1.19	2.68	2.21	0.10	0.17	0.56	1.16	66.92	1023
CV (%)	0.50	1.00	1.70	4.30	3.10	4.81	3.14	0.2	0.66	0.3	0.26	0.4	0.1	0.1	1.05	2.05	16.26	1818.
FLSD (0.05)	0.602**	0.383**	0.599**	0.121**	2.718**	0.369	3.541	0.169	0.381	0.613	0.54	0.83	0.05	0.205	0.5	0.99	7.84	876.8
						15 – 30 cm												
C.	59.21	15.50	25.23	1.70	34.00a	5.0	13.62	0.07	0.27	0.8	3.4	2.0	0.0	0.1	4.3	10.69	53.7	1008

CC BY NC SA

Cultivation	b	d	a	a						7	7	6	83	5	2		8	
Fallow Land	55.30 c	21.50 b	23.20 b	1.40 c	44.00b	5.2	14.74	0.16	0.74	1.24	2.84	2.5	0.11	0.26	1.97	6.36	64.89	3648
Forest Land	55.30 c	25.40 a	19.20 d	1.30 d	51.33a	5.8	16.03	0.23	0.87	1.83	1.81	2.29	0.12	0.34	2.67	7.8	60.44	4358
Grassland	61.30 a	17.50 c	21.20 c	1.60 b	39.30c	5.7	15.08	0.16	0.71	1.41	3.63	2.6	0.17	0.24	1.52	4.93	72.22	3382
Mean	57.78	19.97	22.21	1.50	42.16	4.80	15.9	0.235	0.79	1.38	2.94	2.4	0.12	0.25	2.62	7.44	62.83	3099
SE±	0.4	0.122	0.024	0.004	0.375	0.21	1.75	0.09	0.21	0.34	0.3	0.46	0.05	0.11	0.58	1.14	9.05	1012.4
CV (%)	0.80	0.80	0.10	0.30	1.10	9.1	23.4	30.3	57.2	52.4	21.5	41.6	92.7	97.9	47.1	32.5	30.6	69.3
FLSD (0.05)	0.979**	0.300**	0.058**	0.010**	0.917**	0.427*	3.631	0.195	0.439*	0.708	0.619**	0.959	0.111	0.237	1.208**	2.36**	18.77	2099.6**

CC BY NC SA

CONCLUSION

The conclusions drawn from the study according to the results are that soil chemical properties such as the total N, organic carbon, organic matter, available P, potassium (K), calcium (Ca) and sodium (Na), cation exchange capacity (CEC) and percentage base saturation (%BS) were all significantly different ($p < 0.05$) among land use and decreased with soil depths while the soil was slightly acidic. The forest land recorded the lowest value for bulk density and highest value for total porosity. The soil properties including carbon storage were influenced by the various land use types. Forest land recorded highest values while continuously cultivated soil recorded the lowest values for all the soil nutrients. Soil carbon storage was observed to be highest in forest land followed by fallow land and lowest in continuously cultivated land. The significance difference between the forest land and other land use types shows the need to encourage the conservation of our soil. It is therefore recommended that the various land use types should be practiced in this climate change era only that the continuously cultivated land should be practiced with regular organic matter amendments for sustainable soil productivity.

Ethical clearance
Ethical consent was sought and obtained from the participants used in this study. They were made to understand that the exercise was purely for academic purposes, and their participation was voluntary.

Acknowledgements
1 acknowledge the laboratory technologists for assisting us with sample analysis and data collection. We equally appreciate AEFUNAI University Library staff for their cooperation and support.

Sources of funding
The study was not funded.

Conflict of Interest
The author declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Availability of data and materials
The datasets on which conclusions were made for this study are available on reasonable request.

