Evaluation of Poultry Manure as a Fertility Amendment for Maize Production in a Part of Guinea Savannah Region of Nigeria

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Abstract: The study assessed how poultry manure as a fertility amendment for maize production in a part of guinea savannah region of Nigeria. The study adopted an experimental design. The research used primary sources of data; Four separate farmlands of 5mx5m square parcel located at Kitti Village, in Abuja Municipal Area Council was set up for the study. The farmlands were cultivated to maize plant for the period of three months (90 days) in the dry season ((January 2023 to March 2023), Three weeks after planting, chemical fertilizer was applied to plot B, Plot A was conditioned, thus constitutes the control plot, Plot C was enriched with poultry manure, plot D was conditioned with cow dung manure application plot, 150 liters of water was applied to the poultry plot and control plot per weekly, Two bags of 700 toones of dry poultry manure was 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, Data was subjected to student t-test and one way analysis of variance using SPSS software package 10.1, and mean separation was done using t-test at $p<0.05$ where significant differences was observed. Findings revealed that highest weight of yield was recorded on poultry manure application plot when it was wet and dry (9.1kg and 7.8kg), while the lowest value was recorded on control plot (2.6kg and 2.2kg). The total highest weight of maize yield (16.9kg) was obtained from treatment with poultry dropping followed by cow dung manure application plot (13.4kg), both of the treatment ranks highest, this is attributed to the essential nutrients embedded in them while they are significantly different from the chemical and control. The finding shows 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 study revealed that poultry manure is more suitable for maize grain. The study recommended that 20t/ha of poultry manure is adequate for maximum growth and yield of Maize grains.

***Keywords**: Poultry Manure, Fertility Amendment and Maize Production.*

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I. INTRODUCTION

Maize (Zea mays L.) is a strategic staple and cash crop in Nigeria's Guinea savannah, where it underpins household food security, feed industries, and rural incomes. Yet yields in farmers' fields remain well below genetic potential due to soil fertility constraints, erratic rainfall distribution, and limited access to quality inputs (FAO, 2017; Nkonya *et al.*, 2016). The Guinea savannah—characterized by a unimodal rainy season (roughly 1,000–1,400 mm), high temperatures, and pronounced dry-season desiccation—tends to host highly weathered soils (commonly Alfisols and Ultisols) with low organic matter, low cation exchange capacity (CEC), and widespread nitrogen (N) and phosphorus (P) deficiencies (Lal, 2015; Jones & Wild, 1975). Under continuous cultivation and residue removal, these

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soils rapidly lose organic carbon, exacerbating acidity in patches, nutrient mining, and structural degradation.

Within this context, replenishing soil organic matter and plant-available nutrients is a central agronomic challenge for sustainable maize production. Mineral fertilizers (e.g., NPK formulations) deliver immediately available nutrients and can boost yields in the short term, but sole reliance—especially at suboptimal rates—often fails to rebuild soil organic matter or improve physical quality, and can contribute to acidification and declining biological activity over time (Manna *et al.*, 2005; Vanlauwe *et al.,* 2015). Organic amendments, notably poultry manure (PM), offer a complementary pathway: beyond supplying macro- and micronutrients, PM contributes organic carbon that improves aggregation, water retention, infiltration, and microbial function—key properties for resilience in a rain fed savannah ecology (Adeniyan & Ojeniyi, 2005; Ayeni, 2010).

Poultry manure is comparatively nutrient-dense among farmyard manures—especially in N and P—owing to feed composition and low bedding dilution, and it mineralizes relatively rapidly under warm, moist conditions typical of the Guinea savannah (Adeleye *et al.*, 2010; Agele et al., 2011). Empirical studies across Nigeria have shown that PM can raise soil pH slightly (buffering acidity), increase soil organic carbon and total N, and elevate available P and exchangeable K, resulting in improved maize growth parameters (leaf area index, plant height) and grain yield (Adeniyan & Ojeniyi, 2005; Adekiya *et al.,* 2019). Benefits are often most pronounced where baseline fertility is low and when PM is properly processed (e.g., well-cured or composted), applied at appropriate rates (commonly 2–10 t ha^{-1}), and incorporated before planting to synchronize nutrient release with crop demand (Ayoola & Makinde, 2007; Chivenge *et al.,* 2011).

