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# Determination of the Effect of Changes in Climatic Factors on the Variations in Soil Physicochemical Properties of Farm Settlements located in Ogun State, Nigeria

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**ABSTRACT:** The study of the response of soil to climate change is of fundamental importance for sustainability of life through agriculture. This paper determines variations in physicochemical properties of farm settlements soils, assesses the effect of changes in climatic factors (temperature, relative humidity, and rain-fall) on these soil physicochemical properties and its implication on plant growth. Soil samples were collected from two farm settlements in the major geological zones in Ogun State Southwest, Nigeria. Physicochemical properties of the collected soil samples were determined using standard methods and metrological data were collected from metrological offices in the state. The result of the soil physicochemical properties ranges between; 5.84-6.39 (pH), 14.6-24.9 g/kg (organic carbon (O.C)), 15.9-19.9 mg/kg (phosphorus), 0.99-1.90 g/kg (nitrogen), 2.95-10.3 cmol/kg (cation exchange capacity (CEC)), 0.21-0.33 (exchangeable acidity), 78.1-89.2 (% sand), 5.70-10.2 (% clay) and 4.18-11.8 (% silt). Significant seasonal variations were found in the results obtained from the two farm settlements in properties like: pH, organic carbon and N at 0.05%. Higher C/N ratio recorded in some of the analysed soils may lead to the release of $CO_2$ which is a greenhouse gas. Variations observed in all the climatic factors considered in this study with O.C, CEC, % clay and % silt at $p<0.01$ can be used to assess the effect of climate change on soil health and assist in devising climate adaptive strategies. In other to reduce the negative implication of these variations on plant growth, irrigation facilities must be provided in the studied farms.

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Poor agricultural practice, climate change and land degradation have caused tremendous change in the physicochemical properties of agricultural soils resulting in low productivity (Brevik, 2013). This is currently responsible for food insecurity in many developing countries, particularly, Nigeria (Birara *et al.,* 2015). One way to mitigating against the challenges of climate change on soil is to examine the relationship between soil physiochemical properties and change in climatic factors.

Climate has direct and indirect impacts on many aspects of agriculture. Climate change has been reported to cause changes in global temperature, precipitation patterns (Trenberth *et al.,* 2007), and changes in soil processes and properties. This invariably leads to redistribution of soil nutrients and contaminants from available form to unavailable form or vice-versa. Majorly, redistribution is caused by change in physicochemical properties of the soil like: change in the pH, organic matter content, and oxidation/reduction status (Fatubarin and Olojugba, 2014). Decomposition of organic matter in soil can bring about the release of greenhouse gases like; $CO_2$ and $NH_3$.

Understanding the climatic effect and its adaptation requires evaluation of the interdependence between climatic factors and soils properties. This is germane because climate change can lead to higher variability in crop performance if no adaptation strategies are developed. Most of the farmers in Nigeria farm settlements are illiterates, practice rain-fed agriculture and do not monitor physicochemical properties of their farms (Olaoye and Rotimi, 2010). Evidence of seasonal variation in soil properties and the possibility of dry season farming needed to be giving attention now that the government is advocating a-year-round farming system to meet with the demand of her ever increasing population and also to fight against the ever risen effect of climate change on agricultural produce. This paper is aimed at determining variations in soil physicochemical properties of farm settlements and assesses the effect of changes in climatic factors on these soil physicochemical properties

## MATERIALS AND METHODS

*Description* **of the study area:** The study area is located in Ogun state, south-west, Nigeria. It lies

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within latitude 6°N and 8°N and longitude 2.5 °E and 5 °E (Figure 1). The State falls within the rain forest region of Southwest Nigeria. It has been classified and specifically placed in the humid tropical region due to lack of cold season, high precipitation, low pressure and high relative humidity. There are two main alternating rainy and dry seasons (Solanke, 2014). The area has a bimodal rainfall, with peaks between June-July and September-October. The diurnal temperature ranges from highest in November to May and the lowest from June to October.

