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Research Article

Effect of Varying Rates of Poultry Manure on the Growth and Yield of Maize (Zea mays L.) in Awka, Southeastern Nigeria

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Abstract

Low soil fertility remains a major constraint to sustainable maize (Zea mays L.) production in the humid tropics, often necessitating costly inorganic fertilizer inputs. A field experiment was conducted at the Teaching and Research Farm of Nnamdi Azikiwe University, Awka, Anambra State, Nigeria, during the 2025 wet cropping season (May–August) to evaluate the growth and grain yield response of maize to organic amendment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Treatments comprised four application rates of cured poultry manure: 0 (control), 5, 10, and 15 t ha−1 applied to the maize variety Oba Super 6. Data collected on plant height, leaf area index (LAI), cob length, 100-seed weight, and grain yield were subjected to Analysis of Variance (ANOVA), and treatment means were separated using Least Significant Difference (LSD) at $p \leq 0.05$. Results indicated that poultry manure application significantly ($p < 0.05$) improved all measured agronomic parameters compared to the unamended control. Plots treated with 15 t ha−1 recorded the tallest plants (214.6 cm), highest LAI (3.82), and maximum grain yield (4.28 t ha−1), representing a 131% yield increase over the control (1.85 t ha−1). However, grain yield at 15 t ha−1 did not differ significantly from the 10 t ha−1 treatment (4.05 t ha−1). Therefore, applying 10 t ha−1 of poultry manure is recommended as an economically viable rate for optimal maize production in the Awka agro-ecological zone.

Keywords: Zea mays, poultry manure, soil fertility, grain yield, Randomized Complete Block Design

1. Introduction

Maize (Zea mays L.) is one of the most important cereal crops in the world and a staple food for hundreds of millions of people in sub-Saharan Africa (FAO, 2023; IITA, 2022). In Nigeria, maize is consumed as fresh green maize, pap (ogi/akamu), tuwo, and as a raw material in the feed, brewing, and starch industries (Adeboye et al., 2021; Olaniyan, 2015). Its importance is linked to its high yield potential, short maturity period, adaptability to diverse agro-ecologies, and relatively high energy and protein content compared with many other cereals (Badu-Apraku and Fakorede, 2017; FAO, 2023). Despite this importance, average maize grain yields on farmers' fields in Nigeria, often 1.5–2.5 t ha−1, remain far below the genetic potential of improved hybrids such as Oba Super 6, which can attain 6–9 t ha−1 under good management (IITA, 2022; Olaniyan, 2015). Closing this yield gap is therefore central to food security, rural livelihoods, and the sustainability of cropping systems in southeastern Nigeria.

Low and declining soil fertility is widely recognised as the principal biophysical constraint to maize productivity in the humid tropics (Sanchez, 2002; Vanlauwe et al., 2015; Agegnehu et al., 2016). Soils in southeastern Nigeria are predominantly Ultisols and Alfisols that are strongly weathered, acidic, low in organic matter, and deficient in nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) (Ahn, 1993; Brady and Weil, 2017; Enwezor et al., 1989). Heavy rainfall promotes leaching of basic cations, aluminium toxicity,

and loss of organic matter, while continuous cropping without adequate nutrient replenishment accelerates nutrient mining (Lal, 2015; Agegnehu et al., 2016). In Awka, as in much of Anambra State, short fallows, erosion, and intensive cultivation have further degraded soil physical structure, reducing water retention, aeration, and root proliferation (Nwite et al., 2011; Obi and Ebo, 1995). Under such conditions, even improved varieties fail to express their yield potential because nutrient supply limits vegetative growth, leaf expansion, cob development, and grain filling (Marschner, 2012; Fageria, 2009).