However, outcomes vary with manure quality, application timing, and rate; excessive or poorly timed applications can lead to ammonia volatilization, transient salt injury, or P accumulation with attendant runoff risks (Palm *et al.,* 1997; Bindraban *et al.,* 2020). Variability in nutrient content between PM batches (due to bedding, feed, and handling) necessitates context-specific calibration and, where feasible, simple rapid tests or standardization protocols. Integrated Nutrient Management (INM)—combining PM with judicious mineral NPK—often delivers superior agronomic efficiency and more stable yields than either input alone, by improving synchrony, reducing losses, and sustaining soil biological function (Gruhn *et al.,* 2000; Vanlauwe *et al.,* 2015).

Given the ecological and management realities of the Guinea savannah, a systematic evaluation of PM as a fertility amendment for maize is timely. Such work can quantify PM effects on key soil quality indicators (e.g., SOC, pH, available P, total N, bulk density, microbial activity) and link them to yield and yield components, while benchmarking against (or in combination with) mineral NPK. Evidence from well-designed replica plots can guide best-bet rates, placement, and timing, inform extension recommendations, and support climate-smart intensification pathways that maintain productivity while rebuilding soil capital.

In sum, evaluating poultry manure for maize under Guinea savannah conditions addresses a critical research-to-practice gap: how to optimize locally available organic resources to enhance soil quality, stabilize yields under rainfall variability, and reduce sole dependence on costly mineral inputs—thereby advancing SDG 2 (Zero Hunger) and SDG 15 (Life on Land) through sustainable soil stewardship..

II. MATERIALS AND METHODS

- *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.