Citation:

Orji, J. E. (2025). Influence of land use types on soil carbon sequestration in climate change era in Ikwo, Ebonyi state, south-east Nigeria.. *International Journal of Sub- Saharan African Research*, 3 (4), 209-224

CC BY NC SA
International Journal of Sub-Saharan African Research (IJSSAR)
Vol. 3, Issue 4, pp. 209-224, December, 2025, ISSN: 3043-4467 (Online), 3043-4459 (Print)
doi:10.5281/zenodo.17886367

REFERENCES

Adegbite, K.A., Okafor, M.E., Adekiya A.O., Alori, E.T. and Adebiyi O.T.V. (2019) Characterization and classification of soils of a toposequence in a derived savannah agroecological zone of Nigeria. *The Open Agriculture Journal* 13, 44 - 50.

Ahukaemere, C. M., Okoli, N. H., Aririguzo, B. N., and Onwudike, S. U. (2020). Tropical Soil Carbon Stocks in Relation to Fallow Age and Soil Depth. Malaysian Journal of Sustainable Agriculture (MJSA), 4, 5-9. https://doi.org/10.26480/mjsa.01.2020.05.09

Ahukaemere, M. C., Egbuche, C. T., Akamigbo, F. O. R., Onweremadu, E. U., Chukwuma, M. C., Uzoho, B. U., & Ndukwu, B. N. (2017). Soil Carbon Sequestration Capacity Measurement per Centimetric Depth Unit: A Rational Approach. European Journal of Physical and Agricultural Sciences, 5, 40. http://www.idpublications.org

Amenkhienan, B. E. and Isitekhale,H. H. E.(2020).Physicochemical properties of selected soils formed on cretaceous sediments, shales and quaternary alluvium in Edo State, Nigeria.Journal of Current Opinion in Crop Science, Vol.2 (2), 192 – 201.

Anyadike, R.N.C. (2002). Climate and vegetation in Ofomata, G.E.K. (ed), A Survey of the Igbo Nation. Africana First Publishers. Pp 73- 82.

Asadu, C.L.A., Nnaji, G.U. and Ezeaku, P.I. (2012). *Conceptual issues in pedology*. University of Nigerian Press Limited, University of Nigeria, Nsukka, Nigeria. 34 – 57.

Blake, G.R and Hartage KH (1986). Bulk density. In Klute A (Ed) Methods of Soil Analysis Part 1 American Society of Agronomy 409 Madison Wisconsin, 364-375.

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

Bremner and Mulvanney (1982) Total nitrogen. In: Page A et al (Eds) Methods of soil analysis part 2 ASA, Madison, Wisconsin, pp 595-624.

Celik, I. (2005). Land use effects on organic matter and physical properties of soil in the southern Mediterranean highland of turkey. Soil and Tillage Research 83, 270 – 277.

Chaudhari, P.R., Ahire, D.V., Ahire, V.D., Chkravarty, M., and Maity, S. (2013). Soil bulk density as related to soil texture, organic matter content and available total nutrients of Coinboire soils. *International Journal of Science and Research Publications* 3 (2), 1 - 8

Chokor, J.U and Egborah, J.O (2018). Effect of Land use types on selected soil physical and chemical properties in the Univeristy of Benin Nigeria Journal of Soil Scince 28 (1), 276 -286.

CC BY NC SA

Chukwuebuka C. Okolo , Girmay Gebresamuel , Amanuel Zenebe , Mitiku Haile, Jephter E. Orji, Chinyere B. Okebalama, Chinedu E. Eze, Emmanuel Eze and Peter N. Eze (2023). Soil organic carbon, total nitrogen stocks and CO2 emissions in top and sub-soils with contrasting management regimes in semi-aridenvironments. Scientific Reports (2023) 13:1117 https://doi.org/10.1038/s41598-023-28276-x

Egwu, P.N., Edeh, C.S., Mbah, C.N, Okoro, G., Nwogbaga, A.C., Orji, J and Mbah E.C (20230 Changes in the Properties of an Ultisols ammsnded with Dung and its effects on Okra Yield in Abakaliki Southeast Nigeria. Int'l journal of Agric. And Rural Devt.pp6689-6693.