Inorganic fertilizers can rapidly supply nutrients, but their high cost, irregular availability, adulteration, and the risk of soil acidification and nutrient imbalance limit their sustained use by smallholder farmers (Vanlauwe et al., 2015; Ayoola and Makinde, 2007). Organic amendments offer a complementary and often more sustainable pathway because they supply macro- and micronutrients, add organic matter, improve soil structure, buffer pH, enhance cation exchange capacity, and stimulate soil biological activity (Agbede et al., 2008; Brady and Weil, 2017; Agegnehu et al., 2016). Among organic materials, poultry manure is particularly attractive in Nigeria because poultry production is expanding rapidly, the manure is relatively concentrated in nutrients, and it is often available near urban and peri-urban farms (Agbede et al., 2008; Amanullah et al., 2010). Poultry manure typically contains 3–5% N, 1.5–3.5% P, and 1.5–3.0% K on a dry-weight basis, together with Ca, Mg, and micronutrients, and has a relatively low carbon-to-nitrogen ratio that favours rapid mineralisation (Chastain et al., 2001; Agbede et al., 2008; Amanullah et al., 2010).

Previous studies in Nigeria and other tropical environments have reported that poultry manure improves maize plant height, leaf area, cob length, seed weight, and grain yield (Ayoola and Makinde, 2007; Agbede et al., 2008; Amanullah et al., 2010; Akpan et al., 2021). For example, application of poultry manure at 10 t ha−1 produced superior growth and grain yield in the southern Guinea savanna (Adeyemo et al., 2019; Adekiya et al., 2020), while other studies found that yield continued to increase up to 12 t ha−1 but with diminishing returns beyond an optimum (Agbede et al., 2008; Boateng et al., 2006). The optimum rate, however, is site-specific because it depends on initial soil fertility, manure composition, rainfall, variety, and management (Fageria, 2009; Vanlauwe et al., 2015). In the Awka agro-ecological zone, site-specific evidence on the rate-response relationship for a widely grown hybrid such as Oba Super 6 remains limited, and farmers often apply manure without guidance, either under-applying and obtaining poor yields or over-applying and wasting scarce resources.

This study was therefore designed to evaluate the growth and grain yield response of maize to varying rates of poultry manure in Awka. The specific objectives were to: (i) determine the effect of poultry manure rates (0, 5, 10, and 15 t ha−1) on growth parameters (plant height and leaf area index) of maize; (ii) assess the effect on yield components (cob length and 100-seed weight); and (iii) identify the economically viable rate that optimises grain yield for the Awka agro-ecological zone. It was hypothesised that increasing poultry manure rate would significantly improve growth and yield up to an optimum beyond which additional manure would give no significant yield advantage.

2. Literature Review

2.1 Maize: Importance, Botany and Yield Physiology

Maize is a C4 annual grass with high photosynthetic efficiency, rapid growth, and high harvest index when nutrients and water are not limiting (Marschner, 2012; Badu-Apraku and Fakorede, 2017). Grain yield is the product of plant population, cobs per plant, kernels per cob, and kernel weight, each of which is sensitive to nutrient supply at critical stages (Fageria, 2009; Olaniyan, 2015). Nitrogen drives leaf expansion, chlorophyll formation, and stem elongation; phosphorus supports root development, energy transfer, and early vigour; potassium regulates stomatal function, water relations, and assimilate translocation (Marschner, 2012; Brady and Weil, 2017). Leaf area index (LAI), the ratio of total leaf area to ground area, integrates these processes because it determines light interception and, consequently, biomass accumulation and grain filling (Fageria, 2009; Amanullah et al., 2010). A larger, longer-lasting canopy generally supports longer cobs, more kernels, and heavier seeds, provided lodging and mutual shading do not become limiting (Badu-Apraku and Fakorede, 2017).

Oba Super 6 is a single-cross, pro-vitamin A, yellow flint hybrid released in Nigeria, noted for high yield potential (7–8 t ha−1), maturity in 100–105 days, mid-silking at about 60 days, and tolerance to low soil N and moisture stress (IITA, 2022; Olaniyan, 2015). Its performance in southeastern Nigeria, however, depends strongly on soil fertility and management, because hybrids with high yield potential also have high nutrient demand (Vanlauwe et al., 2015; Adekiya et al., 2020). Understanding how such a hybrid responds to organic nutrient supply is therefore directly relevant to extension recommendations.