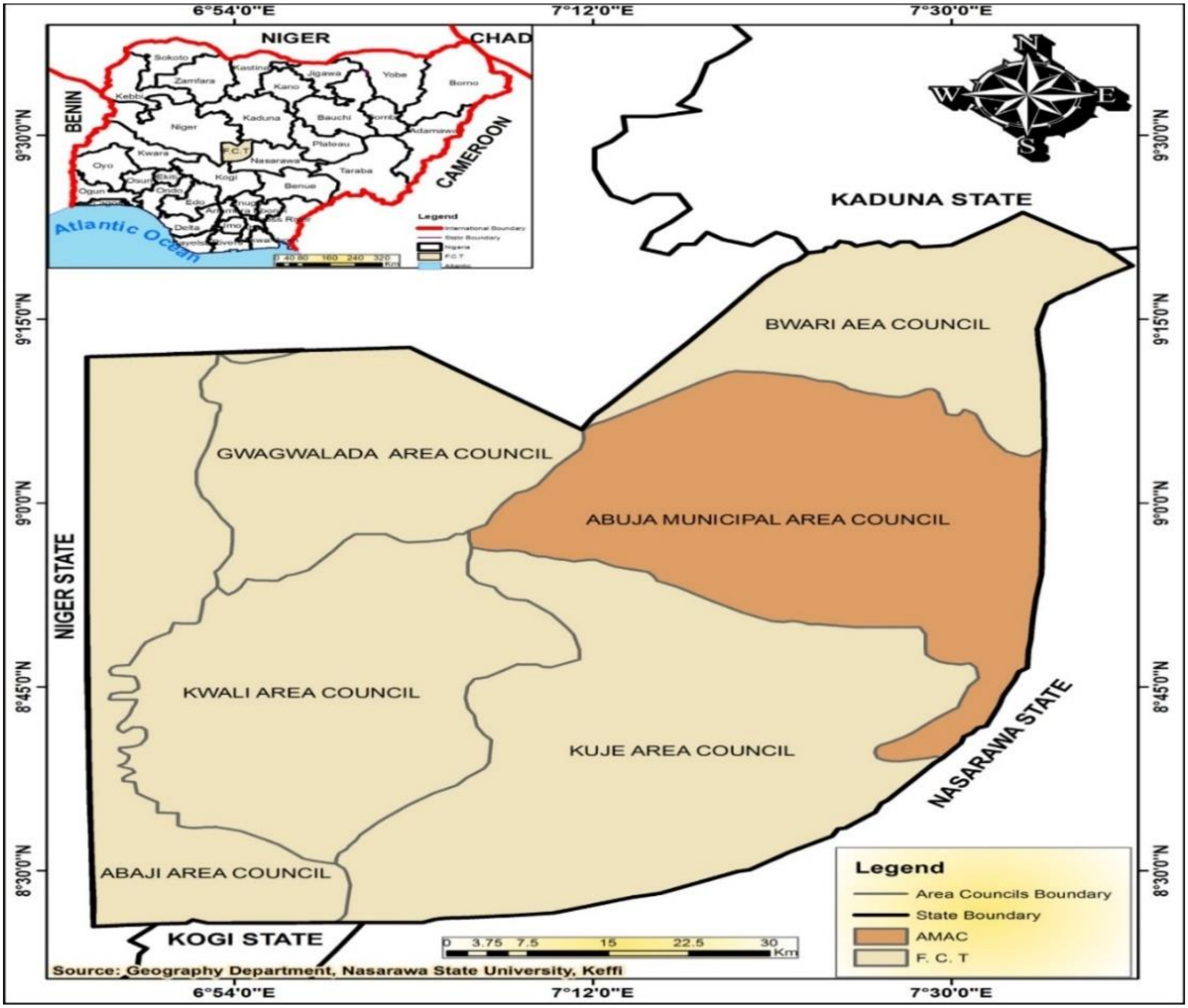

Fig 1: FCT Showing Abuja Municipal Area Council
Source: Abuja Geographic Information System (AGIS, 2019)

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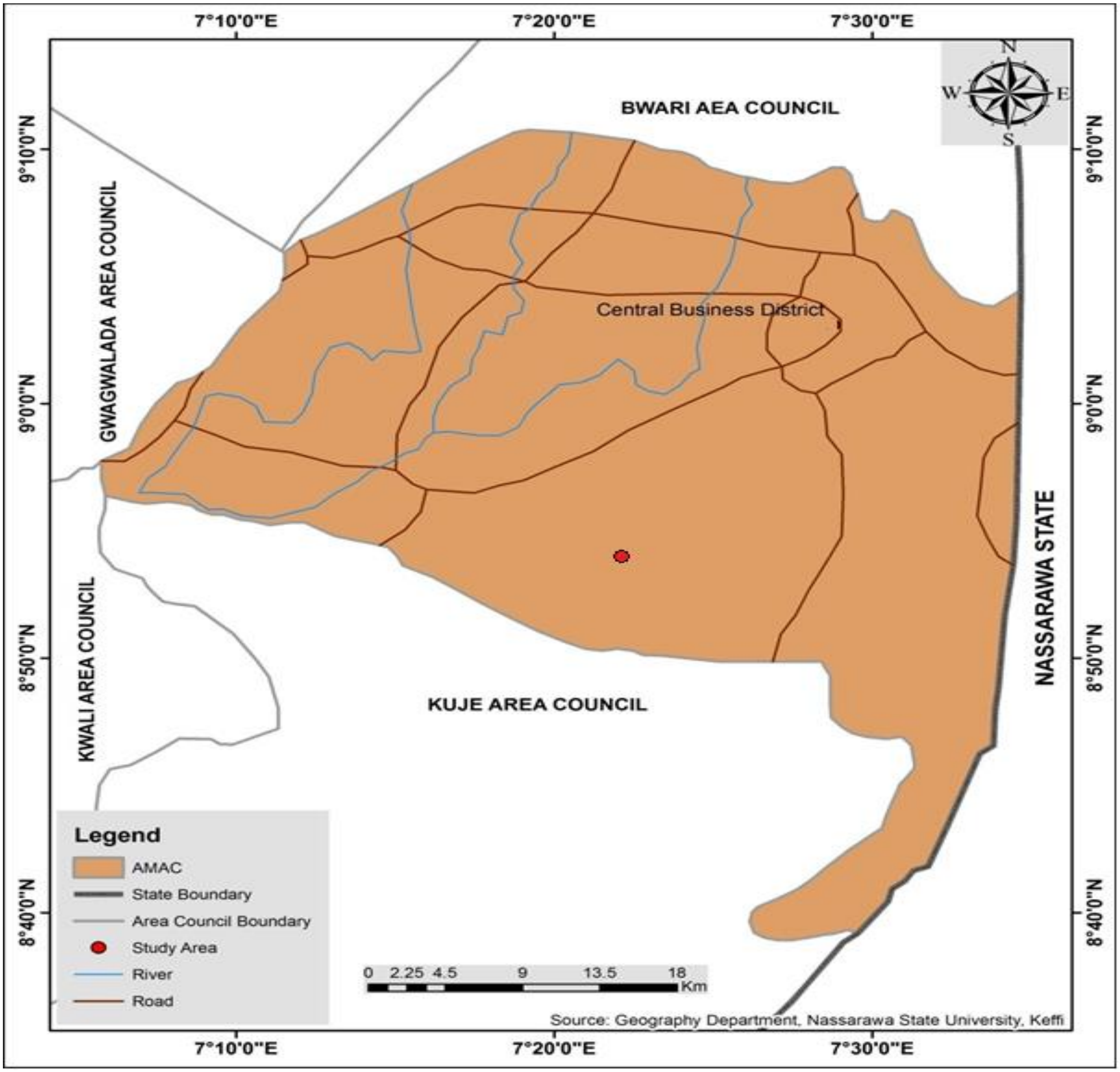

