EFFECT OF DIFFERENT TILLAGE PRACTICES AND FERTILIZER ON SOIL PHYSICAL AND CHEMICAL PROPERTIES IN UMUOKANNE OHAJI-EGBEMA IMO SOUTHEAST, NIGERIA

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Abstract
The assessment of selected soil properties under different tillage practices and fertilizer in Imo State, Nigeria, was carried out at the Agro-Forestry centre,Umuokanne Ohaji-Egbema. The treatments consisted of fallow (control); zero tillage and manure (ZM); conventional tillage, fertilizer and manure (CFM); conventional tillage and fertilizer (CF), and minimum tillage and manure (MM).Soil samples were collected from three (3) different depths of 0- 15, 15-30 and 30-45cm from each of the treatments. The fertilizer application rate for inorganic fertilizer was 200kg/ha while the organic manure (poultry manure) was applied at the rate of 500kg/ha. The result revealed that sand fraction dominated soil particle size distribution in the study area. The values of soil bulk density, hydraulic conductivity, total porosity, moisture content, infiltration rate, aggregate stability, pH, organic carbon content, Nitrogen, Phosphorus, Potassium, Calcium and magnesium were ranging from 1.35-1.44g/cm^3, 0.2-0.37cm/s, 45.08-48.93%, 6.4-13.87%, 6-12.3cm/hr, 8.2-14.63%, 5.31-5.82, 0.78-1.34%, 0.26-0.30%, 3.64-4.57mg/kg, 0.28-0.39cmol$^+$/kg, 0.92-1 .64cmol$^+$/kg and 0.62-0.98cmol$^+$/kg for Agro-Forestry Umuokanne Ohaji-Egbema, respectively,. The analyzed soil properties showed significant difference at P=0.05 Correlation analyses showed that soil bulk density had a negative relationship with the analyzed soil properties while other soil properties had positive relationship with each other. This implies that increase in soil bulk density reduces other soil properties. This study showed that tillage practices such as zero tillage and minimum tillage with the applications of manure improved soil physical and chemical properties and should be encouraged in the study area.

Keywords: Conservation, Egbema Fertilizer, Soil and Tillage

Introduction
Soil management practices are integral components of the overall agricultural systems through which the environment is harnessed for production. Consequently, these management practices are important indicators of agricultural productivity. The system of soil management practices adopted for any eco-region reveal the level of farmer management of the environment (Amanor, 1994). Therefore, the proper land use and management can be useful for improving soil characteristic, reducing soil degradation and in turn achieving the agricultural sustainability (Fayed and Rateb, 2013). Soil physical properties profoundly influence how soils functions in an ecosystem and how they can best be managed. The success of agricultural productivity often hinges on the physical properties of the soil. The occurrence and growth of many plant species are closely related to soil physical properties (Brady and Weil, 2002). These properties are known to influence emergence and early shoot and root growth of crops. They include soil texture, structure, bulk density and as well as the gravel content of the soil (Chen et al., 2008).

Soil tillage is an agronomic practice that requires considerable expense and high- energy inputs, and it is to create favorable conditions for plant growth and development. One of the main goals of soil tillage is influencing soil processes, predominantly modification of the physical, chemical and biological properties of soil (Badalikova and Knakal, 2000). Various soil tillage practices have its effect on the soil environment and subsequently on soil fertility, and farmers should manage the soil in such a way as to prevent soil damage and irreversible degradation processes. In the agricultural practices of soil tillage and establishment of stands of major field crops, the agronomic operations and practices which can be characterized predominantly by reduction in tillage depth and lower tillage intensity, combining more field operations, including crop planting, and leaving crop residues on the soil surface or in the topsoil, have become quite popular (Tebrugge and During, 1999). These soil tillage and planting systems are generally known as minimum tillage and soil erosion control practices. As the world human population continues to increase, there is increasing challenge on the food security as a panacea towards sustaining this teeming population. Consequently more lands are put under cultivation.

In most part of Africa, including Nigeria, due to this increasing population and other social-economic pressures, the land fallow period has been reduced to almost no fallow in order to accommodate the increasing high demand for food (Asfaw, 2007). Thus many farmers have resorted to continuous cropping system as a traditional farming system to produce enough food for the teeming population. Therefore it is important to conduct a study for the assessment of selected soil properties under different conservation tillage practices and fertilizer combinations at Umuokanne Ohaji-Egbema Imo Southeast, Nigeria,

Materials and Methods

Study Area

This study was carried out at in the Agro-forestry, Umuokanne in Ohaji-Egbema. The study area lies within Latitudes 4°40’ and 8°15’N and Longitudes 6°40’ and 8°15’E. It is situated within the humid tropical zone of Nigeria. Temperatures are high and change slightly during the year (mean daily temperature is about 27 °C). The average annual rainfall is about 2400 mm. There is a distinct dry season of about 3 months. Imo State has rain forest vegetation characterized by multiple tree species.