2.2 Soil Fertility Constraints in Southeastern Nigeria

The humid southeastern zone receives 1,800–2,500 mm of rainfall annually, with a bimodal pattern that supports two cropping seasons but also accelerates leaching and erosion (Enwezor et al., 1989; Lal, 2015). The dominant Ultisols are acidic (pH often below 5.5), low in organic carbon (<1.5%), and have low effective cation exchange capacity dominated by kaolinitic clay (Ahn, 1993; Brady and Weil, 2017). Available P is frequently below the

critical level for maize, while exchangeable Ca and Mg are low and aluminium saturation can be high (Enwezor et al., 1989; Obi and Ebo, 1995). Continuous maize cropping without fallow or manure addition has been shown to deplete organic matter and reduce aggregate stability, bulk density, and water-holding capacity (Lal, 2015; Nwite et al., 2011). These constraints explain why unfertilised maize in the region often yields only 1–2 t ha−1, as observed in the control treatment of this study and in earlier work (Ayoola and Makinde, 2007; Agbede et al., 2008).

2.3 Poultry Manure as a Soil Amendment

Poultry manure improves soil fertility through both nutrient supply and soil conditioning (Agbede et al., 2008; Agegnehu et al., 2016). Its relatively high N and P contents, low C:N ratio, and presence of uric acid favour faster decomposition and nutrient release than cattle or goat manure (Amanullah et al., 2010; Chastain et al., 2001). Studies have shown that poultry manure reduces bulk density, increases porosity and water retention, raises soil pH in acidic soils, and increases soil organic carbon, total N, available P, exchangeable K, Ca, and Mg (Agbede et al., 2008; Adekiya et al., 2020; Akpan et al., 2021). It also enhances microbial biomass and enzyme activity, which further improves nutrient cycling (Agegnehu et al., 2016; Brady and Weil, 2017). These effects are particularly valuable on degraded Ultisols, where physical degradation limits root growth even when soluble fertilizer is applied (Lal, 2015; Nwite et al., 2011).

Curing or composting poultry manure before application is recommended to reduce ammonia volatilisation, pathogens, weed seeds, and phytotoxicity, and to stabilise nutrients (Amanullah et al., 2010; Brady and Weil, 2017). In this study, cured manure was used, consistent with best practice and with earlier Nigerian trials that reported superior maize response to cured or composted manure compared with fresh manure (Agbede et al., 2008; Ayoola and Makinde, 2007).

2.4 Response of Maize to Poultry Manure Rates

The literature consistently shows a positive but non-linear response of maize to poultry manure rate (Agbede et al., 2008; Ayoola and Makinde, 2007; Boateng et al., 2006). At low rates, nutrient supply is insufficient to meet crop demand; at intermediate rates, growth and yield increase sharply; at high rates, the response plateaus or declines as nutrients cease to be limiting, or as excess N promotes excessive vegetative growth, lodging, or nutrient imbalance (Fageria, 2009; Marschner, 2012). In Ibadan, fortified poultry manure gave 3.97 t ha−1 compared with 2.48 t ha−1 for unfertilised maize (Ayoola and Makinde, 2007). In southwestern Nigeria, poultry manure at 10 t ha−1 produced the highest grain yield (4.63 t ha−1) among organic and inorganic treatments (Adeyemo et al., 2019). In the savanna, 2 t ha−1 of poultry litter significantly increased yield, with no further gain beyond that rate on relatively fertile soils (Boateng et al., 2006), underscoring that the optimum depends on initial fertility. In Calabar, combined poultry manure and NPK increased sweet maize yield, with poultry manure at 10 t ha−1 performing best (Akpan et al., 2021). Collectively, these findings support the hypothesis that an intermediate rate, around 10 t ha−1, may be optimal on degraded soils such as those in Awka, where the present study found no significant difference between 10 and 15 t ha−1.

3. Materials and Methods

3.1 Study Area

The experiment was conducted at the Teaching and Research Farm of Nnamdi Azikiwe University, Awka (6°12′ N, 7°04′ E), Anambra State, Nigeria, during the 2025 wet cropping season (May–August). Awka lies in the humid tropical rainforest agro-ecological zone, with mean annual rainfall of about 2,000 mm, mean temperature of 27–30 °C, and relative humidity of 70–85% (Enwezor et al., 1989; Nwite et al., 2011). The soils are classified as Ultisols, sandy loam in texture, acidic, and low in organic matter and major nutrients, typical of the region (Ahn, 1993; Brady and Weil, 2017). The site had been under continuous cropping with a short fallow before the experiment, which is representative of smallholder fields in the area.