Fig 2: The study area
Source: Abuja Geographic Information System (AGIS, 2019)

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).

➤ *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).

➤ *Sampling Procedure*

Crop Yield was harvested after crops reached maturity and grain moisture content had decreased. Multiple passes were completed in each plot for grain harvest, with the average values reported for crop yields. Grain moisture contents were measured for each plot through grain analysis immediately after harvest or at time of harvest (Harvest Master, Juniper Systems, Inc.).

Reported yield values were corrected for moisture contents of 15.5% for corn. Sample collected were measured to determine nutrients and moisture contents of maize grain as measure of the preservative strength in the respective plots. Maize sample collected when it was wet and dry and was transported to laboratory to determine and ascertain the nutritional and moisture value of maize leaves/straw for animal feeds across the four replica plots; and determine the nutrient content (quality) of maize grain harvested from the respective plots.

➤ *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 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

➢ *Maize Yield in the Replica Plots*

Table 1: Weight of Maize Yield at the Replica Plots

Plot	Kilogram		Container Weight	Actual Size		Container	Total Actual Size
	Wet	**Dry**	**Wet**	**Wet**	**Dry**		
Control Plot	2.8kg	2.4kg	0.2	2.6kg	2.2kg	0.2kg	4.8kg
Chemical fertilizer application plot	5.8kg	5.2kg	0.2	5.6kg	5.0kg	0.2kg	10.6kg
Poultry manure application Plot	9.3kg	8.0kg	0.2	9.1kg	7.8kg	0.2kg	16.9kg
Cow dung manure application plot manure application Plot	7.4kg	6.4kg	0.2	7.2kg	6.2kg	0.2kg	13.4kg

Source: Author, 2023

The result shows, highest weight of yield was recorded on poultry manure application plot when it was wet and dry (9.1kg and 7.8kg), followed by cow dung manure application plot (7.2kg and 6.2kg), chemical fertilizer application plot (5.6kg and 5.0kg) while the lowest value was recorded on control plot (2.6kg and 2.2kg). The total highest weight of maize yield (16.9kg) was obtained from treatment with poultry dropping followed by cow dung manure application plot (13.4kg), both of the treatment ranks highest, this is attributed to the essential nutrients embedded in them while they are significantly different from the chemical and control.