Ezeaku, P.I., Eze, F.U. and Oku, E.J. (2015). Profile distribution and degradation of soil properties of an Ultisol in Nsukka Semi-Humid Area of Nigeria. African Journal of Agriculture Research,10 (11), 1306 – 1311.

Enwezor, W.O., Udo, E.J., Usoro N.J., Ayotade K.A., Adepetu, J.A., Chude, V.O and Udegbu, C.I. (1989). *Fertilizer use and management practices for crops in Nigeria*. Series 2. Federal Procurement and Distribution Division, Federal Ministry of Agriculture, Water Resources and Rural Development, Lagos. 119 – 121.

Fedaku, A., Kibebew, K.A, Bobe, B.A. and. Asmare, M.B. (2018). Characterization and classification of soils of Yikalo subwatershed in lay Gayint District, Northwestern Highlands of Ethiopia Endalkachew. Eurasian Journal of soil.

Federal Department of Agricultural Land Resources (FDALR) (1999). Status of agricultural landuse in Nigeria. In: evolving an effective agricultural landuse policy for Nigeria. Abuja, Federal Ministry of Agriculture and Natural Resources, P. 165.

Fawole, O.A., Ojetade, J.O., Muda, S.A. and Amusan, A.A. (2016). Genesis and classification of soils on a toposequence underlain by mica schist in Ife Area, Southwestern Nigeria. *Global Journal of Science Frontier Research: Agriculture and Veterinary* 16 (7), 31 - 42

Food and Agricultural Organization (FAO) (1999). Guidelines for land use planning. FAO Development series. FAO Rome, p. 96.

Grossman, R.B and Reinsch, T.G, (2002) Bulk density and linear Extensibility core method. In Dare, J. H. and Topp. G.C Eds., Methods of soil Analysis. Part 4. Physical methods. SSSA incorporated.

Gee, G.W and Bander J.W (1986). Particle size Analysis. In: Klute, A. (eds). Methods of soil Analysis. Part 2: Chemical and Microbiological properties. 2nd ed. Agron . Monograph 9, ASA and SSSA, Madison, WI, USA . pp 320-376.

Gebeyaw, T. (2007). Soil fertility status influenced by different land uses in Maybar areas of south wello zone, North Ethopia. An MSc thesis submitted to the faculty and department of plant sciences, school of graduate studies, Haramaya University.

Hacisalihoglu, S. (2007). Determination of soil erosion in a steep hill slope with different land use types, A case study in Metesdorf (Rumertal/ Germany). *Journal of Environmental Biology*, 28, 433 – 438.

Kekong, M.A; Attoe, E. E and Adiaha, M. S. (2018). Effect of nitrogen fortified rice mill waste on soil chemical properties and yield of maize in Nigeria. Pp 331 – 337.

Kolo, J. (2019). Investigation of topographic influence on soils supporting *Cannibis sativa* and their alternative use for rice production in Southwestern Nigeria. Unpublished PHD Thesis at Soil Science Department, University of Nigeria, Nsukka. 87p

Mbah, C.N and Idike, F.I. (2011). Carbon storage in Tropical Agricultural soils of South Eastern under different Management Practices. International Research Journal of Agricultural SC and soil SC. Vol. 1(2), pp 053-057.

Misir, N. M.; Misir, U.; Karahalil and Yavuz, H. (2007). Characterization of Soil Erosion and Its Implication to forest management. *Journal of Environmental Biology*, 28, 185 – 191.

McLean, E.O. (1965). Aluminum. Pp 978-998. In: C.A. Black (Eds.). Methods of soil analysis. Agronomy. No 9. Part II. American society of Agronomy, Maidson, Wisconsin. USA.