3.2 Experimental Design and Treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications, as described by Gomez and Gomez (1984) and widely used for field trials on heterogeneous soils (Steel et al., 1997). Four treatments comprised cured poultry manure applied at 0 (control), 5, 10, and 15 t ha−1. Each plot measured 3 m × 4 m (12 m²), with 1 m alleys between plots and 1.5 m between blocks to minimise edge effects and cross-contamination. The test variety was Oba Super 6, a high-yielding hybrid described in Section 2.1 (IITA, 2022).

Land preparation involved clearing, ploughing, and harrowing, followed by marking and pegging of plots. Cured poultry manure was obtained from a reputable poultry farm in Awka, analysed for nutrient content, and incorporated into the soil two weeks before planting to allow mineralisation and reduce phytotoxicity (Agbede et al., 2008; Amanullah et al., 2010). Maize seeds were sown at a spacing of 75 cm × 25 cm, giving a plant population of approximately 53,333 plants ha−1, consistent with recommended density for hybrids in the zone (Olaniyan, 2015; Adekiya et al., 2020). Two seeds were sown per hole and thinned to one plant per stand at two weeks after planting (WAP). Weeding was done manually at 3 and 6 WAP, and no inorganic fertilizer or pesticide was applied so that the effect of poultry manure could be isolated. Rainfall was supplemented only by natural precipitation, as is typical for wet-season maize in Awka.

3.3 Data Collection

Data were collected on five agronomic parameters following standard procedures (Gomez and Gomez, 1984; Fageria, 2009). Plant height (cm) was measured from the base of the plant to the tip of the tassel at physiological maturity on five randomly selected plants per plot. Leaf area index (LAI) was estimated from leaf length and width measurements (leaf area = length × width × 0.75) summed per plant and divided by ground area per plant (Amanullah et al., 2010; Fageria, 2009). Cob length (cm) was measured on five cobs per plot at harvest. One hundred-seed weight (g) was determined by counting and weighing 100 randomly selected dry seeds per plot, adjusted to 14% moisture. Grain yield (t ha−1) was obtained from shelled grain per plot, adjusted to 14% moisture, and extrapolated to tonnes per hectare. Soil and manure samples were analysed for pH, organic carbon, total N, available P, and exchangeable K, Ca, and Mg using standard laboratory methods (Enwezor et al., 1989; Brady and Weil, 2017).

3.4 Statistical Analysis

Data were subjected to Analysis of Variance (ANOVA) appropriate for RCBD using standard statistical software, following Gomez and Gomez (1984) and Steel et al. (1997). Treatment means were separated using Least Significant Difference (LSD) at $p \leq 0.05$. Percentage yield increase over the control was calculated as [(treatment yield − control yield) / control yield] × 100. Results are presented as treatment means, with LSD values and coefficients of variation (CV) to indicate precision.

4. Results

Poultry manure application significantly ($p < 0.05$) affected all measured parameters (Tables 1–3; Figures 1–2). The pre-planting soil was acidic and low in nutrients, while the cured poultry manure was rich in N, P, K, Ca, and Mg (Table 1), confirming its suitability as an amendment for the degraded Ultisol (Agbede et al., 2008; Enwezor et al., 1989).

Table 1: Pre-planting soil and cured poultry manure properties (Awka, 2025). Values are laboratory means. The manure showed a markedly higher nutrient concentration than the degraded soil (Agbede et al., 2008; Enwezor et al., 1989).

Property	Pre-planting soil	Cured poultry manure
pH (H2O)	5.32	6.84
Organic carbon (%)	1.12	18.45
Total N (%)	0.09	2.87
Available P (mg kg−1)	8.40	124.60
Exchangeable K (cmol kg−1)	0.18	1.92
Exchangeable Ca (cmol kg−1)	1.24	4.85
Exchangeable Mg (cmol kg−1)	*0.62*	*1.74*
Texture / appearance	*Sandy loam*	*Dark, friable, cured*

Table 1 shows that the soil was low in organic carbon, total N, available P, and exchangeable bases, consistent with the characterisation of southeastern Ultisols by Ahn (1993) and Enwezor et al. (1989). The manure, by contrast, supplied substantial organic matter and nutrients, providing a mechanistic basis for the growth and yield responses reported below.

