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Comparative Assessment of Organic Manures (Cow Dung and Poultry Manure) and NPK Fertilizer on Soil Quality in a Part of Guinea Savannah Region of Nigeria

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Abstract: The study assessed how organic (cow dung and poultry manure) and NPK Fertilizer on soil quality. The study adopted an experimental design. The research used primary sources of data; primary data was data on soil, maize grain and maize leaves; two experimental plot was set up for poultry and control plot, the experimental plot was set up at size of 5mx5m and separated by 2meter apart, two bags of 25kg of dry poultry manure was applied to the poultry plot and the maize was planted at the depth of 15cm, twenty-five (25) top soil and twenty five (25) sub soil sample were collected at each experimental plot making a total of hundred (100) soil sample collected altogether at the study area, after which the top soil samples were composted as one and the sub soils were also composted as one, crop grains and leaves were also plugged and tested in the laboratory. Findings revealed that Poultry manure application plot recorded highest value of Organic carbon (0.511% and 0.452%), organic matter (1.031% and 1.101%), total nitrogen (0.213% and 0.221%), available phosphorus (46.81mg/kg and 49.22mg/kg), potassium (1.031 coml/kg and 1.106 coml/kg), calcium (7.35coml/kg and 7.01coml/kg), magnesium (4.01coml/kg and 3.945coml/kg), sodium (0.103coml/kg and 0.067coml/kg) on top and sub soil, ECEC (11.98 and 10.31) and base saturation (79.41and 61.32). The findings revealed poultry manure is more suitable for animal folder than other nutrients plot, as poultry recorded three major macro nutrients (potassium (15235.69), magnesium (1054.73), and phosphorus (5.56) against the two recorded by control plot. the study revealed that poultry manure is more suitable for maize grain. statistically, there is significant difference in the soil properties among the replica plots at top soil, there is also significant variation in maize yield in the four plots, more also there is significant variation in the nutritional value of maize leaves/straw as potential animal feeds in the respective plots, furthermore there is significant variation in the nutrient content of maize grain across the replica plots. The study recommend application of apply poultry manure to improve soil fertility status during decline in soil fertility.

Keywords*: Organic Manures, Cow Dung, Poultry Manure), NPK Fertilizer and Soil Quality.*

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I. INTRODUCTION

Soil quality is a critical determinant of agricultural productivity, ecosystem health, and environmental sustainability. It encompasses the chemical, physical, and biological properties of soil that influence its capacity to function effectively as a living system (Karlen *et al.*, 1997). Over the years, intensive agriculture, continuous cropping, and over-reliance on synthetic fertilizers have led to a decline in soil quality, particularly in tropical regions where nutrient depletion and organic matter loss are prevalent (Lal, 2015). This has prompted research into sustainable soil fertility management strategies, including the use of organic amendments such as cow dung and poultry manure in combination or comparison with mineral fertilizers like NPK.

Organic manures such as cow dung and poultry manure are rich in macro- and micronutrients and contribute significantly to the improvement of soil structure, water-holding capacity, and microbial activity (Ayoola & Makinde, 2007). These amendments release nutrients more slowly than inorganic fertilizers, thus providing a sustained nutrient supply to crops and enhancing long-term soil fertility. Cow dung has been widely recognized for its ability to increase soil organic matter, reduce bulk density, and enhance cation exchange capacity (Olaniyan & Ojetayo, 2011). Poultry manure, on the other hand, is noted for its higher nutrient content, particularly nitrogen and phosphorus, making it an excellent complement to mineral fertilizers (Adeniyan & Ojeniyi, 2005).

Inorganic fertilizers, such as NPK formulations, are valued for their immediate nutrient availability and their role in boosting crop yields in the short term (FAO, 2017). However, prolonged and sole application of NPK fertilizers without organic matter inputs can lead to soil acidification, reduced microbial activity, and deterioration of soil physical properties (Manna et al., 2005). As such, integrated nutrient management (INM)—the combined use of organic and inorganic sources—has emerged as a promising approach to improving soil quality while sustaining high crop yields (Gruhn, Goletti & Yudelman, 2000).