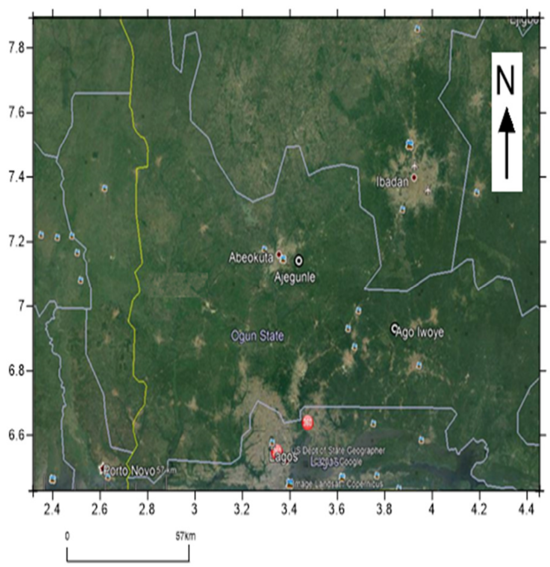


**Fig 1**: Map of Ogun State showing the sampling areas (Extracted Google map)

*Collection of Metrological Data***:** The regional climate characteristics data (rainfall, temperature, and relative humidity) with respect to Ogun State were collected for this study period from the meteorological records kept by the meteorological offices in the state (Ijebu-Ode and Abeokuta) under the Federal Ministry of Aviation (FMA), Abuja.

*Sampling:* The sampling area comprises two farm settlements; Ago-Iwoye and Ajegunle located in major geological zones in the state (Figure 1). Sampling were conducted in dry (November, December and February) and rainy seasons (May, July and September), between 2011 and 2012. Each sampling site (arable farmland and oil palm plantation) were stratified into three segments and plot of 100m × 100m approximately was randomly selected from each segment to make three sampling plots per site. In each season, fifty-four soil samples were collected from each farm settlement and two hundred and sixteen samples collected in the four seasons of this study. Collecting equipment include soil auger, hand trowel, plastic spatula and tape rule. Samples co-ordinate points were read using Geographical Position System (GPS). All soil samples, collected into well labeled polythene bags were transported to the laboratory for analysis.

*Laboratory Analysis***:** The soil samples were air-dried for two weeks at ambient temperature, pulverized and passed through a 2 mm mesh sieve, prior to soil physical and chemical analysis. Soil particle-size distribution was measured by the Bouyoucos densimeter method modified by Di Stefano et al. (2010) and organic carbon (O.C) was determined using the modified Walkley-Black method (Silva et al. 1999) Soil Total Nitrogen (TN) was determined by wet-oxidation procedure of the Kjeldahal method while available phosphorus was measured colorimerically after extraction with diluted $HCL/NH_4F$ (Bray and Kurtz, 1965). Soil extracts used for determination of exchangeable bases were obtained by leaching the soil using neutral 1 M ammonium acetate solution while cation exchange capacity was determined by the summation method (Chapman, 1965). Exchangeable acidity was determined by barium chloride-triethanolamine method.

*Statistical Analysis:* Results obtained from the analysis were analyzed using descriptive and inferential statistical techniques. Correlation analysis was carried out to determine the degree of association among the soil properties and climatic factors using the software Statistical Package for Social Sciences, SPSS Version 17.

## RESULTS AND DISCUSSION

*Climatic Factors: Rainfall*: Rainfall in the study area occurs with high spatio-temporal variations, as shown in figure 2. It varies from less than 20 mm in January to more than 200 mm in June and July and relatively lower (140 mm) during the interposed "August Break".

Highest values were recorded in July and September while lowest was recorded in December and January (Fig. 2). The annual precipitation values recorded during the study period were above 1000 mm (Ajegunle: 1625.47 mm, 1277.64 mm while: Ago-iwoye 1820.60 mm, 1761.40 mm) and there is decrease in amount of rainfall recorded between 2011 and 2012 (Fig 2). This may have implication on depletion and enrichment trends of soil nutrients and properties (Rabbi *et al.,* 2015). Precipitation has been predicted to increase in high latitudes, and decrease in most subtropical land regions-some by as much as about 20 percent (IPCC, 2007).