4.1 Growth Parameters

Plant height and LAI increased progressively with poultry manure rate (Table 2; Figure 1). The tallest plants (214.6 cm) and highest LAI (3.82) were recorded at 15 t ha−1, followed by 10 t ha−1 (203.9 cm; 3.51), 5 t ha−1 (185.7 cm; 2.78), and the control (162.4 cm; 2.14). All manure treatments were significantly taller and had higher LAI than the control, and the difference between 10 and 15 t ha−1 was significant for height but modest for LAI, indicating that canopy expansion approached saturation at 10 t ha−1.

Table 2: Effect of poultry manure rate on growth parameters of maize (Oba Super 6) at Awka, 2025 wet season. Means in the same column differing by more than the LSD are significantly different at $p \leq 0.05$.

Poultry manure (t ha−1)	Plant height (cm)	Leaf area index (LAI)
0 (control)	162.4	2.14
5	185.7	2.78
10	203.9	3.51
15	214.6	3.82
LSD (p ≤ 0.05)	*9.8*	*0.32*
CV (%)	*4.1*	*6.8*

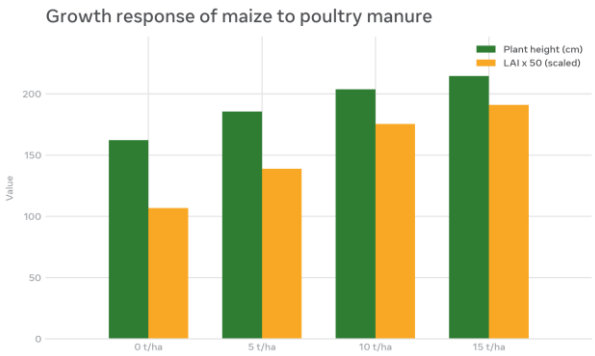

Figure 1: Plant height and leaf area index (LAI, scaled × 50 for visual comparison) of maize under varying poultry manure rates. Both traits increased with manure rate, with the largest gain between 0 and 10 t ha−1. Source: Field data, Awka, 2025 (this study).

Figure 1 illustrates the near-linear increase in height and canopy development up to 10 t ha−1, followed by a smaller increment to 15 t ha−1. This pattern is consistent with the law of diminishing returns in plant nutrition, where the first increments of a limiting nutrient produce the largest response (Fageria, 2009; Marschner, 2012).

4.2 Yield Components and Grain Yield

Cob length, 100-seed weight, and grain yield followed the same trend as growth parameters (Table 3; Figure 2). Cob length increased from 13.2 cm in the control to 19.1 cm at 15 t ha−1, while 100-seed weight increased from 21.5 g to 28.1 g. Grain yield increased from 1.85 t ha−1 in the control to 2.96 t ha−1 at 5 t ha−1, 4.05 t ha−1 at 10 t ha−1, and 4.28 t ha−1 at 15 t ha−1. The yield at 15 t ha−1 represented a 131% increase over the control, but it did not differ significantly from the yield at 10 t ha−1 (119% increase), confirming that 10 t ha−1 captured most of the yield benefit.

Table 3: Effect of poultry manure rate on yield components and grain yield of maize at Awka, 2025 wet season. Grain yield at 10 and 15 t ha−1 did not differ significantly ($p > 0.05$).

Poultry manure (t ha−1)	Cob length (cm)	100-seed weight (g)	Grain yield (t ha−1)	Yield increase over control (%)
0 (control)	13.2	21.5	1.85	—
5	15.8	24.8	2.96	60.0
10	18.4	27.3	4.05	118.9
15	19.1	28.1	4.28	131.4
LSD (p ≤ 0.05)	*1.4*	*1.9*	*0.38*	—
CV (%)	*5.6*	*4.9*	*6.2*	—

