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Research Article

Selected soil properties as influenced by cropping system and sampling depths in Igboora, Nigeria

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Abstract: The influence of cropping systems on some selected soil properties was studied at Igboora, Oyo State, Nigeria. The cropping systems evaluated included monocropping, intercropping, and uncultivated land as control. Soil samples were collected from each of these cropping systems at two depths (0-20 cm and 20-40 cm) with four replications. Data collected were subjected to analysis of variance (ANOVA) and the means separated using the Least Significant Difference (LSD) at 5% level of probability. The physico-chemical characteristics of the soil considered were significantly different among various cropping systems and soil sampling depth. The sand fraction of the soils decreased with soil depth while silt and clay fraction increased with soil depth. Except N, all other chemical characteristics of the soil (pH, OC and K) were highest in uncultivated cropping land. The values were 6.51, 1.7 % and 0.33 cmol kg^{-1} for pH, OC and K, respectively. However, available P was highest (4.93 mg kg^{-1}) in monocropping. In addition, all chemical characteristics (OC, pH, N, P and K) were observed to decrease with soil sampling depth. This study concluded that both cropping systems and sampling depth affects the soil properties in the area.

Keywords: Cropping systems, soil depth, organic carbon, soil fertility, soil properties

1. Introduction

The soil is a natural resource base for sustainable agriculture. Soil, a component of landscape occupies a central position in the landscape balance due to its diverse functions. It constitutes a dynamic system within which a series of changes such as addition, losses, modification and alterations constantly occur. These changes have been reported to directly affect the composition, properties and productive potentials of the soils (Akinbode, 1986; Oriola & Bamidele, 2012). Soil responds to improvement or deterioration in properties and fertility status due to anthropogenic activities. Humans have been to affects their environment as they respond to the changing conditions set by the environment and the environment's response to human manipulation, thereby creating a state of dynamic equilibrium that continues to adjust and re-adjust in space with time (Olofin, 2000). Thus, the consequences of man's activities in his immediate environment often led to a number of problems which may be positive or negative.

Human-induced changes in soil properties within a region or agricultural zone are well documented. For instance, irrigation farming practices has been reported to cause some soil chemical translocation in the soil (Oriola, 2004). Similarly, Adamu and Maharaz (2014) in their comparative study of the changes in soil fertility under two farming practices reported that soil under mixed cropping have higher levels of chemical properties than sole cropped plot. Recent studies have also shown that cultivation, residue management and land-use conversion continue to alter soil structure, nutrient dynamics, and microbial composition of the soil (Li et al, 2025). It is also important to note that physical, chemical, and biological properties of soil

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are essential for sustainable crop production. Hence, non-availability of any of these acts as limiting factor which could negatively impact the crop. The chemical properties of the soil such as organic carbon, total nitrogen, phosphorus, cation exchangeable capacity and exchangeable bases are in particular associated with the colloid fraction and affect nutrients availability, biota growing conditions, and in some cases, soil physical properties (Yakubu, 2012). For example, organic matter content is an indicator for soil quality and its fertility and may be lost through continuous cultivation (Lombin, 1999; Brady & Weil, 2002).

Different crops have been reported to exhibit various root distribution and growth habit, therefore under different cropping systems the network of root distribution varies (Millar and Turk, 2002). Thus, the crop combinations employed in cropping system practice directly influence the soil nutrient management and consequently crops yields and farmers' income. Additionally, land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization and leaching, etc. (Celik, 2005; Xiao-Li et al., 2010). Thus, effect of cropping systems on soil properties provides an opportunity to evaluate sustainability of agro ecosystem and the basic processes of soil degradation in relation to agricultural use. The resultant effects of these changes in soil properties are exhibited in the fertility status of the soil which can either increase or reduce crop productivity. Therefore, it has become very imperative that a good understanding of the effect of different cropping system on soil elements and fertility status is essential to enhance sustainable agricultural productivity and land resources management.

The dearth of information on cropping systems and land management as they affect soil properties in the Oyo State College of Agriculture and Technology, Igboora farm compelled the setting up of this research. Therefore, the objective of this study was to evaluate the influence of different cropping systems and sampling depths on some selected soil properties in Oyo State College of Agriculture and Technology, Igboora, Ibarapa Central Local Government Area of Oyo State.