Geology and Geomorphology

Soils of the study site have been classified as Typic Paleudult or Owerri and Orlu (Federal Department of Agricultural land Resources, 1985). They are acidic, have low cation exchange capacity, low base saturation, and low fertility status, usually suffering from multiple nutrient deficiencies. Soil fertility is maintained by fallow, whose length is fast reducing due to high demographic pressure (Onweremadu, l994). Uzoho and Oti (2005), reported in their study of phosphorus adsorption characteristics of selected southeastern Nigerian soils that the practice of bush fallow of 5 years average length was used for fertility restoration in soil of Imo State (Ihiagwa), and the soils are derived from coastal plain sand and having kaolinite as the dominant clay mineralogy. Soil color is dark brown with a weak fine granular structure. Earthworm activity is evident. It is well drained and on a flat topography of elevation of 91 m above sea level. Farming is a major economic activity even in urban areas where patches of subsistence farms are found.

Treatments

The treatments comprised of T1 ,Bush Fallow as the control, T2 , Zero Tillage and Manure (ZM), T3, Conventional tillage, Fertilizer and Manure (CFM), T4, Conventional Tillage and Fertilizer (CF) and Minimum Tillage and Manure (MM).

Soil Sampling and Laboratory Analysis

Soil samples for the determination of selected soil physical and chemical properties were collected randomly from each of the treatments, replicated three (3) times at three (3) different depths of 0-15cm, 15-30cm and 30-45cm using soil auger for each of the study sites, while soil samples for bulk density determination and hydraulic conductivity was collected with core samplers of known volume at different depths of 0-15 cm, 15-30 cm and 30-45 cm. The core sampler was attached to soil auger for easy of collection of the top soil sampler. The soil samples were air-dried and sieved with a 0.02mm sieve and used for chemical analysis. The following soil properties were analyzed:

- Infiltration rate: Infiltration of water into the soil was determined in the experimental field using a double ring infiltrometer (Bouwer, 1986), with a 30 cm inner diameter and 60 cm outer diameter cylinder inserted 10 cm into the soil at the experiment field. Water entering the soil was measured with a calibrated ruler. A constant water head of 20 cm was maintained in both rings. Infiltration measurements were made at three separate randomly selected points in each plot.
- Saturated hydraulic conductivity Ks was determined by the constant-head method (Klute and Dirksen 1986). The Ks was measured for soil cores from each of the 0-15, 15-30 and 30-45cm depth from each plot.
- Particle size distribution was determined by hydrometer method according to the procedure of Gee and Bauder (1986).
- Bulk density was determined using core sampler, as described by Blake and Hartge, (1982).
- Water-stable aggregation: Soil water-stable aggregate distribution was determined by placing the soil sample on a nest of sieves, immersing directly in water, and agitating the sieves up and down for 15 mm. Samples remaining on each sieve were dried and proportions of wet stable aggregates at more than 2, 2-1, 1-0.25, and less than 0.25 mm were calculated. The fraction of micro- aggregates was taken as those less than 0.25 mm (Oades and Waters, 1991).
- Moisture content was determined gravimetrically thus:

$$\theta\text{m} = 1 + \frac{\text{wet soil sample} - \text{dry soil sample}}{\text{Dry soil sample}} X \frac{100}{1}$$

Where $^{\theta}$m = gravimetric moisture content (saturated) (%).

- Total porosity was calculated from values of bulk density obtained by clod method (Blake and Hartge, 1986), at an assumed particle density of 2.65g/cm^3. Mathematically, it is expressed as follows:

$$\text{TP} = 1 - \frac{Bd}{Pd} X \frac{100}{1}$$

Where TP = Total porosity (%)

Bd= Bulk Density (g.cm^{-3})

Pd = Assumed Particle Density (2.65g/cm^3)

- Soil pH in water, with soil to water ratio of 1:2.5, using pH meter.
- Total carbon was measured by Walkley and Black wet digestion method (Nelson and Sommers, 1982).
- Total Nitrogen, using micro-kjeldahl digestion procedure method as described by Bremner, (1996).
- Available phosphorus was estimated using Bray II method (Bray and Kurtz, 1954).
- Potassium using Flame Emission Spectrophotometer.
- Calcium using Atomic Absorption Spectrophotometer.
- Magnesium using Atomic Absorption Spectrophotometer.

Experimental Design and Data Analysis

The experiment consisted of five treatments and five replications and laid out in a randomized complete block design.The Data collected were subjected to Analysis of Variance (ANOVA). Significant means were separated using the Fisher Least Significant Difference (LSD) as described by Gomez and Gomez (1984) at P=0.05. Simple linear correlation was used to study the relationship between soil properties and the yield obtained.