Table 2: Test of Significant Variation in Maize Yield in the Four Plots.

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	52.29833	3	17.43278	3.765166	0.186199	3.098391
Within Groups	197.52	20	9.876			
Total	249.8183	23				

Source: SPSS, 2023

From the analysis, the F-calculated is 3.76 while the table value at $\alpha=0.05$ is 3.09. It then means that since the calculated value of 3.76 is higher than the table value 3.09, therefore the hypothesis is rejected, we therefore concluded that there is significant variation in maize yield in the four plots, this corroborates the finding established above, as value recorded in poultry significantly varies with value of other plots, recording highest value while control plot recorded the lowest value. This implies that poultry manure increased the yield of maize than other manure and chemical fertilizer and control plot.

➢ *Suitability of Poultry Manure for Maize Growth*

Table 3: Moisture Contents of Maize Grain as Measure of the Preservative Strength in The Replica Plots

Parameters		**Control Plot Maize**	**Chemical Fertilizer Maize**	**Poultry Manure Maize**	**Cow Dung Manure Application Plot Manure Maize**
Moisture content %	Wet	13.60	12.96	13.69	13.20
	Dry	12.07	10.89	11.82	12.12
	Total	25.67	23.85	25.51	25.32
	Mean	12.84	11.93	12.76	12.66
	Stand deviation	1.08	1.46	1.32	0.76

Source: Author, 2023

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The result on Table 3 shows, highest moisture content of yield was recorded on poultry manure application plot (13.69) for wet matter and cow dung manure application plot (12.12) for dry matter. The lowest value was recorded at the chemical fertilizer plot for wet and dry matter of 12.96 and 10.89 respectively.

Table 4: Nutritional Value of Maize Leaves/Straw for Animal Feeds Across the Four Replica Plots for Dry Matter

Parameters	**Control plot stock**	**Chemical Fertilizer Stock**	**Poultry Manure Stock**	**Cow dung manure application plot Stock**
Cu (mg/Kg)	50.58	37.0	21.09	28.24
Fe (mg/Kg)	155.25	243.25	182.82	116.75
K (mg/Kg)	12337.65	12487.38	15235.69	12962.94
Mg(mg/Kg)	993.64	935.00	1054.73	945.64
Na(mg/kg)	226.66	133.43	178.26	175.37
Zn(mg/kg)	39.73	37.46	29.23	33.92
Ca(mg/kg)	3668.79	3090.58	2954.85	1886.98
Sulphur mg/Kg	22.78	38.95	46.04	48.92
Phosphorus mg/Kg	2.25	8.34	5.56	4.33

Source: Science and Technological Center Kwali, 2023

The result shows on Table 4 shows, highest copper (50.58), nitrate (226.66), calcium (3668.79) and zinc (39.73) were recorded on the control plot, highest value of iron (243.25) and phosphorus (8.34) was recorded on the chemical plot, highest value of potassium (15235.69), magnesium (1054.73), while highest value of Sulphur (48.92) was recorded on the cow dung manure application plot.

Table 5: Test of Significant Variation in The Nutritional Value of Maize Leaves/Straw as Potential Animal Feeds in the Respective Plots.

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	750340.2	3	250113.4	3.013136	0.997898	2.90112
Within Groups	6.09	32	19039593			
Total	6.1	35				

Source: SPSS, 2023

From the analysis, the F-calculated is 3.013 while the table value at α=0.05 is 2.90. It then means that since the calculated value of 3.013 is higher than the table value 2.90, therefore the hypothesis is rejected and therefore there is significant variation in the nutritional value of maize leaves/straw as potential animal feeds in the respective plots, this implies that control plot increased the nutritional value of maize leaves/straw as potential animal feeds in the respective plots.