2. Materials and methods

2.1. Description of study area

The study was carried at the Oyo State College of Agriculture and Technology, Igboora Oyo State, Nigeria. The different cropping systems was used as a guide for the sampling locations. The coordinates of the different cropping systems used for the experiment was taken with a Geographical Positioning System (GPS); Monocropping (Latitude 7.4085, Longitude 3.29414), Intercropping (Latitude 7.41053, Longitude 3.29855) and Uncultivated land (Latitude 7.40767, Longitude 3.29457). The monocropping, a cassava plot was established in 2014 and has since been receiving fertilizer application. This is where Cassava: Adding Value for Africa II (CAVA-II) used as research plot. The intercropping plot was established in 2009. It has

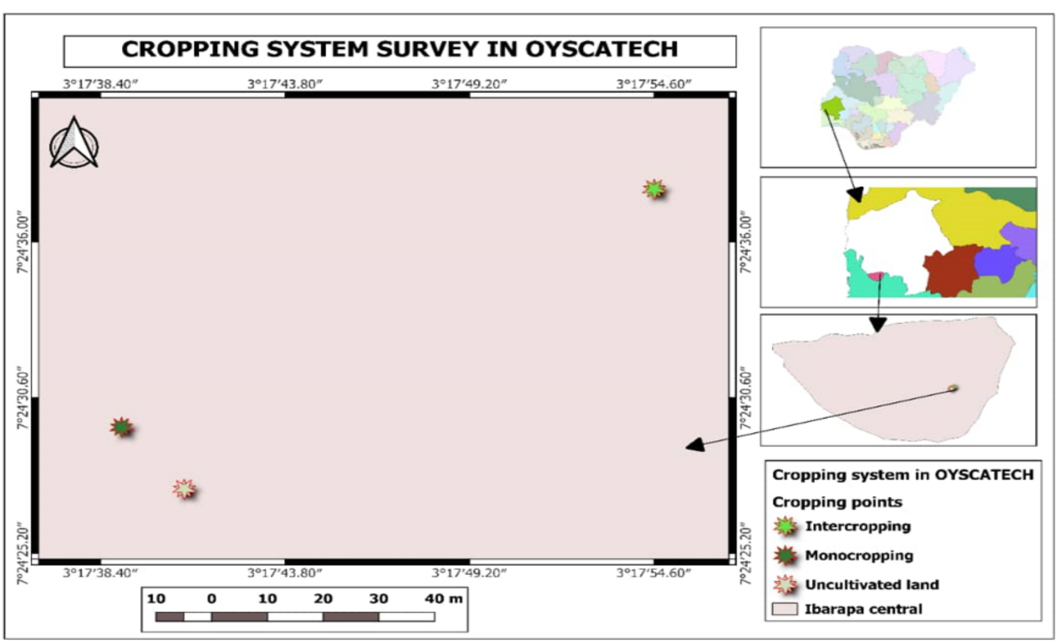

Figure 1: Map showing the various cropping systems where soil samples were taken for the experiment.

okra and pepper and no history of fertilizer use on this land. The Uncultivated land (control) has been in existence since the establishment of Oyo State College of Agriculture and Technology, Igboora in 2006 and has not been cultivated for use since that time. Igboora area of Oyo State has a bimodal rainfall pattern with rain usually commencing in late March or early April and ending in late October or early November with a short break in August. The mean annual rainfall is about 1,455 mm with maximum rainfall in July and September, while mean monthly temperature range between 27^{O}C and 30^{O}C

2. 2. Experimental details

The three cropping systems namely mono cropping, intercropping and uncultivated land were considered. The uncultivated land served as the control. Samples were randomly collected from each cropping system at different soil depths, surface (0-20 cm) and sub-surface (20-40 cm). This was replicated four times.

2.3. Soil sampling and analysis

Two sampling depths were selected for the following reasons: the soil depth (0-20 cm) is the average crop land plough layer in the study area and the soil depth (20-40 cm) constitute the average depth to which nutrients and clay particles are leached in a high rainfall area and fine roots of trees have a role in nutrient addition and recycling. Four soil samples were collected using soil auger from each cropping land used types. The samples were air dried and passed through a 2mm sieve prior to laboratory examination. Soil pH (1:2) in water was determined by glass electrode pH meter (IITA, 1982). Organic carbon was determined by chromic acid oxidation method (Walkley and Black, 1934). Total N was by regular macro kjeldahl procedure. Available P was by Bray -1 P method and P content determined colourimetrically from spectrophotometer using ammonium molybdate method (Bray and Kurtz, 1945). Exchangeable potassium (K) was extracted using 1 N neutral ammonium acetate solution. Potassium in the extract was determined using flame photometer.