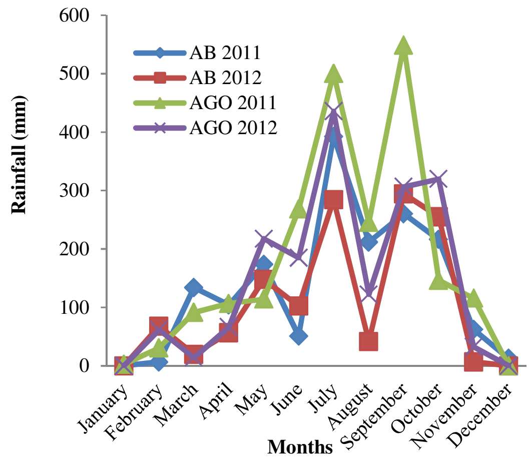


**Fig. 2:** Rainfall distribution in the studied sites**:** Note: AB-Abeokuta and AGO-Ago-Iwoye

*Temperature:* The mean annual temperatures of the sampling locations, collected from the meteorological stations, were 27.4 °C at Ajegunle and 27.2 °C at Ago-Iwoye. The trend in the temperature recorded in the two stations are similar (Fig. 3) The maximum temperature varies between 25.1 and 25.3°C during the peak of the wet season and 29.4- 29.5°C at the onset of the wet season (February and March) at the two stations.

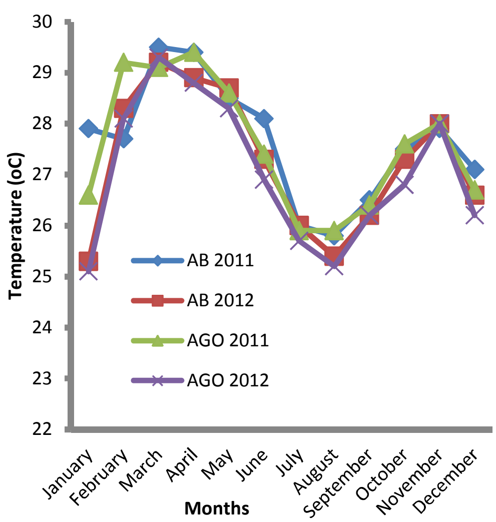


**Fig. 3:** Temperature distribution in the studied sites

Relative humidity: The relative humidity of the state is averagely high throughout the year (Fig. 4). This has been said to be attributable to the prevalence of moisture-laden tropical maritime air mass over the state for about 9 months in the year (Solanke, 2014).

The relative humidity varied between 72-80% in January and February to about 84.5-88% in June and July in the two stations. Mean relative humidity of the area is generally high (about 80%) with the peak between May and October.

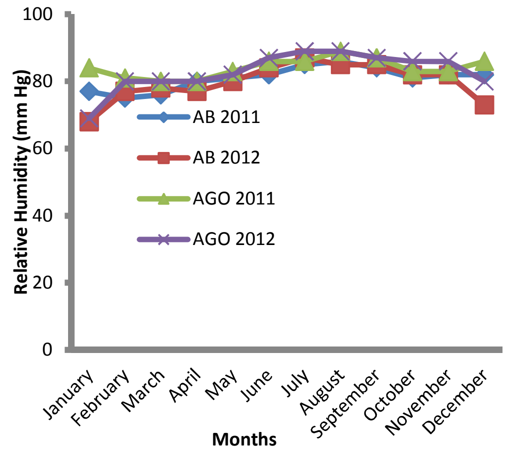


**Fig. 4:** Relative Humidity distribution in the studied sites

*Soil Physicochemical Properties:* Physicochemical properties of soil samples collected from arable farmland and oil palm plantation of the three farm-settlements (Ago-Iwoye, Ajegunle, and Sawonjo) for the rainy and dry seasons are presented in Tables 1 and 2.

Variation was discovered in the result of the physicochemical properties of the sampled soils from the two farm settlements based on season, land use and location.

*Variation in soil properties based on land use***:** In terms of land use, though, physicochemical properties of soil samples from oil palm plantations were found to be more than that of arable, T-Test analysis at 0.05% C.L showed that no significant difference exist in all the results obtained for the two land use (Arable and oil palm) except for organic carbon, organic matter, nitrogen and Carbon: Nitrogen ratio (Table 1).