Several studies have compared the impacts of organic and inorganic fertilizers on soil properties. For example, Okonkwo *et al.* (2020) found that poultry manure significantly improved soil pH, organic carbon, and total nitrogen compared to sole NPK application. Similarly, cow dung application was reported to enhance soil aggregation and nutrient retention better than inorganic fertilizers alone (Nwite *et al.*, 2013). The synergistic effects of combining NPK with organic manure have been shown to optimize nutrient use efficiency, reduce nutrient losses, and improve long-term soil health (Adekiya *et al.*, 2019).

Given the pressing need to maintain soil quality in the face of population growth and climate change, research on the comparative and combined effects of cow dung, poultry manure, and NPK fertilizer on soil quality is both timely and essential. Such studies provide evidence for sustainable nutrient management practices that balance immediate productivity with long-term soil health.

II. MATERIALS AND METHODS

A. Study Area

Kitti is a typical rural community located within the outskirt of the Abuja Municipal Area Council (AMAC). The geographical positioning of Kitti community is between Latitude 8.888338° to 8.903620° and longitude 7.364957° to 7.398132° with an average elevation of 1,432ft. Beside the geographical positioning of Kitti, the basic geographical features and characteristics of Kitti is typical to that of AMAC. The map of the study area is presented below in Figure 1 and Figure 2.

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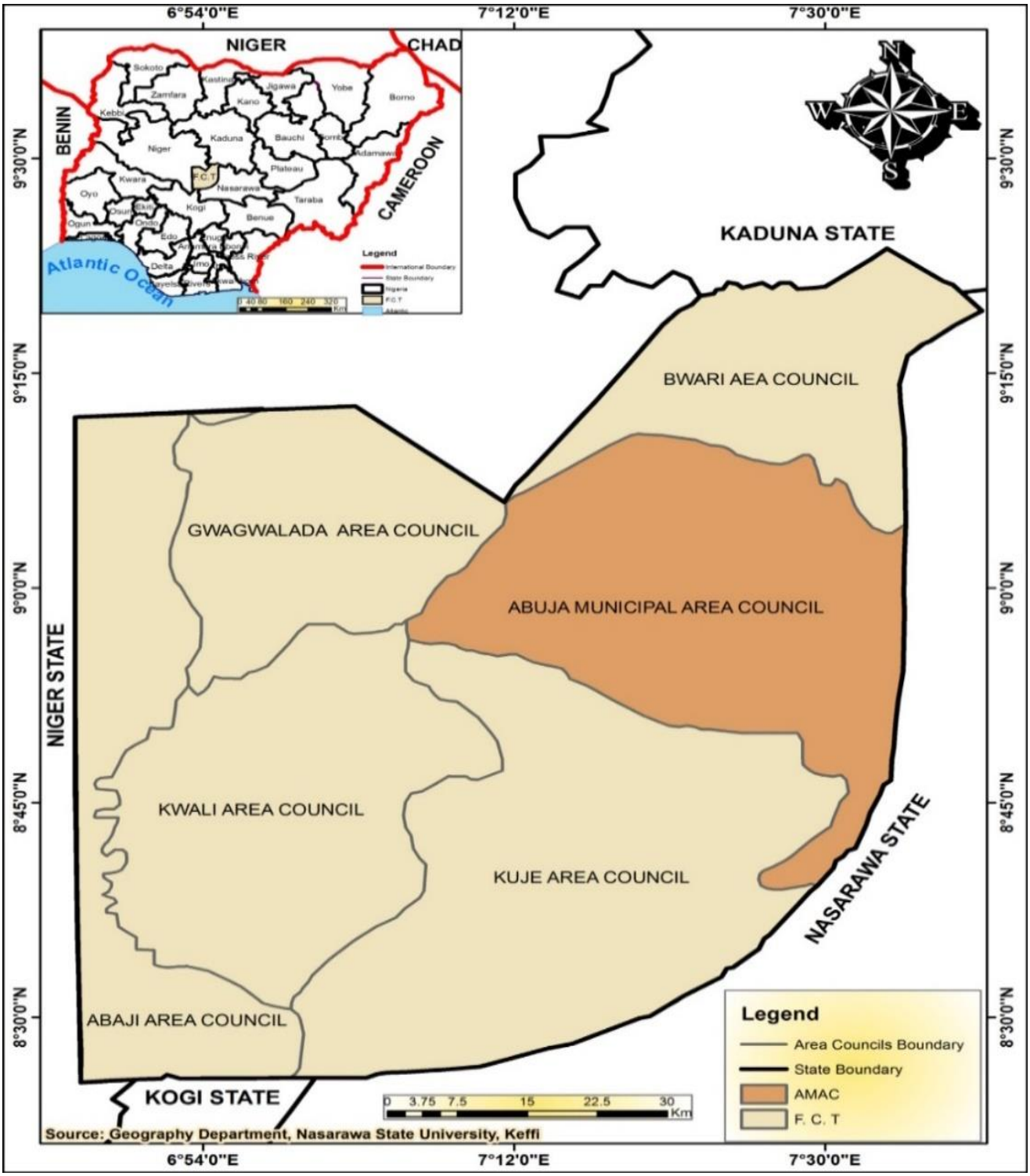