Meysner, T., Szajdak, L. and Kus, J. (2006). Impact of the farming systems on the content of biologically active substances and the forms of nitrogen in the soils. *Agronomy Research,*4, 531 – 542.

Mohammed, Y. M. (2017). Impact of landuse and management practice on soil physical and chemical quality indicators of vertisols at Pawe North Western Ethiopia. *African. Journal. Agric. Res.* 12(15), 1306 – 1313.

Nelson, D.W and Sommers, L.E (1998). Total organic carbon and organic matter. In: Methods of soil analysis, 3rd Ed. Spaus D.L; page A.L..Helmke, P.A Leoppert, R.H; Soltanpour, P.N., Tahatabai M.A and Johnson, C.I (Eds) Amenrican society of Agronomy; Madison, WI, USA pp, 961-1010.

Nsor, M.E. (2017). Pedogenesis, classification and management implications of soils derived from Nanka sands of false bedded sandstones lithology in Orumba North L.G.A, Southeastern, Nigeria. Proceeding of the 41st Annual Conference of Soil Science Society of Nigeria held between 13 - 17th March, 2017 at ATBU, Bauchi, Nigeria. 195 – 204.

Nsor, M.E and Adesemuyi, E.A (2018) Nature, properties and management of soils derived from an acid and basic igneous rock parent material in southern Nigeria. *Nigeria Journal of Soil Science*, 28 (1), 161 – 172.

Nwite,J.N, Orji J.E and Okolo C (2018). Effect of different land use systems on soil carbon storage and structured land use systems on soil carbon storage and structured indices in Abakaliki, Nigeria. Indian journal of ecology 45 (3), 322-327.

CC BY NC SA

Oguike, P. C and Mbagwu, J. S. C. (2009). Variations in some physical properties and organic matter content of soils of coastal plain sand under different landuse types. World Journal of Agricultural Science 5(1), 63 – 69.

Popoola, E.O and Mgbonu, K (2018). Variability in soil properties of the different land use types in federal college of Education Kontagora, Niger state, Nigeria. In: Oluwatosin G.A, Ande O.T, Adediran J A and Anikwe M.A.N (eds). Sustainable management of soil and water resources for food security, climate change adaptation and mitigation. Proceedings of the 42nd Annual Conference of the Soil Science Society of Nigeria, 22-30 pp.

Thomas, E.Y and Oke O.S (2018) Assessment of some trace elements from selected soil along the top sequence in Ibadan, South western Nigeria. Proceedings of the 42^{nd} Annual Conf. of the Soil Science Society of Nigeria p 434-447.

.Uchenna, S.O., Agbani, L., Ihem, E. and Onyegbule, U (2017). Influence of land use types on soil properties and micronutrients concentrations on soils of similar lithology in Owerri, Southeast Nigeria. Journal of Agricultural Science .4, 1- 9

.Uzoho, B.U, Ekpe I.I., Ahukaemere, C.M., Ndukwu, B.N., Okoli N.H., Osis F.A and Chris-Emenyeonu, C.M. (2014). Nitrogen status of soils of selected land uses of cropping systems in the humid tropical rainforest, Southeastern Nigeria. *Advances in Life Sciences and Technology* 25: 24 – 33.

Vogelmann, E.S., Reichert, J.M., remert, D.J. Mentges, M.I., Vieira, D.A, Peixotode Baros, C.A, and Fasimmirin, J.T (2010). Water repellency in Soils of humid subtropical Climate of Rio Grande do sul, Brazil. Soil Till. Res. 110, 126-133.

Wang, J., Projietu, V.Q. and Liding, C. (2001). Soil nutrients in relation to land use and landscape position in the semi-arid small catchment on the loess plateau in China. *Journal of Arid Environment* 48, 537 - 550 63.

Yihenew, G.S. and Getachew A. (2013). Effect of different land use systems on selected physicochemical properties of soils in North-western Ethopia. *Journal Agricultural. Science.* 5(4), 112 – 120.