Variation observed in soil properties of soils from different agro-ecosystems has been attributed to differences in the plant soil requirements and root type (Osobamiro and Adewuyi, 2015).

Soil quality also varies due to many external factors such as land use, soil and crop management, environmental interactions, societal goals as well as variation in natural conditions (Liebig *et al.,* 2004).

**Table 1** Mean value of physicochemical properties of soil under the two different agro-ecosystems in the three Farm Settlements

| | | Mean ± S.D | Sig. (2-tailed) | Is Mean Diff sig.? | Range |
|---|---|---|---|---|---|
| pH | Arable | 6.05±0.31 | 0.15 | Not sig | 5.50-6.50 |
| | Oil Palm | 6.18±0.34 | 0.15 | | 5.40-6.80 |
| Organic carbon g/kg | Arable | 15.9±5.1 | 0.00 | Sig | 9.80-26.5 |
| | Oil Palm | 21.4±6.9 | 0.00 | | 12.6-36.1 |
| Organic matter g/kg | Arable | 27.6±9.0 | 0.00 | | 16.9-45.6 |
| | Oil Palm | 37.5±12.3 | 0.00 | Sig | 22.7-63.7 |
| Phosphorus mg/kg | Arable | 19.2±5.9 | 0.08 | | 8.66-29.3 |
| | Oil Palm | 16.3±4.9 | 0.08 | Not sig | 3.54-23.9 |
| Nitrogen g/kg | Arable | 1.12±0.41 | 0.00 | | 0.68-2.20 |
| | Oil Palm | 1.74±0.64 | 0.00 | Sig | 1.06-3.60 |
| CEC cmol/kg | Arable | 6.27±3.31 | 0.56 | | 2.69-11.1 |
| | Oil Palm | 5.73±3.03 | 0.56 | Not sig | 2.56-12.0 |
| Exchangeable acidity | Arable | 0.23±0.06 | 0.28 | | 0.15-0.31 |
| | Oil Palm | 0.26±0.12 | 0.29 | Not sig | 0.10-0.60 |
| % Sand | Arable | 84.1±4.7 | 0.39 | | 76.4-89.4 |
| | Oil Palm | 85.4±5.3 | 0.04 | Not sig | 72.4-92.6 |
| % Clay | Arable | 7.83±2.07 | 0.87 | | 5.40-11.0 |
| | Oil Palm | 7.73±1.76 | 0.87 | Not sig | 4.80-11.0 |
| % Silt | Arable | 8.08±3.38 | 0.27 | | 4.00-14.4 |
| | Oil Palm | 6.90±3.83 | 0.27 | Not sig | 1.40-16.6 |
| C/N | Arable | 14.2 | 0.02 | | 14.4-12.0 |
| | Oil Palm | 12.3 | 0.02 | Sig | 7.50-17.7 |

**Table 2:** Mean values of soil physicochemical properties in the rainy and dry seasons of the three Farm Settlements.

| | Season | Mean ± S.D | Range | Sig. (2-tailed) | Is Mean Diff sig.? |
|---|---|---|---|---|---|
| pH | Dry | 6.32±0.26 | 6.23-6.39 | 0.00 | Sig |
| | Rain | 5.91±0.25 | 5.84-6.04 | 0.00 | |
| Organic carbon | Dry | 16.0±5.0 | 14.6-18.7 | 0.01 | Sig |
| | Rain | 21.3±7.1 | 15.9-24.9 | 0.01 | |
| Organic matter | Dry | 27.5±8.5 | 24.9-31.9 | 0.00 | Sig |
| | Rain | 37.6±12.5 | 29.5-43.8 | 0.00 | |
| Phosphorus | Dry | 18.0±6.0 | 16.5-19.9 | 0.71 | Not sig |
| | Rain | 17.4±5.1 | 15.9-18.3 | 0.71 | |
| Nitrogen | Dry | 1.47±0.37 | 1.15-1.72 | 0.64 | Not sig |
| | Rain | 1.39±0.80 | 0.99-1.90 | 0.64 | |
| CEC | Dry | 3.22±0.41 | 2.95-3.55 | 0.00 | Sig |
| | Rain | 8.78±2.00 | 7.61-10.3 | 0.00 | |
| Exch. acidity | Dry | 0.23±0.06 | 0.21-0.25 | 0.19 | Not sig |
| | Rain | 0.26±0.11 | 0.21-0.33 | 0.20 | |
| % Sand | Dry | 88.2±2.8 | 86.6-89.2 | 0.00 | Sig |
| | Rain | 81.3±4.4 | 78.1-83.2 | 0.00 | |
| % Clay | Dry | 6.69±1.39 | 5.90-7.55 | 0.00 | Sig |
| | Rain | 8.87±1.73 | 7.70-10.2 | 0.00 | |
| % Silt | Dry | 5.15±2.18 | 4.18-5.83 | 0.00 | Sig |
| | Rain | 9.83±3.27 | 8.63-11.8 | 0.00 | |
| C/N | Dry | 11.0 | 9.41-12.8 | 0.01 | Sig |
| | Rain | 15.9 | 12.1-19.6 | 0.01 | |