Fig 1: FCT Showing Abuja Municipal Area Council
Source: Abuja Geographic Information System (AGIS, 2019)

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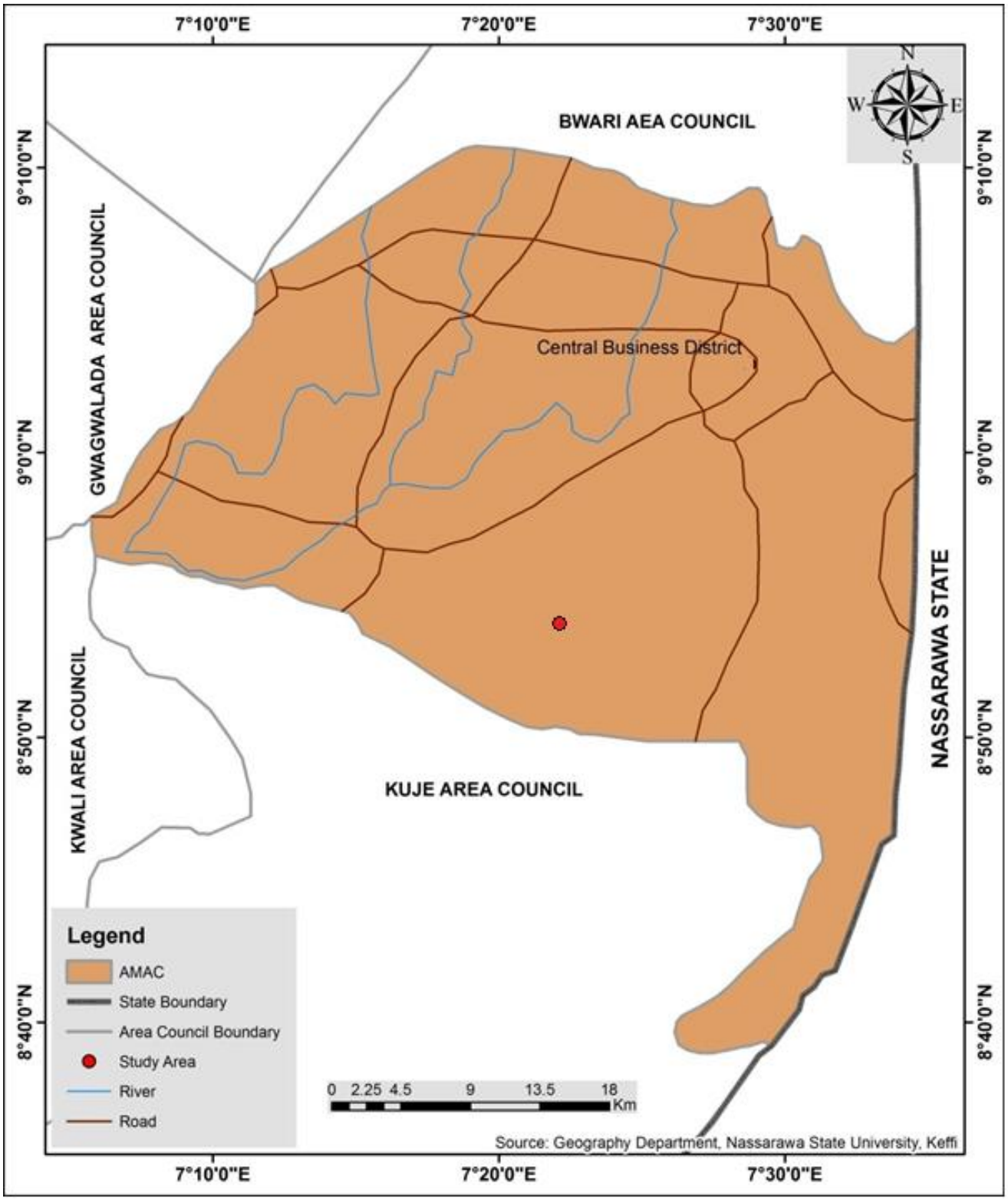