Results and Discussion

Soil Physical Properties in the Agro-Forestry of Umuokanne

The results of the effect of different conservation tillage practices and fertilizer combinations on soil physical properties is presented in Table 1

Table 1: The Effects of Different Conservation Tillage Practices and Fertilizer Combinations on Soil Physical Properties in Agro-Forestry Umuokanne Ohaji Egbema of the Three Sampling Depths

	B.D (g/cm^3)	H.C (cm/s)	P(%)	M.C (%)	I.R (cm/hr)	A.S (%)	T.C
			0 - 15cm				
Fallow	1.32^d	0.53^a	50.2^a	18.3^a	15.0^a	20.0^a	SCL
ZM	1.36^c	0.40^b	48.8^b	15.3^b	11.7^b	16.3^b	SCL
CFM	1.39^a	0.30^c	47.5^b	11.0^c	10.0^c	14.0^c	SCL
CF	1.42^a	0.23^d	46.5^d	7.0^d	6.0^d	9.3^d	LS
MM	1.36^c	0.39^b	48.7^b	15.0^b	12.3^b	16.0^{bc}	LS
LSD$_{(P=0.05)}$	0.01	0.03	0.5	0.6	1.3	2.11	
C.V (%)	0.3	3.8	0.5	2.4	6.2	7.4	
			15 – 30cm				
Fallow	1.34^e	0.50^a	49.4^a	15.7^a		17.0^a	SCL
ZM	1.39^c	0.37^b	47.5^c	14.0^b		14.3^b	SCL
CFM	1.41^b	0.28^c	46.9^d	10.7^c		12.3^b	SCL
CF	1.44^a	0.20^d	45.7^e	6.5^d		8.5^c	LS
MM	1.38^d	0.38^b	47.8^b	13.0^b		13.7^b	SL
LSD$_{(P=0.05)}$	0.01	0.03	0.12	1.26		2.62	
C.V (%)	0.2	4.6	0.6	5.6		10.5	
			30cm – 45cm				
Fallow	1.36^c	0.45^a	48.6^b	14.7^a		14.0^a	SCL
ZM	1.31^d	0.34^b	50.6^a	12.3^b		13.3^{ab}	SCL
CFM	1.43^{ab}	0.26^c	46.1^c	9.5^c		11.7^b	SCL
CF	1.45^a	0.16^d	45.1^d	5.7^d		6.8^c	LS
MM	1.42^b	0.34^b	46.4^c	12.0^b		12.7^{ab}	LS
LSD$_{(P=0.05)}$	0.02	0.03	0.6	1.24		1.94	
C.V (%)	0.8	4.6	0.6	6.1		8.8	

NOTE: Figures with the same superscript are not statistically significant

Effects of Different Conservation Tillage Practices and Fertilizer Combinations on Soil Physical Properties

Bulk Density

Mean bulk density in the soil depth of 0-15cm under fallow, ZM, CFM, CF and MM were 1.32, 1.36, 1.39, 1.42, 1.36 g.cm^{-3}respectively (Table 1).The statistical analysis of variance shows that there is significant difference between fallow and other treatments (ZM, CFM, CF, and MM) but there is no significant different between ZM and MM at P=0.05. Mean bulk density in the soil depth of 15-30cm were fallow (1.34 g.cm^{-3}), ZM (1.39 g.cm^{-3}), CFM (1.41 g.cm^{-3}), CF (1.44 g.cm^{-3}) and MM (1.38 g.cm^{-3}). The analysis of variance (ANOVA) showed that there is a significant difference in treatment means at P=0.05. Mean bulk density in the soil depth of 30-45cm were 1.36, 1.31, 1.43, 1.45 and 1.42 g.cm^{-3} for fallow, ZM, CFM, CF and MM respectively and there is significant difference between fallow and other treatment means, but there is no significant difference between CFM (1.43 g.cm^{-3}) and CF (1.45 g.cm^{-3}) at P0.05 (Table 1). CF and CMF have the highest Bulk density values in the three (3) different depths, and this indicates the development of a compacted hard pan beneath tillage depth, caused by tractor traffic associated with tillage. The changes of soil bulk density are consistent with the findings of Mou*et al*, (1999) who showed that bulk density is lower for non-tillage than for conventional tillage after 5 years. Correlation analysis as shown in Table (3) indicates that soil bulk density has a negative correlation with all other soil properties analyzed. Which means that as soil bulk density increases other analyzed soil properties decreases.