Particle size analysis was by the use of hydrometer method (Bouyoucous, 1945). The percent of sand, silt and clay of the soil were used to determine the textural class using USDA textural triangle.

2.4. Statistical analysis

All the data collected were subjected to analysis of variance (ANOVA) using Genstest Statistical Package and means were separated using least significant difference (LSD) at 5 % level of probability.

3. Results and discussion

3.1. Effect of cropping systems on particles size analysis

The results of particle sizes analysis of the cropping systems is shown in Table 1. The sand proportion (88.20 %) of soil from uncultivated land was more than that from other crop land use (monocropping had 87.32 % while intercropping had 84.20 %). This value was significantly higher ($p<0.05$) than all other crop lands. In terms of silt fraction, soil from intercropping had the highest value of 10.40 % and the lowest value of 6.40 % from uncultivated land. Similarly, clay fraction (6.12 %) from soil in monocropping was higher than that from other crop lands used in the study area. Both intercropping and uncultivated cropping lands had the same clay value of 5.40 % which was lower than that of monocropping. All these values were significantly different at 5% level of probability.

Table 1: Effect of cropping systems on particle analysis

Cropping system	Sand %	Silt %	Clay %	Textural class
Monocropping	87.32	6.62	6.12	Loamy Sand
Intercropping	84.20	10.40	5.40	Loamy Sand
Uncultivated	88.20	6.40	5.40	Sand
LSD	0.03	0.030	0.03	

3.2. Effect of soil sampling depth (cm) on particle size analysis

The particle size analysis of different sampling depth is presented in Table 2. The result showed that top soil (0-20 cm) had the highest sand fraction (88.60%). However, in terms of silt and clay the sub-soil (20-40 cm) had the highest value of 9.74% and 5.74%, respectively. Thus, the result showed that particle size analysis of sand decreased with the sampling depth. On the contrary, the silt and clay fraction increase with depth. This observation revealed that the soil particle size analysis significantly ($p<0.01$) changes with soil depth in all the crop lands. Similar observations have been reported by Adugna and Abegaz (2015) in North East Ethiopia that particle size analysis varied with sampling depth. Kassa et al (2017) also noted sub-soil to constitute the average depth to which nutrients and clay particle are leached in high rain fall area.

Table 2: Effect of soil sampling depth (cm) on particles size analysis

Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
0-20	88.60	5.87	5.54	Sand
20-40	84.54	9.74	5.74	Loamy Sand
LSD	0.02	0.02	0.02	

3.3. Effect of cropping systems and sampling depth (cm) on particles size analysis of the soil

Results presented in Table 3 shows the effect of cropping system and sampling depth on particle size analysis of the soil. The top-soil soil (0-20 cm) of monocropping land had the highest sand fraction of (91.41%) which was significantly ($p<0.01$) higher than all other crop land and sampling depth. The lowest value of sand fraction (83.20%) was observed from sub-soil (20-40 cm) of the uncultivated land. On the other hand, the top-soil from intercropping gave the highest value of 11.40 % in silt fraction, while the top-soil of monocropping had the lowest silt fraction of 2.81 %. Similarly, the sub-soil of monocropping had the highest clay fraction of 6.42 %. It is important to note that except in soil from monocropping and intercropping plot, sand fraction from the uncultivated crop land decreased with depth. On the contrary, silt fraction from uncultivated crop land increased with depth while it decreased in monocropping and intercropping. However, except in soil from monocroping where clay fraction decreased with depth, all other crop land use in this study did not show any significant difference with sampling depth (0-20 cm; 20-40 cm). The experiment showed that particle size analysis change with depth and crop land use. This observation confirms the report of Azeez et al (2013) that particle size analysis varied with sampling depth among various land use types.