Fig 2: The study area
Source: Abuja Geographic Information System (AGIS, 2019)

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According to Edicha and Mgbanyi (2013), AMAC experiences the Aw or Tropical Continental climate characterized by twoseasons annually, which include the warm humid wet season and the extremely hot dry. The wet season last for the period 7 months (April-October), while the dry season last for the period of 5 months (November-March). These seasons are intermittent by the harmattan wind which occur during the months of December to January (Ibilewa, Ishaya and Magaji, 2021).

The average monthly maximum temperature of AMAC varied from 37.7°C in the month of August to 28.8°C in March, while the average daily temperature varied from 38°C daytime to 24°C at night, indicating a deviation of ±2°C from the average daytime temperature. Studies shows that the chilliest nights can be accompanied by daytime extreme temperatures above 40°Cduring the dry season (Adakayi, 2000; Adams and Bamanga, 2020).

AMAC is underlain by the crystalline basement complex rocks and Nupe sandstones which consists of granitic rocks (Adams and Bamanga, 2020). The textural properties of the underlain rock are mostly medium to coarse grained, typically grey colored, even grained, massive and homogenous (Aleke and Nwachukwu, 2018). The basement rock is generally within the surface, with variable overburden thickness that constitutes aquifer zone (Aleke and Nwachukwu, 2018). These zones are permeable due to the presence of fracture of weathering.

The soil properties of AMAC and Kitti in particular are modified by the geological mineralogy of the parent materials. Balogun (2021) identified three local soil types in AMAC and described them as the alluvial soils, the luvisols and the entisols. These soil types show high level of variability comprising mainly of sand, silt, clay and gravel. Alluvial soils are predominantly found in the valleys of the various Rivers within AMAC but highly concentrated at the valley of River Usuma. The water table around the area where this soil type dominates is usually very high. It has well decomposed organic matter content in the surface layer; its texture is heavier with depth as the weathered parent material is approached (Balogun, 2001). The luvisols and entisols are soils on the foot plains of inselbergs, wooded hills and mountains. Soils within this area are generally coarse and poorly drained almost all year round and to a great extent support farming due to its various natures (Edicha and Mgbanyi, 2013).

B. Field Work

Field experiments was done at a randomized complete plot design with four replications, this was carried out at Kitti Village in Abuja Municipal Area Council, to evaluate the potential of Poultry manure application towards crop production improvement in Abuja Municipal Area Council.

The size of each experimental plot was 5mx5m square parcel. Plots were separated by a margin of 2m apart with a barrier built at the height of 5cm. The experiment was performed in the same location at same slope angle. Two bags of 700 tons of dry poultry manure were applied to the poultry plot and the maize was planted at the depth of 15cm. The experimental plots were cleared before set up and were weed at three weeks interval after planting till point of harvest.

Maize farm was selected as appropriate to assess the potential of Poultry manure application plot. For the experiment, the treatment consists of:

- Application of NPK 15-15-15 fertilizer applied alone based on field recommendation for maize production
- Application of poultry manures alone based on field recommendation for maize production.
- Application of cow dung manure application plot at appropriate rate
- control, no amendment whatsoever (C).