Hydraulic Conductivity

Soil hydraulic conductivity in 0-15 cm soil depth for fallow, ZM, CFM, CF and MM were 0.53, 0.40, 0.30, 0.23 and 0.39 cm/s respectively, and there are significant difference using ANOVA at P=0.05 (table 1). In the 15-30cm soil depth the mean hydraulic conductivity were 0.50, 0.37, 0.28, 0.20 and 0.38 cm/s for fallow, ZM, CFM, CF and MM respectively and there is also significant difference at P0.05. For the soil depth of 30-45 cm, the mean hydraulic conductivity were fallow

(0.45cm/s), ZM (0.34cm/s), CFM (0.26cm/s), CF (0.l6cmJs) and MM (0.34cm/s) there was also significant difference using ANOVA at P=0.05.

The hydraulic conductivity were in the order Fallow> ZM> MM> CFM> CF. The decrease of hydraulic conductivity in conventional tillage practices could be attributed to the destruction of stable aggregates and reduction of the pores in ploughed soils (Singh et al; 2002). The correlation analysis of soil hydraulic conductivity (Ks.) as shown in Table (3) shows that hydraulic conductivity has a negative relationship with bulk density (r=:0.834), while it has a strong positive relationship with other soil properties analyzed. Therefore, increase in soil hydraulic conductivity increases other soil properties.

Porosity

Total soil porosity has significant differences among the treatment means in the soil depth of 0-15cm except ZM and MM which shows no significant difference at P0.05, whereas there are significant difference in the treatment means of total porosity from the soil depth of 15 - 30cm (Table 1). However, CFM (46.1%) and MM (46.4%) shows no significant difference at P=O.05 in the soil depth of 30-45cm. This result coincided with the changes in soil bulk densities at these depths. CF has the least Total porosity in all the soil depths as compared to other treatment means. This could be as a result of wheel traffic during ploughing and also due to no application of manure to the soil. The correlation analysis in Table (3) shows that total porosity has a very strong negative relationship with bulk density (r-0.999), whereas it has a very strong positive relationship with other soil properties analyzed.

Moisture Content

The treatment means of the study area for soil moisture content shows that fallow has a significant moisture content compared to other treatment means in all the sampled soil depth at P=0.05 (Table 1). But there was no significant mean difference between ZM and MM in the sampled soil depth. However CF and CFM have the least soil moisture content in all the sampled soil depth, even though there is a significant difference between CFM and CF in all the depths at P0.05 (Table 1). This result could be as a result of the levels of exposure of soil under different tillage practices, as compared to fallow that has some resistance to direct impact of solar radiation on the soil, and also due to the impact of organic manure in the conservation of soil moisture. Bescansa et al. (2006) also reported that retention of water was significantly greater in untilled soils than in tilled soils. The correlation analysis in Table (3) shows that soil moisture content has a very strong relationship with other soil properties analyzed, except for soil bulk density that shows a very strong negative relationship (r = -0.833).

Infiltration Rate

The dynamics of infiltration was also used to assess tillage effects. Soil water infiltration rate was of the order fallow>MM>ZM>CFM>CF giving a final (steady state) infiltration rates of 15.0, 12.3, 11.7, 10.0 and 6.0 cm/hr respectively (Table 1). The greater final (steady state) infiltration rate of soil under fallow was probably due to residence retention on the soil surface and less disturbance to the continuity of water conducting pores (Acharya and Sood 1992). Conventional tillage significantly reduced porosity and pores continuity, thereby decreasing water infiltration. The treatment means for infiltration rates of the study area shows that there is no significant difference between ZM and MM, but there is significant difference between other treatment means and those that are under conventional tillage practices at P0.05 (Table 1). The correlation analysis as shown in Table (3) indicates that infiltration rate has a strong positive relationship with other soil properties analyzed, but has a very strong negative relationship with bulk density (r = -0.985).

Aggregate Stability

The mean treatment for fallow in soil depths of 0-15 and 15-30cm showed a significant difference with the mean treatments of ZM, CFM, CF and MM in the same depth of 0-15 and 15-30cm. But there was no significant difference between ZM (16.3%) and MM (16.0%) and also there was no significant difference between MM (16.0%) and CFM (140%). However, there was a significant difference between every other treatment means and CF (9.3%) in all the soil depths examined. In the soil depth of 30-45cm, there was no significant difference between fallow (14.0%), ZM (13.3%), and MM (12.7%) at P=0.05 (Table 1). Aggregate stability followed this order fallow> ZM>MM> CFM> CF> in all the soil depths. The greater proportions of larger aggregate stability found in fallow, MM and ZM may be as a result of greater biological activity in no-tillage soils (Tisdall and Oades 1982), and the decreased breakdown of surface and deep soil aggregates owing to the residue protection and minimum tillage (Oyedele et al., 1999). The correlation analysis as shown in Table (3) indicates that aggregate stability has a strong positive relationship with other soil properties analyzed, but has a very strong negative relationship with bulk density (r = -O.825).