Table 6: Wet and Dry Matter Maize Grain Harvested from the Respective Plots

Parameter mg/kg	**Control**		**Chemical fertilizer application plot**		**Poultry manure application plot**		**Cow dung manure application plot manure application plot**	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Cu	BDL	18.11	BDL	13.78	BDL	13.69	BDL	16.96
Fe	136.24	39.13	976.69	28.98	615.77	63.92	409.87	53.05
Potassium (K)	90539.45	6039.16	100531.15	5222.79	90245.16	5730.99	82126.17	5493.06
Magnesium (Mg)	7789.80	547.09	8406.15	456.45	8308.77	550.34	7967.54	556.18
Sodium (Na)	776.64	81.59	1094.70	78.18	571.65	61.13	5120.07	366.62
Zinc (Zn)	BDL	28.79	120.04	27.76	38.16	27.40	30.48	27.79
Calcium (Ca)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphur (S)	76.60	77.21	77.12	77.68	54.23	51.79	11.90	12.42
Phosphorus (P)	14.19	8.09	8.03	8.59	8.04	9.33	7.48	14.71

Source: Science and Technological Center Kwali, 2023

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The result on Table 6, shows that copper ranged between 13.69 to 18.11, this is similar to value recorded by John *et al*., (2011) in their study in Uyo, control plot (18.11) recorded highest value of copper for dry sample while poultry manure application plot record lowest value of 13.69). copper was higher in control cow dung manure application plot plot than the poultry manure plot and chemical plot, The finding is similar to finding by John *et al.,* (2011) where Cu were higher in cattle dung than in poultry.

Highest value of iron, potassium, magnesium, zinc for wet sample was recorded on chemical fertilizer application plot (976.69, 100531.15, 8406.15, and 120.04) while on dry sample, poultry recorded the highest value or iron (63.920) and control for potassium and zinc (6039.16 and 28.79), cow dung manure application plot for magnesium (556.18), cow dung manure application plot recorded highest value of sodium for dry and wet sample (5120.07 and 366.62). Chemical fertilizer recorded highest value of Sulphur for wet and dry sample (77.12 and 77.68). Control plot recorded highest value of phosphorus for wet sample (14.19) while cow dung manure application plot recorded highest value for dry sample (14.71).

IV. DISCUSSION

The result shows, highest weight of yield was recorded on poultry manure application plot when it was wet and dry, this study confirm assertion by scholars such as Eneji *et al*., (2018); Agbede and Ojeniyi, (2019), their results indicate that the addition of poultry manure improved the physical fertility of the cultivated soil leading to increased maize growth. The study results are in line with those of Payebo and Ogidi (2021) on their studies on the evaluation of the effect of cow dung manure application plot and poultry dropping on maize kernel yield in Delta state, while it was in contrast with finding by Boateng *et al*. (2006) and Wajid *et al.,* (2011) where higher value was recorded on the chemical fertilizer plot against poultry plot. Grain yield is a function of interaction among various yield components and these components are affected by source of nutrients and crop management practices. This study shows that poultry manure improves the size of yield than Cow dung manure application plot and chemical fertilizer as the yield weigh more in size more than other experimental plots, control plot recorded lowest yield sizes, this is because continuous cultivation of arable soils results in the deterioration of soil structure leading to reduced crop yield. Chemical fertilizer plot where NPK fertilizer was added recorded second to the lowest in size of yield, this proves the assertion by Bolan *et al*., (2022), which states that improving the chemical fertility status of the cultivated soil alone through chemical fertilizer input, is not enough to achieve the potential maximum yield of maize crop in soils.

The finding reveals that averagely, poultry site has higher moisture content as compare to other experimental plots, while chemical fertilizer application plot has poorest moisture content of the maize yield. This implies that maize grain of the poultry has higher preservative strength against the maize gran on other experimental plots. According to Weinberg *et al.,* (2008) it is easier to process maize grains at higher moisture contents (m.c.) and intermediate and high moisture content of maize was stored without spoilage in hermetically sealed jars and prevention of deterioration of the maize under such conditions is apparently due to the self-regulated anaerobic atmospheres generated under sealed conditions. It is expected that maize grain in poultry plot, under anaerobic condition will last longer than the maize grain of other experimental plots.