C. Sampling Procedure

Replica plots were identified in the study area which was measured 5m length and 5-meter breadth, a grid line was super imposed and then the grid was measured 1 meter, making 25 grid area for an experimental point, sample was collected at each point at depth of 0-15cm for top soil and 15-30cm for sub soil, twenty-five (25) top soil and twenty five (25) sub soil sample were collected at each experimental plot making a total of two hundred (200) soil sample collected altogether at the study area, after which the top soil samples were composted as one and the sub soils were also composted as one, making one top soil sample and sub soil at each replica plot. Soil samples were collected using soil auger and were packed and represented concerning each site. The samples collected were further stored in clean polythene bags before laboratory analysis.

The soil auger and GPS, notebook and camera were used during data collection. During data collection, quality assurance was strictly followed and soil samples were guided against any form of contamination. After soil collection, the sample was transported to Abuja branch of research laboratory of Department of Soil Science and Land Resources Management, University of Uyo.

D. Statistical Analysis

The data was analyzed using descriptive and inferential method of data analysis. Hypothesis was tested using one way-analysis of variance.

➢ *Descriptive Statistics of Data*

Descriptive statistics was used to analyze the soil properties of the replica plot. The value obtained was analyzed empirically with the use of measures of central tendency such as frequency and mean which was presented in Tables.

➢ *Inferential Statistic of Data*

Data was subjected to student t-test and one way analysis of variance using SPSS software package 10.1, and mean

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separation was done using t-test at $p<0.05$ where significant differences was observed. This was used to determine if there was significant variation in soil treated with poultry manure and that of control.

III. RESULTS

➢ *Effects of Organic (Cow Dung and Poultry Manure) and NPK Fertilizer on Soil Quality*

Table 1: Soil Physical Properties on the Experimental Plots

Sample ID	Depth	Sand	Silt	Clay	TC	Bd	TP	MC	HC
	Cm	g/kg				g/cm^3	%		cm/hr
Control plot	0 - 15	53.9	30.9	15.2	SL	1.51	31.32	9.3	1.21
	15 - 30	45.3	15.9	38.8	SCL	1.55	30.66	11.23	0.96
Chemical Fertilizer application plot	0 - 15	52.9	31.9	15.2	SL	1.33	48.1	11.31	1.83
	15 - 30	61.5	28.1	10.4	SL	1.3	47.01	13.1	1.72
Poultry Manure application plot	0 - 15	53.1	32.7	14.2	SL	1.29	49.71	15.91	1.79
	15 - 30	71.2	15.7	13.1	SL	1.22	47.61	15.01	1.78
Cowdung manure application plot	0 - 15	59.1	18.5	22.4	SCL	1.37	39.3	14.9	1.61
	15 - 30	54.1	19.5	26.4	SCL	1.29	36.01	15.03	1.56

Source: Department Of Soil Science and Land Resources Management. Research Laboratory, University of Uyo
NB: TC = textural class, Bd = bulk density, TP = total porosity, MC = Moisture content, HC = Hydraulic conductivity
SL = sandy loam, SCL = sandy clay loam, gSL = gravelly sandy loam, gSCl = gravelly sandy clay loam.

The result on Table 1 shows that top soil and sub soil of chemical fertilizer plot and poultry manure application plot and top soil of control plot is sandy loam while the top and sub soil of cowdung plot and sub soil of control plot is sandy clay loam. In other words, soil of the chemical and poultry fertilizer is more stable as compare to soil of other plots, followed by control plot and then cow dung manure application plot plot.

Bulk density which affects the rate of porosity of soil shows that top and sub soil of the control plot recorded highest value, 1.51g/cm3 and 1.55g/cm3 of bulk density and lowest value of porosity of 31.32% and 30.36% on top and sub soil respectively while poultry recorded lowest value of bulk density on top and sub soil of 1.29g/cm3 and 1.22g/cm3 and highest value of porosity of 49.71% and 47.61% on top and sub soil respectively. This shows that control plot soil contains lower moisture for plant intake while poultry manure application plot as higher soil moisture for plant intake. The moisture content is lowest at the control plot on top and sub soil of 9.3% and 11.23% and highest at the top and sub soil of the poultry manure application plot with 15.91% and 15.01% respectively.

Table 1 further shows that hydraulic conductivity is highest at the top soil of the chemical fertilizer plot with 1.83cm/hr and highest at the sub soil of poultry manure application plot with 1.78cm/hr, however it is lowest at the top and sub soil of control with 1.21cm/hr and 0.96cm/hr respectively.