Textural Class

The data showed that soil texture in the (0-15cm) soil depth for Bush fallow, zero tillage and manure (ZM), conventional tillage, fertilizer and manure (CFM) are sandy clay loam (SCL), while conventional tillage and fertilizer (CF) and minimum tillage and manure (MM) are loamy soils (LS). In the soil depth of (15-30cm), fallow, ZM and CFM are SCL, while CF and MM are LS and sandy loam (SL) respectively. In soil depth of (30-45cm), the textural class followed the same trend as seen in the surface layer (0-15cm). The soils of the study area are dominated by sand fraction followed by silt and clay.

Chemical Properties of Soil under Different Conservation Tillage Practices and Fertilizer Combinations

The effect of different conservation tillage practices and fertilizer combinations on soil chemical properties in agro-forestry Umuokanne Ohaji Egbema is presented in Table 2.

Table 2: The Effect of Different Conservation Tillage Practices and Fertilizer Combinations on Soil Chemical Properties in Agro-Forestry Umuokanne Ohaji Egbema

	pH (H_2O)	OC %	N (%)	P (mg/kg)	K ($cmol^+$/kg)	Ca ($cmol^+$/kg)	Mg ($cmol^+$/kg)
				0 - 15cm			
Fallow	6.27a	1.62^a	0.36^a	6.32^a	0.43^a	1.87^a	1.16^a
ZM	6.09^b	1.25^c	0.32^{bc}	4.88^b	0.42^a	1.75^{ab}	1.05^b
CFM	5.86^b	1.36^{bc}	0.33^b	4.66^b	0.45^a	1.66^b	0.8^c
CF	5.5^d	0.92^d	0.30^c	3.94^c	0.31^b	1.15^c	0.68^d
MM	6.08^b	1.45^b	0.32^{bc}	5.13^b	0.43^a	1.69^b	1.04^b
$LSD_{(0.05)}$	0.12	0.13	0.02	0.5	0.06	0.16	0.06
C.V (%)	1.1	5.5	3.8	5.3	7.3	5.1	3.3
				15 – 30cm			
Fallow	6.09^a	1.19^b	0.31^a	5.24^a	0.37^a	1.71^a	1.05^a
ZM	5.77^b	1.21^b	0.29^a	4.62^{ab}	0.36^a	1.56^b	0.97^a
CFM	5.56^c	1.24^{ab}	0.29^a	4.07^{bc}	0.4^a	1.55^b	0.80^b
CF	5.32^d	0.78^c	0.26^b	3.67^c	0.28^b	0.92^c	0.63^c
MM	5.75^b	1.34^a	0.31^a	4.44^{ab}	0.38^a	1.62^{ab}	1.00^a
$LSD_{(0.05)}$	0.1	0.12	0.02	0.93	0.04	0.13	0.12
C.V (%)	0.96	5.5	3.9	11.2	5.6	4.8	7.1
				30cm – 45cm			
Fallow	5.74^a	1.12^b	0.28^a	4.3^a	0.32^a	1.49^a	1.02^a
ZM	5.61^{ab}	1.16^{ab}	0.27^a	4.2^a	0.32^a	1.60^a	0.91^a
CFM	5.30^c	1.19^{ab}	0.27^a	3.52^{bc}	0.33^a	1.52^a	0.70^b
CF	5.10^d	0.65^c	0.21^b	3.31^c	0.25^b	0.68^b	0.56^c
MM	5.52^b	1.22^a	0.27^a	3.85^{ab}	0.35^a	1.60^a	0.96^a
$LSD_{(0.05)}$	0.16	0.08	0.02	0.5	0.05	0.17	0.12
C.V (%)	1.5	4.2	4.4	7.1	7.9	6.5	7.6

NOTE: Figures with the same superscript are not statistically significant

Soil pH

Soil pH of the study area indicates that there was a significant difference between fallow and other treatment means in soil depths of 0-15 and 15-30cm but there was no significant difference between fallow (5.74) and ZM (5.61) in soil depth of 30- 45cm. however there was no significant different between ZM and MM in all the soil depths of 0-15, 15-30 and 30-45cm at P0.05 (Table 2). But CFM and CF have significant difference with other treatment means. The soil pH values were of the order Fallow> ZM> MM> CFM> CF. The decrease in soil pH value downthe soil depth could be as a result of mineralization process and decrease in biological activities. Correlation analysis as presented in Table (3) showed that soil pH has a positive relationship with other soil properties analyzed, except for soil bulk density which showed a negative relationship with soil pH (r = -0.798).