**CEC- cation exchange capacity *Exch. Acidity- Exchangeable acidity*

**Table 4**: Correlation analysis of climatic factors of the studied site with soil properties

| | pH | OC | OM | P | N | CEC | Sand | Clay | Silt |
|---|---|---|---|---|---|---|---|---|---|
| Rainfall mm | $-0.55^{**}$ | $0.38^{**}$ | $0.39^{**}$ | -0.13 | -0.08 | $0.92^{**}$ | $-0.82^{**}$ | $0.70^{**}$ | $0.77^{**}$ |
| *Temp. $^0$C | $0.64^{**}$ | $-0.43^{**}$ | $-0.48^{**}$ | 0.02 | 0.14 | $-0.56^{**}$ | $0.46^{**}$ | $-0.36^{*}$ | $-0.45^{**}$ |
| *Rel. Hum. % | $-0.64^{**}$ | $0.38^{**}$ | $0.42^{**}$ | -0.13 | -0.10 | $0.83^{**}$ | $-0.69^{**}$ | $0.55^{**}$ | $0.67^{**}$ |

**Temp- Temperature and Rel. Hum. - Relative Humidity p<0.01*

*Seasonal Variation in Soil Properties:* The result in Table 2.0 indicated that there are seasonal variations in the soil properties of the soil samples from the two farm settlements. There is increase in the values of most of the parameters determined in rainy season, these include; organic carbon, organic matter, CEC, Exchangeable acidity, % clay and % silt. Significant variations was observed in soil properties such as;

pH, organic carbon, organic matter, CEC, % sand, % clay and % silt at p=0.05. This has great implication on the soil fertility and dry season farming unless irrigation facilities are provided and organic content of the soil is supplemented.

pH of a soil is crucial because crops grow best in a narrow pH range (pH 6- 8) which can vary among crops. pH of the soil solution is very important because soil solution carries in it nutrients such as N, P, and K that plants need in specific amounts to grow (Osemwota, 2010). If the soil solution is too acidic, plant cannot utilize N, P and K and other nutrients they need and plants are more likely to take up toxic metals and may eventually die of toxicity (Sylvia *et al.,* 1998). Low pH values observed in soils from arable farms (Though not significant), could be attributed to the effects of inorganic fertilizers used in crop production, leaching of basic cations, following high intensity of rainfall prevalent in the region, porous nature of the soils and the accumulation of aluminum ions. Lower pH recorded in rainy season may be due to the increase in the degree of ionization releasing more $H^+$. This finding corroborates the report of Ndukwu *et al.* (2010) who stated that soils under continuous cassava cropping and oil palm plantation have low pH.

Different land-use causes variation in the levels of soil organic matter contents. This is obviously attributed to the addition of plant residues on the surface of these soils and their reduced rate of disturbance. The lower organic matter content in arable soil is attributed to anthropogenic factors (e.g. reduced biomass return as a result of removal of plant) that enhance organic matter loss by hastening oxidation. The relatively better organic matter content in the soil of plantation may be attributable to higher biomass input (Gebrelibanos and Assen, 2013).