3.4. Effect of cropping systems and sampling depth on pH, OC, N, P and K

The pH (H2O) of the soil from intercropping land had the highest value of 6.51, while the lowest value of 6.05 was recorded in monocropping (Table 4). The values were significantly different at ($p<0.05$). The highest value of 6.51 pH value recorded in soil from intercropping land showed that the soil was slightly acidic. However, the pH value range in all the three cropping lands falls within the range for most crops in this region (FMARD, 2012).

The organic carbon was highest in soil from intercropping which is 1.70% while the lowest value of 0.91% was observed from sample collected from monocropping. The high amount of organic matter observed in both intercropping and uncultivated lands may be due to accumulation of litters (from the leaves of mango and other trees) in these soils compared to monocropping system which is being cultivated every year.

The distribution of N among the various cropping systems showed that soil from uncultivated land had the highest 0.12 % N while the monocropping and intercropping had the same values of 0.11 %. These values were very low when compared with the fertility rating for most Nigerian soils. It is important to note however, that the value of N in intercropping land was relatively above other cropping systems. This may be due to the fact that the kind of crop being planted here (vegetable and pepper) are low feeders on N when compared with tree crops in uncultivated and cassava in monocropping.

The available P in soil from monocropping had the highest value of 4.93 mg kg-1 which was significantly higher ($p<0.05$) than all other crop land use type. Apart from monocropping which was low in P, both intercropping and uncultivated crop lands were very low in P.

Table 3: Effect of cropping systems and sampling depth (cm) on particles size analysis of the soil

Cropping system	Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
Monocroping	0-20	91.41	2.81	5.81	Sand
	20-40	83.22	10.42	6.42	Loamy Sand
Intercropping	0-20	83.20	11.40	5.40	Sand
	20-40	85.20	9.40	5.40	Loamy Sand
Uncultivated	0-20	91.21	3.41	5.40	Loamy Sand
	20-40	85.20	9.40	5.40	Loamy Sand
	LSD	0.04	0.04	0.04	

The result in Table 4 also showed that soils from intercropping and uncultivated land had the similar highest values of exchangeable K (0.33 cmol kg-1), while the lowest value (0.2 cmol kg-1) was recorded in the soil from monocropping. These values were significantly different ($p<0.01$). This observation may be attributed to the feeding pattern of the crops grown in these cropping systems. For instance, cassava is characterized as a heavy feeder of soil K while pepper is considered as a light feeder.

Table 4: Effect of cropping system and sampling depth on particles size analysis on pH, OC, N, P and K

Cropping system	pH	OC (%)	N (%)	P (mg kg^{-1})	K (cmol kg^{-1})
Monocropping	6.05	0.91	0.11	4.93	0.2
Intercropping	6.32	1.58	0.12	3.01	0.33
Uncultivated	6.51	1.70	0.11	2.85	0.33
LSD	0.03	0.03	0.03	0.03	0.03

3.5. Effect of soil sampling depth (cm) on particles size analysis on pH, OC, N, P and K

The pH values of the soils decrease with the sampling depth as presented in Table 5. Surface soil (0-20 cm) had the highest pH (6.64) while sub-soil had pH value of 5.94. This trend is in accordance with findings of Azeez et al (2013); Kassa et al (2017) that reported a decrease in soil pH with depth.

The soil organic carbon (SOC) distribution with the sampling depth also decreased with depth. The highest value of 1.15 % was observed in the upper part (0-20 cm) of the soil, while the sub-soil (20-40 cm) had 1.14 % organic carbon value. This observation may be attributed to high accumulation of litters on the soil surface compared to the sub-soil. This confirms the earlier report of Adugna and Abegaz (2015) that surface layer is the most biologically active of the soil profile.

The N content of the soils also decreased with sampling depth just like the case in pH and SOC. The variation in the distribution of N was significantly ($p<0.05$) affected by the sampling depth. The leaves fallen on the top layer of the soil may have accounted for high N value recorded in the top-soil (Kassa et al, 2017).

Available P however, decreased with sampling depth which also corroborate the findings made by Azeez et al (2013); Adugna and Abegaz (2015) who reported a decrease with depth in soil P under different land use types.

Exchangeable K also decreased with depth of soil with the surface soil (0-20 cm) having the highest K value of 0.32 cmol kg-1 while the sub-soil (20-40 cm) had the lowest value of 0.26 cmol kg-1. This is in accordance with the findings of Adugna and Abegaz (2015).