Organic Carbon

Data from table (2) indicates that soil organic carbon contents vary from depth to depth, with fallow having the highest organic carbon content in soil depth of 0- 15cm. But there was no significant difference when fallow, ZM and CFM were compared with one another at the soil depth of 1 5-30cm. However, CF has significant difference with every other treatment means in all the soil depths at P=0.05. These results could be as a result of CF having no organic matter application, thus having low organic carbon content due to continuous cropping. Risikesh et al. (2011) also reported that co-joint use of FYM and NPK substantially improved the organic carbon status of soil. The correlation analysis shows that soil organic carbon content has a positive relationship with all the soil properties evaluated, but has a negative strong negative relationship with bulk density (r= -0.648), Table (3).

Total Nitrogen

Mean Nitrogen content in the soil depth of 0-15cm were 0.36, 0.32, 0.33, 0.30 and 0.32% for fallow, ZM, CFM, CF, and MM respectively, and there was significant difference between fallow and all other treatment means, although there was no significant difference between ZM, CFM and MM. CF has the least nitrogen content even though there was no significant difference between CF, ZM, and MM at P=0.05 in soil depth of 0-15cm (Table 2). However, in soil depth of 15-30 and 3 0-45cm, there was no significant difference between Fallow, ZM, CFM and MM, but these treatments were significantly difference from CF in soil depths of 15-30 and 30-45cm. these results could be as an indicator to show the positive relationship between mineralization of organic matter and accumulation of nitrogen in the soil. Table (2) also showed that the nitrogen contents of the soil decrease along depths, thus having a greater nitrogen concentration in the 0-15cm depth followed by 15-30cm and 30-45cm soil depth. The correlation analysis result in Table (3) showed that soil nitrogen has a positive relationship with other soil properties analyzed, except for soil bulk density which showed a negative relationship with soil nitrogen content (r = -0.614).

Avil. Phosphorus

Soil phosphorus content has a significant mean difference between fallow (6.32 $mg.kg^{-1}$) and other treatment means of ZM (4.88 $mg.kg^{-1}$), CFM (4.66 $mg.kg^{-1}$), CF (3.94 $mg.kg^{-1}$) and MM (5.13 $mg.kg^{-1}$) in the soil depth of 0-15cm.However, there was no significant difference between ZM, CFM and MM in the soil depth of 0-15cm, at P=O.05. Treatment means of fallow, ZM and MM shows no significant difference in both soil depths of 15-30 and 30-45 cm (Table 2), whereas there was significant difference between CF and treatment means of ZM and MM. Even though there was no significant difference between CF and CFM in soil depths of 15-30 and 30-45cm at P=0.05. This result is in accordance with the findings of Bowman et al. (1999), who stated that decline in soil nutrients are usually associated with intensive cropping and absence of crop rotations. Correlation analysis in Table (3), showed that Phosphorus has a very strong positive relationship with all the soil properties analyzed but has a negative relationship with soil bulk density (r=-0.782).

Potassium

Table (2) shows that treatment means of potassium for the different tillage practices of fallow, ZM, CFM, CF and MM followed the same pattern in all the soil depths of 0-15, 15-30 and 30-45cm. There was no significant difference between treatment means of Fallow, ZM, CFM, and MM in all the soil depths, but there was significant difference between CF and all other treatment means at PO.O5. This result may be as a result of no application of organic manure in a conventional tillage practice of continuous cropping System.These results were similar to the findings of Pouyat*et al*., (2007), who related the differences in soil properties, particularly P, K, pH, and BD, to differences in land use. Correlation analysis in Table 3 showed that Potassium has positive relationship with all the soil properties analyzed but has no significant relationship with soil bulk density.

Calcium

Treatment means for calcium content of this study area ranged from 1.15 -1.87, 0.92 -1.71, and 0.68 -1.60 cmol^{+}/kg in the soil depths of 0- 15, 15-30 and 30-45cm respectively. The analyzed result shows that in the soil depth of 0 - 15cm, there is no significant difference between fallow and ZM but there is a significant difference between fallow, CFM, CF and MM. Even though there was no significant difference between ZM, CFM and MM. However, CF has a significant difference with all other treatment means at P=0.05. In the soil depth of 15-30cm, there was no significant difference between fallow, ZM, CFM and CF with treatment means of 1.71, 1.56, 1.55 and 0.92 cmol^{+}/kg respectively. Table (2) also shows that there was no significant difference between ZM, CFM and MM in soil depth of 15-30cm. however CF significantly differs from other treatment means. In soil depth of 30-45cm, Table (2) shows that that fallow, ZM, CFM and MM having treatment means of 1.49, 1.60, 1.52 and 1.60 cmol^{+}/kg have no significant difference with all the treatment means in soil depth of 30-45cm at P=0.05. The findings of these results were similar to Beshay and Sallam (2001), who found out that the different land Management practices, affects nutrient availability. Correlation analysis in Table (3), showed that calcium has a very strong positive relationship with all the soil properties analyzed but has a negative relationship with soil bulk density (r = -0.727).