All the studied soils are sandy with small clay content which was found to increase in rainy season (Table 2.0). Virtually all the soil analyzed contains high percentage of sand (they are coarse texture soils). Though sandy soils tend to have a lower CEC (Masteron and Hurley, 2002) but, the contribution of SOM to CEC has been reported to be higher in sandy and silt soils than in clayey soil (Dube *et al.,* 2001). This may account for the little higher CEC recorded in rainy season with increase in SOM in the studied sites. Sandy soils are much more sensitive to climatic fluctuations than the loam and clay soils (Brevik, 2013).

Seasonal variation in physical and chemical properties of soil which can be as a result of changes in pH, organic matter, and oxidation/reduction status, change over time and difference in location or soil depth (Palm *et al.,* 2007) usually leads to redistribution of heavy metals in soil (Shiowatana *et al.,* 2001).Increase in the physicochemical properties observed in rainy season for the two agro-ecosystems and lower pH may be attributed to increase in precipitation, high clay content; increase in the rate of decomposition of organic materials leading to high CEC (Shiowatana *et al.,* 2001).

*Soil Properties and Climate Change:* There are a large number of agronomic-ecological interactions that occur in a world with increasing levels of $CO_2$, higher temperatures and a more variable climate. The two most important soil properties that greatly affect climatic factors are the carbon and nitrogen cycles; these are important components of soil organic matter (Brady and Weil, 2005). Human management of soils can have a great impact on the balance of emission of these greenhouse gasses (Carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$)) from soils, and therefore influences global climate change (Brevik, 2012).

The more the C/N ratio is above 10-12; the greater the chances of these nutrients being immobilized by micro-organisms which render them unavailable to plants (Brady and Weil, 2008). Higher C:N ratios greater than 23, have been shown to favour slow degradation of residues by the associated micro-organisms (Eiland *et al.,* 2001), higher mineralization effects (Goma, 2003) and limited N in the soil which may lead to reduced crop yields (Uriyo *et al.,* 1979). The C/N ratio in rainy season is higher than in dry season in all the sampled soils. Arable soils have the highest C/N ratio though the maximum value for oil palm soil is higher than that of arable soil (Table 1). Excess C may be released in form of $CO_2$ when C/N ratio is low, as recorded in dry season in most of the sampled sites; organisms make use of the available carbon and excess N is loss as ammonia. Both $CO_2$ and $NH_3$ are strong greenhouse gases causing global warming and climate change.

Rainfall and % Relative humidity showed significant negative correlation with pH, and % sand and significant positive correlation with O.C, O.M, CEC, % clay and % silt at p<0.01 (Table 4). Organic carbon strongly depends on environmental conditions that influence soil proprieties such as local climate, temperature, humidity, insulation, topographic profile, land-use (Dube *et al.,* 2001; Rabbi *et al.,* 2015). This is confirmed in the strong significant positive correlation observed between organic carbon and rainfall and relative humidity. Decrease or fluctuation in rainfall predicted as one of the effect of climate change in the tropics will definitely bring about a decrease in soil properties such as; organic matter content, CEC, % clay and silt (Fatubarin and Olojugba, 2014). To favor dry season farming and nullify the effect of prolong draught being experience as a result of climate change, irrigation facilities must be provided and this may account, in part, for the commonly observed good performance of crops during dry season irrigation farming.

Soils are expected to become more susceptible to erosion by wind and/or water when rainfall increases through climate change and anthropogenic activities (Sivakumar, 2011). Therefore, as climate change increases soil erosion, this will have great impact on the soil properties; reducing soil fertility thereby causing food shortage.

Temperature gives a significant negative correlation with O.C, O.M, CEC and % silt. Meaning that as temperature increases due to global warming, O.M and CEC in the soil will decrease which will invariably affect crop yield. Increased temperature is likely to have a negative effect on C allocation to the soil, leading to reductions in soil organic C (Brevik, 2013). An increase of $10^{o}C$ in temperature has been reported to double bio-chemical reaction rates, which can exerts important effect on soil chemistry because most chemical reactions are highly sensitive to temperature changes (Elder, 1989). Changes in temperature recorded in the locations under study were not up to $5^{o}C$, since the state has been known to maintain a more or less almost uniform temperature throughout the year. Changes in climatic factors have great impact on pH, organic matter, CEC, P, and N based on the findings from this study.