3.6. Effect of cropping system and sampling depth (cm) on particles size analysis of the soil on pH, OC, N, P and K

The pH of all the soils from the three crop land use types (monocropping, intrcropping and uncultivated land) and sampling depth (0-20 cm; 20-40 cm) varied significantly ($p<0.01$) as shown in Table 6. The highest pH value of 7.05 was recorded in the top-soil from monocropping, while the lowest pH value of 5.04 was recorded in soils from the sub-soil of monocropping. Thus the pH in all crop land use types and sampling depths ranged from slightly acidic to neutral. Azeez et al (2013) had reported a decrease in soil pH with sampling depth under different land use types. Moreover, the lowest value of pH observed in soils from monocropping could be attributed to depletion in base forming cations like Ca2+, Mg2+, and Na+ through a continuous nutrients uptake by plants as a result of repeated cultivation of the land as reported by Kassa et al (2017).

Table 5: Effect of soil sampling depth (cm) on pH, OC, N, P and K

Soil depth(cm)	pH	OC (%)	N (%)	P (mg kg^{-1})	K (cmol kg^{-1})
0-20	6.64	1.65	0.12	4.85	0.32
20-40	5.94	1.14	0.10	2.34	0.26
LSD	0.02	0.02	0.02	0.02	0.02

The impact of crop land use and sampling depth on SOC distribution showed that the highest SOC (2.01 %) was recorded in soils from the top-soil in intercropping, while the lowest value (0.66 %) was recorded in sub-soil of monocropping. These values were significantly different from all other crop land use and soil sampling depth. In all the crop land use, the amount of SOC was observed to decrease with depth. This observation is in agreement with earlier report by Azeez et al (2013); Adugna and Abegaz (2015). This observation may be as a result of litter addition to the top layer of the soils under the different cropping systems.

The amount of N as influenced by the different cropping systems and sampling depth showed that top-soil from intercropping had the highest value of 0.13 %, while the lowest (0.09 %) was recorded in sub-soil of intercropping. It is important to note that the N decreased with depth in all the crop land use types except that of monocroping. This may be attributed to exposure of the land under monocropping to the effect of surface erosion and leaching due to continuous cropping as well as the use of heavy machines on the land. This is in accordance with the findings of Adugna and Abegaz (2015).

The available P of the different cropping systems showed that it decreased with depth in soils from monocropping, intercropping and uncultivated land. However, the highest P value of 7.57 mg kg-1was recorded from top-soil of monocropping, while the lowest P value of 1.09 mg kg-1 was obtained from the sub-soils of intercropping. Highest available P value in the sub-soils under different land use types has been reported by Azeez et al (2013); Kassa et al (2017).

The exchangeable K decreased with depth in soils from monocropping and uncultivated while exchangeable K in intercropping increased with depth. The results also revealed that, the highest K value of 0.37 cmol kg-1 was recorded in the top-soil of intercropping, while the lowest value of 0.18 cmol kg-1 was recorded in the sub-soil of monocropping.

Table 6: Effect of cropping system and sampling depth on particles size analysis of the soil on pH, OC, N, P and K

Cropping system	Soil depth (cm)	pH	OC (%)	N (%)	P (mg kg^{-1})	K (cmol kg^{-1})
Monocropping	0-20	7.05	1.15	0.12	7.57	0.23
	20-40	5.04	0.66	0.10	2.28	0.18
Intercropping	0-20	6.50	2.01	0.13	3.80	0.37
	20-40	6.52	1.50	0.09	1.90	0.38
Uncultivated	0-20	6.38	1.80	0.12	3.20	0.35
	20-40	6.26	1.37	0.12	2.83	0.32
	LSD	0.04	0.04	0.04	0.04	0.04

4. Conclusion

The result of present study revealed that both the physical and chemical properties of the soil under investigation were greatly affected by both cropping systems and soil sampling depths. The sand fraction of the soil decreased with sampling depth, while silt and clay fractions increased with soil depth. The pH of the soil also varies significantly amongst the cropping systems with monocropping land having the lowest pH value. The pH was observed to decrease with soil depth in all the soil, similar trend was also observed for N and SOC. Available P was lowest in soil from intercropping, while highest value was recorded from monocropping. However, available P decreased with soil depth. Exchangeable K also decreased with depth, while highest value recorded in both intercropping and uncultivated land with the lowest value in monocropping land. It can therefore be concluded that both the cropping systems and sampling depths affected both the physical and chemical properties of soils from this area. Fertilizer application especially P fertilizer is suggested to boost the nutrient content of the soils in the cropping systems.