Magnesium

The treatment means of Magnesium under different tillage practices of fallow, ZM, CFM, CF and MM having the values of 1.69, 1.05, 0.88, 0.68 and 1.04cmol^{+}/kg respectively in soil depth of 0 - 15cm. This result shows that fallow has a significant difference in magnesium content as compared to other treatment means in soil depth of 0-15cm at P = 0.05, whereas there was no significant difference between treatment means of ZM and CFM. CFM and CF have significant difference between each other and among other treatment means in soil depth of 0-15cm.However, in soil depths of 15-30 and 30-45cm, there was no significant difference between fallow, ZM and MM, but CFM and CF significantly differed from each other and among other treatment means at P 0.05 (Table 2). This result could be due to increase in soil Bulk density as evidence by the use of tractor in conventional tillage practices, thus reducing the soil moisture content, microbial activities and organic matter mineralization rate. Correlation analysis in Table (3), showed that calcium has a very strong positive relationship with all the soil properties analyzed but has a negative relationship with soil bulk density (r= -0.814).

Correlation Analysis of selected Soil Physical and Chemical Properties

The result of the correlation analysis of some selected soil physical and chemical properties under different conservation tillage practices and fertilizer combinations in Agro-Forestry at Umuokanne Ohaji Egbema is presented in Table 3.

Table 3: Correlation Analysis of selected Soil Physico-Chemical Properties Under different conservation tillage practices and fertilizer combinations in Agro-Forestry Umuokanne Ohaji Egbema

	Bd	**Hc**	**PO**	**MC**	**IR**	**AS**	**pH**	**OC**	**N**	**P**	**K**	**Ca**	**Mg**
BD	1	-.843**	-.999**	-.833**	-.985**	-.825**	-.798**	-.648**	-.614*	-.782**	-.501	-.727**	-.814**
HC			.828**	.969**	.967**	.937**	.880**	.743**	.698**	.857**	.584*	.808**	.958**
PO				.831**	.978**	.828**	.802**	.654**	.627*	.782**	.512	.738**	.810**
MC					.985**	.970**	.905**	.825**	.720**	.867**	.691**	.872**	.979**
IR						.995**	.990**	.944*	.858	.958*	.772	.949*	.958*
AS							.945**	.887**	.832**	.925**	.793**	.912**	.929**
pH								.801**	.890**	.955**	.815**	.813**	.883**
OC									.884**	.782**	.893**	.936**	.795**
N										.871**	.875**	.790**	.697**
P											.746**	.730**	.825**
K												.835**	.652**
Ca													.849**
Mg													1

** => significant at 0.01

* => significant at 0.05

Conclusion

The study assessed selected soil properties under different conservation tillage practices and fertilizer combinations in Imo State, Nigeria. Following a long term cropping systems revealed that soil properties under Zero tillage and manure (ZM) and Minimum tillage and Manure (MM) showed better soil property as compared to those of conventional tillage, fertilizer and manure (CFM) and conventional tillage and fertilizer (CF). Tropical soils are generally known to have poor soil quality due to the fact that it is highly weathered and leached, and also being formed from coastal plain sand and having kaolinite as its clay mineralogy. Therefore, based on the findings of this study, the following recommendations are made

1) Farmers that practice long-term cropping system should be encouraged to practice proper tillage method like conservational tillage methods (zero and minimum tillage) in order to avoid soil compaction and its adverse effects.
2) There is need to incorporate organic manure into the soil to improve the soil quality.
3) Due to acidic nature of the soils, lime application should be encouraged.

References

Acharya, C.L. and Sood, M.C. (1992). Effect of tillage methods on soil physical properties and water expense of rice on an acidic Alfisol. Journal of Indian Society of Soil Science 40: 409-414.

Amanor, K. S. (1994). The New Frontier. Farmers Response to Land degradation: A West African Study. UNRISD, Geneva Zed Books Ltd. London and New Jersey. 244pp.

Asfaw, B. (2007). Carbon and Nitrogen inputs and inorganic fertilizer on maize yield and microbial biomass. Australia Journal of applied Science 1 (13):187-192.

Badalikova, B. and Knakal, Z. (2000). Effect of different tillage systems for winter wheat on physical properties of soil. In: CD ISTRO-Conference 2000, Tillage at the Threshold of the 21st Century: Looking Ahead, Texas, USA.

Bescansa, P., Imaz, M.J., Virto, I., Enrique, A. and Hoogmoed, W.B. (2006). Soil water retention as affected by tillage and residue management in semiarid Spain. Soil and Tillage Research 87: 19-27.

Beshay, N.F. and Sallam, A.S. (2001). Effect of land management practices on soil characteristics and sustainable productivity (East of the Nile Delta). Egypt. I Soil Sci. 41(3,):353-378.