*Conclusion:* Variations in climatic factors considered in this study have significant effect on soil physicochemical properties (pH, org matter, CEC, and particle size) which could be used to assess the effect of climate change on soil health and assist in devising climate adaptive strategies. In other to favor a-year-round farming system and nullify the effect of prolong draught being experience as a result of climate change, irrigation facilities must be provided in the studied farms.

## REFERENCES.

Allen, DE; Singh, BP; Dalal, RC (2011). Soil health indicators under climate change – a review of current knowledge. In: (Singh BP; Cowie AL; Chan KY (ed) “Soil Health and Climate Change.” Soil Biology Series, pp. 25-45, Springer-Verlag, Berlin, Heidelberg.

Akanni, CO (2000). ‘Physical Environment’ in Onakomaiya, SO; Odugbemi OO; Oyesiku, OO; Ademiluyi, IA (ed) Ogun State: Local and Regional Perspectives, Centre for Sandwich Programmes (CESAP) Ogun State, University, Ago-Iwoye. Pp.14-26

Bouyoucos, GJ (1962). Hydrometer method improved for making particle size analysis of Soils. *Agro. J.* 5(3): 464-465.

Brady, NC, Weil, RR. (2008). The Nature and Properties of Soils, 14th (ed); Pearson Prentice Hall: Upper Saddle River, NJ, USA.

Bray, HR; Kurtz LT (1965). Determination of total, organic and available forms of phosphorus in soils. *Soil Sci.* 5(9): 45-59.

Brevik, EC (2013). The Potential Impact of Climate Change on Soil Properties and Processes and Corresponding Influence on Food Security. *Agric.* 3:398-417.

Brevik, EC (2012). Soils and climate change: Gas fluxes and soil processes. *Soil Horiz.* 5(3), doi:10.2136/sh12-04-0012.

Birara, E; Mequanent, M; Samuel T (2015). Assessment of Food Security Situation in Ethiopia: A Review. *Asian J. Agric. Res.* 9: 55-68.

Chapman HD (1965). Cation exchange capacity. In Black CA. *et al*., (ed) Methods of soil analysis. Part 2.American Society of Agronomy, Madison. pp. 891-901

Di Stefano, C., Ferro, V. and Mirabile, S. (2010). Comparison between grain-size analyses using laser diffraction and sedimentation methods. *Biosystems Engineer.* 106: 205-215

Dube A; Zbytniewski R; Kowalkowski T; Cukrowska E; Buszewski B (2001). Adsorption and Migration of Heavy Metals in Soil. *Polish J. Environ. Stud.* 10:1-10.

Eiland F; Klamer M; Lind AM; Leth M; Baath E (2001). Influence of initial C/N ratio on chemical and microbial composition during long term composing of straw. *Microbial Ecol.* 41: 272-280.

Elder, J.F (1989). Metal biogeochemistry in surface-water systems-A review of principles and concepts: U.S. *Geological Survey Circular* 11013. 43p

Fatubarin, A; Olojugba, M R. (2014). Effect of rainfall season on the chemical properties of the soil of a Southern Guinea Savanna ecosystem in Nigeria. *J. of Ecology Natural Environ.*. 6: 182- 189.

Gebrelibanos, T; Assen, M (2013). Effects of Land-Use/Cover Changes on Soil Properties in a Dryland Watershed of Hirmi and its Adjacent Agro Ecosystem: Northern Ethiopia International *J. Geosci. Res.* 1: 45-57.

Goma, HC (2003). Potential for changing traditional soil fertility management systems in the wet miombo woodlands of Zambia: the chitemene and fundikila systems: In: Gichuru, MP; Bationo, A; Bekunda, MA; Goma, HC; Mafongoya, PL; Mugendi, DN; Murwira, HK; Nandwa, SM; Nyathi, P; Swift, MJ (ed). (2003). Soil fertility management in Africa: a regional perspective, pp. 187-218.