Table 2: Soil Chemical Properties on the Experimental Plots

Sample ID	Depth	pH	EC	OC	OM	TN	AV. P	K	Ca	Mg	Na	EA	AL+	ECEC	BASE SAT.
	cm	(H2O)	dS/m	%			mg/kg	coml/kg							%
Control Plot	0 - 15	6.41	0.211	0.1	0.112	0.005	2.101	0.006	1.13	1.23	0.021	1.87	1.45	3.023	45.1
	15 - 30	6.59	0.231	0.11	0.121	0.011	3.045	0.011	1.04	1.14	0.011	1.14	1.1	3.913	39.312
Chemical Fertilizer application plot	0 - 15	6.61	0.461	0.15	0.213	0.015	38.31	0.101	4.02	3.091	0.045	3.49	1.61	10.23	65.31
	15 - 30	6.72	0.441	0.21	0.251	0.031	39.55	0.105	3.79	2.44	0.039	3.98	1.15	9.521	60.11

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Poultry Manure application plot	0 - 15	6.79	0.613	0.511	1.031	0.213	46.81	1.031	7.35	4.01	0.103	4.31	2.031	11.98	79.41
	15 - 30	6.81	0.631	0.452	1.101	0.221	49.22	1.106	7.01	3.945	0.067	3.77	1.502	10.31	61.32
Cowdung manure application plot	0 - 15	6.59	0.461	0.429	0.312	0.149	44.31	0.613	6.71	3.01	0.039	3.56	3.021	11.03	75.01

NB: EC = electrical conductivity, OC organic carbon, OM = organic matter, TN = total nitrogen, AV.p Available phosphorus, Ca = calcium, Mg = magnesium, Na = sodium, K Potassium, EA = exchangeable acidity, AL = aluminum, ECEC = effective cation exchange capacity, Base sat. = base saturation

The result on Table 2 shows that soil of the experimental plot is acidic with all values less than 7, however, poultry plots record highest value of 6.79 and 6.81 on top soil and sub soil while lowest value of 6.41 for top soil was recorded at the control plot and 6.31 for sub soil on cow dung manure application plot.

Highet value of electrical conductivity of 0.613 dS/m and 0.631 dS/m on top and sub soil respectively was recorded at the poultry manure application plot while lowest value of 0.211 dS/m and 0.231 dS/m for top and sub soil respectively was recorded at the control plot.

Poultry recorded highest value of Organic carbon (0.511% and 0.452%), organic matter (1.031% and 1.101%), total nitrogen (0.213% and 0.221%), available phosphorus (46.81mg/kg and 49.22mg/kg), potassium (1.031 coml/kg and 1.106 coml/kg), calcium (7.35coml/kg and 7.01coml/kg), magnesium (4.01coml/kg and 3.945coml/kg), sodium (0.103coml/kg and 0.067coml/kg) on top and sub soil, ECEC (11.98 and 10.31) and base saturation (79.41and 61.32) While control recorded lowest value of Organic carbon (0.1% and 0.11%), organic matter (0.112% and 0.121%), total nitrogen (0.005% and 0.011%), available phosphorus (2.101mg/kg and 3.045mg/kg), potassium (0.006 coml/kg and 0.011coml/kg), calcium (1.13coml/kg and 1.04coml/kg), magnesium (1.23coml/kg and 1.14coml/kg), sodium (0.021coml/kg and 0.011coml/kg), ECEC (3.023coml/kg and 3.913coml/kg) and base saturation (45.1% and 39.312%).

Poultry manure application plot record highest value of exchange acidity on top soil with 4.31coml/kg while cow dung manure application plot recorded highest value of 3.91coml/kg on sub soil, the lowest value of 1.87coml/kg and 1.14 coml/kg were recorded on top and sub soil of the control plot.

Cow dung manure application plot plot recorded heist value of aluminum on top and sub soil with 3.021coml/kg and 2.01coml/kg while lowest value on top and sub soil was recorded at the control with 1.45coml/kg and 1.1coml/kg.