The findings confirm the finding by Basso *et al.* (2023) suggested that poultry manure addition increased water content in maize grain by around 23% compared to the control. High moisture content in soil of the poultry l plot implies that the soil of the poultry manure application plot improves moisture content of the maize than other experimental plots. The study implies that natural state of the soil better enhances moisture content of maize against applying nutrients enhancer to support the moisture content. Furthermore, the finding reveal that poultry manure application plot has more preservative strength than other experimental plot of the study area, this is as a result of maize germinating in its natural state without support with any chemical or nutrients. Addition of nutrients to soil not only enhances the soil for maize germination alone but other weed within the sampling plots, this weed will share in the moisture content of the soil thereby reducing the moisture content meant for the maize yield.

The result shows that control plots recorded highest value of two major nutrients require by animal especially cow to remain healthy and for the body to function properly, which are sodium and calcium and one micro or trace element (zinc), chemical fertilizer application plot also recorded two macro nutrients (phosphorus and magnesium), while cow dung manure application plot site recorded one macro nutrient (Sulphur). This shows that control site produces more macro and micro nutrients of maize leave and straw more than other experimental plots. This implies that maize leave and straw on the control plot is better feed for livestock as compared to maize leave and straw where poultry, cow dung manure application plot and chemical fertilizer is applied.

It is noted that accumulation of major mineral nutrients showed increase with increasing rate in case of cow dung manure application plot and poultry manure. In contrast this trend was not followed in case of N, Ca and Zn when the plant was treated with poultry manure. Higher doses of poultry manure resulted in a decrease in the uptake of N, and Ca in comparison to the lower doses. The reason might be attributed to the adverse effect of highest rate of poultry manure in the plant. But in case of Mg no such adverse effect was observed but remained higher to the immediate high doses of poultry manure.

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The result shows that averagely, chemical fertilizer application plot and cow dung manure application plot recorded highest value of nutrient for wet and dry matter, this is similar to the result presented by Solomon *et al.,* (2022) in their studies on the effect of different types of fertilizer (organic and inorganic) on some external features (height, leaves, stem diameter root and shoot dry weight) of the plants was observed. Their studies found out a significant increase were observed in both NPK and cow dung manure application plot treated plants over the control treatment. The result is in contrast to finding by Reyhan and Amisalani (2006) which reported increasing uptake of N, P and K with increasing doses in cow dung manure application plot and poultry manure plot.

V. CONCLUSION AND RECOMMENDATION

The study concluded that poultry manure improves the size of yield than cow dung manure application plot and chemical fertilizer as the yield weigh more in size more than other experimental plots. Furthermore, the study concluded that in terms of maize grain, it can be reported that uptake of nutritional content was better in poultry manure plot soil in comparison to the cow dung manure application plot and chemical plot. This might happen due to favorable nutrient content in poultry manure soil reaction created in soil where poultry manure was applied, while low nutritional value recorded on the cow dung manure application plot is attributed to longer time it takes for cow dung manure application plot to decompose. In terms of macro and micro nutrients for plants, the result shows that averagely, chemical fertilizer application plot and cow dung manure application plot is better than poultry and control experimental plot. Over all, the finding indicates that poultry dropping is better organic manure which should be used to substitute inorganic fertilizer due to their environmental friendliness and no health hazard posed on human being.

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

- It is recommended that 20t/ha of poultry manure is adequate for maximum growth and yield of Maize grains.
- It is recommended that to ascertain the variation in terms of nutrients as its relates to leaves, straw and maize, a further study of nutrients content of soil of the other nutrients should be analyzed.
- The study recommended a longer duration of study to establish the actual effect of different manure on cop yield and nutrients content.
- The study recommended more research into Poultry manure application, especially rates and method of application on different crops, and storage/composting process.

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