Hansen, J; Sato, M; Kharecha, P; Russell, G; Lea DW; Siddall, M. (2007). Climate change and trace gases. *Philos. Trans. R. Soc. A.365*: 1925–1954.

Liebig, MA; Tanaka, D; Wienhold, BJ (2004). Tillage and cropping effects on soil quality indicators in the northern Great Plains. Soil Till. *Res. 78*: 131–141.

IPCC, Climate Change (2007).Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Parry, Martin, L; Canziani; Osvaldo, F; Palutikof;,Jean, P; van der Linden, Paul J; Hanson, Clair E (ed)]. Cambridge University Press, Cambridge, United Kingdom, 1000 pp

Masteron, WL; Hurley, CN (2002). Chemistry: Principle and reaction. *2nd Saunders College Publishing. Fortworth Texas.*

Ndukwu, B; Idigbor, CM; Onwudike, SU; Chukwuma, MC (2010). Evaluation of the Effects of Selected Agricultural Land Utilization Types on Soil Properties in Nando Southeastern Nigeria. Inter. *J. Sustainable Agric.* 2: 34-38.

Olaoye, JO; Rotimi, AO (2010). Measurement of agricultural mechanization index and analysis of agricultural productivity of farm settlements in Southwest Nigeria. *Agric. Eng. Int. J.* 12: 125-134.

Osemwota, OI (2010). Effect of Abattoir Effluent on the Physical and Chemical Properties of Soils. *Environ Monit Assess*, 167:399 – 404.

Osobamiro, MT; Adewuyi, GO (2015). Levels of Heavy Metals in the Soil: Effects of Season, Agronomic Practice and Soil Geology. *Journal of Agricultural Chemistry and Environment* **4**: 109-117.

Palm, C; Sanchez, P; Ahamed, S; Awiti, A (2007). Soils: A Contemporary Perspective, *In: Annual Review Environ. Res.* 3(2): 99-129.

Rabbi, ZMF; Tighe, M; Delgado-Baquerizo, MA; Cowie A; Robertson, F (2015).Climate and soil properties limit the positive effects of land use reversion on carbon storage in Eastern Australia. *Sci. Rep.*5: 1-10.

Shiowatana, J; Tantidanai, N; Nookabkaew, S; Nacapricha, DJ (2001). *Environ. Qual*. 30: 1195-1205

Silva, A. C; Torrado, P. V; Junior, J. de S. A. (1999). Methods of quantification of the organic matter of the soil. Revista da Universidade de Alfenas, 5, 21–26.

Sivakumar, MVK (2011). Climate and Land Degradation. In *Sustaining Soil Productivity in Response to Global Climate Change: Science, Policy, and Ethics*; Sauer, TJ; Norman, JM.; Sivakumar, MVK (ed) John Wiley & Sons, Inc.: Oxford, UK, pp. 141–154.

Solanke, MO (2014).Urban Socio-Economic Development and Intra-City Travel in Ogun State, Nigeria. *Ethiopian J. Stud. Manage.*7:202 – 209.

Sylvia, DM; Fuhmann, PG; Hartel, PG; Zuberer, DA, (ed) (1998). Principles and application of soil microbiology. *Upper saddle river*, New Jersy.

Trenberth, KE; Jones, PD; Ambenje, P; Bojariu, R; Easterling, D; Tank, AK; Parker, D; Rahimzadeh, F; Renwick, JA; Rusticucci M (2007). Observations: Surface and Atmospheric Climate Change. In Climate Change (2007)*: The Physical Science Basis*; Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Solomon, S; Qin, D; Manning, M; Chen, Z; Marquis, M; Averyt, KB; Tigno, M; Miller, HL (ed) Cambridge University Press: Cambridge, UK, pp. 235–336.

Uriyo, AP; Mongi, HO; Chowdhury, MS; Sing, BR; Semoka, JMR (1979). Introductory Soil Science. Tanzania Publishing House, Salaam. 232pp

Violante, AV; Cozzolino, V; Perelomov, L; Caporale, AG; Pigna, M. (2010). Mobility and Bioavailability of Heavy Metals and Metalloids in Soil Environments. *J. soil. Sci. Plant Nutr.* 10:268-292