Table 3: Soil Micro Nutrients Properties on the Experimental Plots

Sample ID	**Depth**	**Fe**	**Mn**	**Cu**	**Zn**
	cm	**mg/kg**			
Control Plot	0 - 15	151.2	95.64	1.012	3.31
	15 - 30	131.6	90.3	1.122	3.351
Chemical Fertilizer application plot	0 - 15	133.3	131.3	1	4.091
	15 - 30	121.4	193.2	1.012	3.132
Poultry Manure application plot	0 - 15	401.3	377.2	2.001	3.31
	15 - 30	321.3	356.1	1.301	2.981
Cowdung manure application plot	0 - 15	339.1	301.3	1.331	2.134
	15 - 30	207.1	299.1	1.431	1.009

Source: Department Of Soil Science and Land Resources Management. Research Laboratory, University of Uyo
NB: Fe = iron, Mn = manganese, Cu copper, Zn = Zinc

The result of Table 3 shows that highest value of iron (401.3mg/kg and 321.3mg/kg), manganese (3.77.2mg/kg and 356.1mg/kg) for top and sub soil was recorded on the poultry manure application plot while the lowest value was recorded on the control plot.

Highest value of copper of 2.001mg/kg on top soil was recorded at the poultry manure application plot while the highest value on sub soil of 1.431mg/kg was recorded at the cow dung manure application plot, lowest value of 1mg/kg and 1.012mg/kg was recorded at the chemical fertilizer plot for top soil and sub soil respectively.

Chemical fertilizer plot record highest value of zinc on top soil with 4.091mg/kg and control recorded highest value of 3.351mg/kg on sub soil, the lowest value on top and sub soil of 2.134mg/kg and 1.009mg/kg respectively was recorded at cow dung manure application plot.

Table 4: Test of Significance of Soil Properties Among the Replica Plots at Top Soil

ANOVA						

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Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	11826.59	3	3942.196	2.731217	0.535861	2.699393
Within Groups	517563	96	5391.281			
Total	529389.6	99				

From the analysis, the F-calculated is 2.73 while the table value at α=0.05 is 2.69. It then means that since the calculated value of 2.73 is higher than the table value 2.69, therefore the hypothesis is rejected, therefore it is concluded that there is significant difference in the soil properties among the replica plots at top soil. This implies that some nutrients enrich the soil more than others at the top soil.

Table 5: Test of Significance of Soil Properties Among the Replica Plots at Sub Soil

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	7104.257	3	2368.086	2.572429	0.634508	2.699393
Within Groups	397143.2	96	4136.908			
Total	404247.5	99				

From the analysis, the F-calculated is 2.57 while the table value at α=0.05 is 2.69. It then means that since the calculated value of 0.57 is lower than the table value 2.69, therefore the hypothesis is accepted, therefore it is concluded that there is no significant difference in the soil properties among the replica plots at sub soil.

IV. DISCUSSION

➢ *pH*

The pH soil in the study carried out by Sadia *et al.*, (2022) were within the value recorded in the study area, however the value recorded in their poultry was less acidic with 7.13 as compare to 6.79 recorded in the study area, the value recorded were higher than value recorded by Izechukwu *et al.*, (2007), which shows that it was more acidic as compare to the result obtained in this study. The value of organic carbon recorded in the study area is lower than value recorded by Sadia *et al.*, (2022) which ranges between 1.04 to 1.49, the study conforms with the result of the finding that poultry manure increases organic carbon than cow dung manure application plot and chemical fertilizer, this could be due to the nutrients contain in the poultry waste.

➢ *Organic Matter*

The value of organic matter recorded in the study area is quite lower as compare to the study of Izechukwu *et al.*, (2007) of 3.6 to 5.30. Application of organic manures such as cow dung manure application plot and poultry manure exhibit an increase of soil organic carbon as mentioned by several researchers (Mondal *et al.*, 2019; Sanni, 2016; Noor *et al.*, 2007). Mathew and Nair (1997), reported that the organic carbon was increased by the application of organic manure. The positive impact of poultry manure and cow dung manure application plot on the soil organic carbon might be due to the high organic carbon status and slow decomposition rate of those applied manures as stated by Cooperband (2002).