Blake, G.R. and Hartge, K.H. (1986). Bulk density. In: Methods of soil analysis Part 1, Vol. 9 (A. Kiute, Ed.), American Society of Agronomy: Madison Wi, 363-392.

Bouwer, H. (1986). Intake rate: cylinder infiltrometer. In: Kiute A ed. Methods of soil analysis, Part 1. Physical and Mineralogical Properties, Monograph 9. American Society of Agronomy and Soil Science Society of America, Madison, united States. Pp. 825-843.

Bowman, R.A.; Vigil, M.F.; Nielson, D.C. and Anderson, R.L. (1999). Soil organic matter changes in intensively cropped dry land systems. SSSAI 63:186-191.

Brady, N.C. and Weil, R.R. (2002). The Nature and Properties of Soil. 13th Edition, Prentice Hall Inc., New York, pp 4: 152-180.

Bray, R.H. and Kurts, L.T. (1954). Determination of total organic and available forms of phosphorus in soils. Soil Sci., 59, 39-45.

Bremner, J.M. (1996). Nitrogen. Total in. sparks D.L (ed.) Method of soil analysis part 3 chemical method SSAS Book series No. 5 Am SocAgron Madison WI. pp 1085- 1121

Chen, H., Bai, Y.H., Wang, Q.J., Chen, F., Gao, H.W., Tullberg, J.N., Murray, J.R., Li, H.W. and Gong, Y.S. (2008). Traffic and tillage effects on wheat production on the Loess Plateau of China: 1. Crop yield and SOM. Australian Journal of Soil Research 46: 645-651.

Fayed, R.I. and Rateb, K.A. (2013). Long-Term Cropping System Impacts on Some Physical and Chemical Properties and Fertility Status in Alluvial Soils of Egypt. Soil Salinity Lab. Alex., Soil, Water and Environ. Res. Inst., Agric. Res. Center-Egypt.

Federal Department of Agricultural Land Resources, (1985). The reconnaissance soil survey of Imo State, Nigeria (1:250,000), Soils Report, 133.

Gee, G. W. and Bauder, J.W. (1986). Particle-size analysis. In: Methods of soil Analysis. Part 1. Edited by A. Klute, Madison W.I. Am. Soc. Agron. 9:91-100.

Gomez L.A and G.O. Gomez 1984 statistic for biology and agriculture research Oxford University press UK.P84-102

Klute, A. and Dirksen, C. (1986). Hydraulic conductivity of saturated soils. In: Kiute A ed. Methods of soil analysis. American Society of Agronomy and Soil Science Society of America, Madison, united States. Pp. 694-700.

Mou, S.J., He, M.H., Zang, F.Y., Ma, J.X. and Huang, M.Q. (1999). Study on the coordinative techniques of no-tillage, mulch, deep loosening and the farming mode. Journal of Tianjin Agricultural College 6: 22-26 (in Chinese).

Nelson, D.W. and Sommers, L.E. (1982). Total carbon organic matter. In method of soil analysis. Part 2. Edited by A.L. Page; R.H. Miller and D.R Keeney. Madison. Am. Soc. Agron. Pp 539-998.

Oades, J.M. and Waters, A.G. (1991). Aggregate hierarchy in soils. Australian Journal of Soil Research 29: 815-828.

Onweremadu, E.U. (1994). Investigation of soil and other related constraints to sustained agricultural productivity of soils of Owerri zone in Imo State, Nigeria M.Sc., Thesis University of Nigeria, Nsukka, Nigeria, 164.

Oyedele, D.J., Schjonning, P., Sibbesen, E. and Debosz, K. (1999). Aggregation and organic matter fractions of three Nigerian soils as affected by soil disturbance and incorporation of plant material. Soil and Tillage Research 50: 105-114.

Pouyat, R.V., Yesilonis, I.D., Russell-Anelli, J. and Neerchal, N.K. (2007). Soil chemical and physical properties that differentiate urban land use and cover types. Soil Sci. Soc. Am. 1 71(3): 1010-1019.

Risikesh, T., Sawarkar, S.D., Vaishya, U.K. and Singh Muneshwar. (2011). Impact of continuous use of inorganic fertilizers and organic manure on soil properties and productivity under soybean-wheat intensive cropping of a vertisol. I Indian Soci. Soil Sci., 59(1): 74- 81.

Tebrugge, F. and During, R.A (1999) Reducing tillage intensity - a review of results from a long term study in Germany. Soil Till Res 53:15-28

Tisdall, J.M. and Oades, J.M. (1982). Organic matter and water- stable aggregates in soils. J Soil Sci 33:141-163.

Uzoho, B. U. and Oti, N. N. (2005). Phosphorus Adsorption Characteristics of Selected Southeastern Nigerian Soils. Journal of Agriculture, Food, Environment and Extension Volume 4, Number 1, January 2005 pp 50-55.