References

Abegaz, A., Adugna, A. (2015) Effects of soil depth on the dynamics of selected soil properties

among the highlands resources of Northeast Wollega, Ethiopia: are these signs of degradation. *Solid Earth Discussions,* 7, 2011-2035.

Adamu, G. K., & Maharaz, A. Y. (2014) A Comparative study of changes in soil fertility under two farming practices in Kano closed-settled zone. *European Scientific Journal*, 10 (2),313-323.

Akinbode, A. (1986) Imperative for rural development in Nigeria. In Adeniyi, E.O. and Bello –Immam, I.B. (eds) Development and the environment. *Proceeding of a National Conference.* Nigerian Institute of Social and Economic Research, Ibadan, Nigeria.

Azeez, J. O., Aloba, F. O. Ogunwale, O. V., Oguntade, O. A., Adekunle, I. O. & Amusan, A. O. (2013) Effect of land use and soil depth on soil phosphorus fractions. *Nigerian Journal of Soil Science*, *23 (2),* 219-225.

Bouyoucos, G. J. (1951). A recalibration of the hydrometer method for making mechanical analysis of soils. *Agronomy Journal*, 43, 434-438.

Brady, N. & R. Weil. (2002) The nature and properties of soils, 13th Edition. Prentice Hall. Upper Saddle River, New Jersey. 960 p.

Bray, R. H., & Kurtz, L. T. (1945) Determination of total and available forms of phosphate in soils. *Soil Science,* 59, 225-229.

Celik, I. (2005) Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. *Soil and Tillage Research, 83(2),* 270-277.

FMARD, (2012) Fertilizer use and management practices for crops in Nigeria. *Federal Ministry of Agriculture and Rural Development,* Abuja. Pp 40-41

IITA. (1982). Selected methods for soil and plant analysis. Agriculture Manual series No.7. *International Institute of Tropical Agriculture (IITA)*, Ibadan, Nigeria.

Kassa, H., Dondeyne, S., Poesen, J. Frankl, A. & Nyssen, J. (2017) Impact of deforestation on soil fertility, soil carbon and nitrogen stocks: the case of the Gacheb catchment in the White Nile Basin, Ethiopia. *Agriculture, Ecosystems and Environment*, 247, 273-282.

Li, X., Chen, H., Wang, X., Ali, Q., Lv, L., Zhou, T., Ijaz, M., Ahmed, T., Yan, J. & Li, B. (2025) Reshaping of soil properties and microbial community by the conversion from non-grain cultivated land to paddy field. *Frontiers in Microbiology*, 16,1643144

Lombin, G. (1999) Soil Science, In Youdeowei A. et al (eds). Introduction to tropical agriculture. (5th Edition). Longman pp 50.

Millar, C. E. & Turk, L. M. (2002) *Fundamentals of soil science*. Daya Books. 72(6), 481pp

Olofin, E. A. (2000) Geography and Environmental Monitoring for Effective Resources Management. *The Nigerian Geographical Journal*. New Series, 3 & 4, 1-14.

Oriola, E. O. & Bamidele, I. O. (2012) Impact of cropping systems on soil properties in derived savanna ecological zone of Kwara State, Nigeria. *Con J. Envtal. Stds.*, *7,* 34-41.

Oriola, E. O. (2004) Dynamics of soil chemical properties in Oke-Oyi irrigation project site of the Lower River Basin Development Authority, Ilorin, Nigeria, *Geo-Studies Forum* 2 (1), 86-94

Walkley, A. & Black, I. A. (1934) An examination of the degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*, 37**,** 29-38.

Xiao-Li, L. I. U., Yuan-Qiu, H. E., Zhang, H. L., Schroder, J. K., Cheng-Liang, L. I., Jing, Z. H. O. U., & Zhang, Z. Y. (2010) The impact of land use and soil fertility on distributions of soil aggregate fractions and some nutrients. *Pedosphere, 20(5),* 666-673.

Yakubu, S. (2012) Changes in soil chemical properties due to different land uses in part of Nigerian northern guinea savanna. *Nigerian Geographical Journal, New Series*, 8 (2**)**, 142-155.