➢ *Total Nitrogen*

The value of total nitrogen recorded in the study area is very low compare to the study of Sadia et al., (2022) of 54 to 66, the study confirms higher value of nitrogen recorded in the poultry as compare with cow dung manure application plot and control plot, the result recorded is similar to finding of Izuchukwu et al., (2007). The trend of increasing available N with increasing rates of manures could be result of increased organic matter content and microbial activities which might have enhanced the decomposition of the organic N. Similar result was reported by Mondal et al., 2012; Sanni, 2016; Monira et al., 2007). Ogunbanjo et al. (2007) observed that poultry manure caused the highest soil available N compared to other animal manures.

➢ *Available Phosphorus*

The result of available phosphorus recorded in this study is higher than value recorded by Izuchukwu et al., (2007) of 0,07 to 0.14 in the study conducted in Owerri, Imo state, Nigeria, only the value recorded on control is similar to the value recorded by Izuchukwu of 3.14 to 3.55. Also, the result is higher than value recorded by Sadia et al., (2022) of 12.70 to 15.87, only the value recorded in the control is lower. The finding still conforms to the result of the finding of higher value recorded on the poultry manure application plot as compare to cow dung manure application plot and control plot. Comparison between these two manures indicated that the poultry manure exerted higher response relative to cow dung manure application plot. Maerere et al. (2001) reported significant higher residual P in soils treated with poultry manure comparing to other types of manure. These findings are also supported by the reports of Akanni and Ojeniyi (2008) and Adeleye et al. (2010).

➢ *Potassium*

The value of potassium recorded in the study area is quite lower compared to value recorded by Izechukwu (2007) of 1.08 to 1.66 and Sadia et al., (2022) of 96.33 to 170.00., the result is

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in contrast to the result obtained in the study as higher of potassium were higher on cow dung manure application plot than poultry plot. The present findings partially agree with the results of Olowoake and Adeoye (2013) who reported that the organic manure increased soil potassium. They suggested that increase of available potassium might be as a result of the slow rate in which their nutrients are released into the soil. Islam (2006) evaluated that poultry manure showed the best performance on available potassium than cow dung manure application plot and fertilizer.

➢ *Calcium*

The value of calcium recorded is similar to value recorded by Izechukwu et al (2007) and lower than value recorded by Sadia et al., (2022) of 402.10 to 612.00, the finding contradicts the result of the finding with higher value recorded on the cow dung manure application plot as compared to poultry manure and control plot.

➢ *Magnesium*

The value of magnesium recorded in the study area is higher compared to the value recorded by Izechukwu *et al.*, (2007) of 1.65 to 1.88 and lower as compared to value recorded by Sadia et al., (2022) of 238.5 to 295.00, the study of Sadia *et al.*, (2022) and Izechuwku confirm the result of the finding that value of chemical properties on the poultry manure application plot are higher than value on cow dung manure application plot and control plot due to increase of nutrients added by poultry waste. Similar reports were attributed by Akannni and Ojeniyi (2008) and Adeleye *et al.* (2010) as they showed that poultry manure and cattle manure improved Mg status of soil.

V. CONCLUSION AND RECOMMENDATION

The study also concluded that poultry manure improves, physical, chemical and micro nutrients of soil compare to cow dung manure application plot and chemical fertilizers. Also, the study established that poultry manure application plot has higher moisture content as compare to other experimental plots, while chemical fertilizer application plot has poorest moisture content of the maize yield, it concluded that maize grain of the poultry manure application plot has higher preservative strength against the maize gran on other experimental plots.

Therefore, in order to improve soil productivity as regards to manure application, the following are recommended;

- Manure often is typically considered as a waste and government policies are strongly related to this view. This implies a greater focus on risk management and tends to limit use of manure rather than on the potential benefits of manure use as a fertilizer. Good manure management is also hindered by the fact that responsibilities for manure management are often spread over a number of ministries, without clear responsibilities and without good enforcement of rules. Based on these findings we recommend that government policies should regard manure as a fertilizer and that they enact and enforce manure management policies that look to utilize this resource while still mitigating associated risks to human health and the environment.
- Government ministries also need to coordinate their policies on manure management to avoid inconsistencies and to clarify responsible parties for enforcement. It is necessary therefore, to organize sensitization programs to inform policy makers and other actors of the benefits of manure management, giving them a better chance to create a favorable environment for adoption of these practices, combined with adequate control and enforcement of such policies.

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