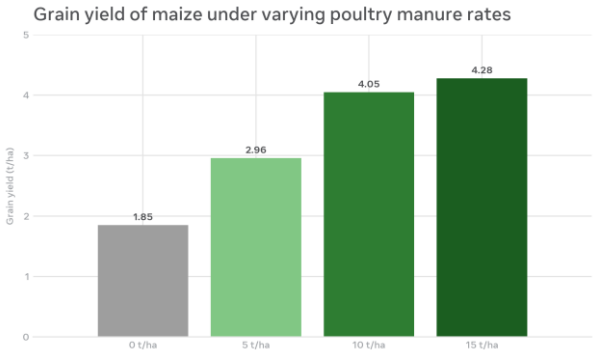

Figure 2: Grain yield of maize (t ha−1) under varying poultry manure rates. Yield rose sharply to 10 t ha−1 and plateaued at 15 t ha−1, supporting the recommendation of 10 t ha−1 as the economically viable rate. Source: Field data, Awka, 2025 (this study).

Figure 2 makes the plateau explicit: the gain from 0 to 10 t ha−1 was 2.20 t ha−1, while the additional gain from 10 to 15 t ha−1 was only 0.23 t ha−1. This diminishing marginal return is central to the economic interpretation in Section 5.3.

5. Discussion

5.1 Growth Response

The significant increase in plant height and LAI with poultry manure is attributable to improved N, P, and K supply, enhanced soil organic matter, and better soil physical conditions (Agbede et al., 2008; Agegnehu et al., 2016). Nitrogen promotes cell division and elongation, leading to taller plants, while P supports early root growth and leaf initiation (Marschner, 2012; Fageria, 2009). The larger LAI at higher manure rates reflects greater leaf expansion and longer leaf duration, which increases light interception and photosynthesis (Amanullah et al., 2010; Badu-Apraku and Fakorede, 2017). Similar increases in height and leaf area with poultry manure have been reported by Ayoola and Makinde (2007), Adeyemo et al. (2019), and Akpan et al. (2021). The modest additional height gain from 10 to 15 t ha−1 suggests that nutrient supply ceased to be the primary limitation at 10 t ha−1, and that genetic and environmental factors began to constrain further growth, as expected for a hybrid with a defined height potential (IITA, 2022; Olaniyan, 2015).

5.2 Yield Components and Grain Yield

Cob length and 100-seed weight are key determinants of grain yield, and both responded positively to manure (Fageria, 2009; Olaniyan, 2015). Longer cobs indicate more kernel rows and kernels per cob, while heavier seeds indicate better grain filling, both of which depend on assimilate supply during silking and grain filling (Marschner, 2012; Badu-Apraku and Fakorede, 2017). Poultry manure likely improved these traits by sustaining nutrient release throughout the season, unlike soluble fertilizers that may leach rapidly in high-rainfall soils (Brady and Weil, 2017; Vanlauwe et al., 2015). The grain yield of 4.05–4.28 t ha−1 at 10–15 t ha−1 in this study is comparable to yields reported for poultry manure at 10 t ha−1 in southwestern Nigeria (4.63 t ha−1) (Adeyemo et al., 2019) and for fortified poultry manure in Ibadan (3.97 t ha−1) (Ayoola and Makinde, 2007), and is well above the 1.85 t ha−1 control, which mirrors typical smallholder yields without amendment (FAO, 2023; IITA, 2022). The lack of significant difference between 10 and 15 t ha−1 aligns with Boateng et al. (2006) and Agbede et al. (2008), who found plateaus beyond an optimum, and supports a recommendation based on marginal benefit rather than maximum yield alone.

5.3 Economic and Practical Implications

For smallholder farmers, the economically viable rate is the rate that maximises net benefit, not necessarily the rate that gives the highest absolute yield (Vanlauwe et al., 2015; Fageria, 2009). In this study, moving from 10 to 15 t ha−1 required 50% more manure for only a 5.7% yield gain (0.23 t ha−1), which is unlikely to cover the additional cost of sourcing, transporting, curing, and applying 5 t ha−1 of manure, especially where labour and transport are expensive (Adeboye et al., 2021; Agegnehu et al., 2016). By contrast, moving from 0 to 10 t ha−1 more than doubled yield, giving a strong return on the manure investment. Farmers in Awka who have limited manure or cash should therefore prioritise achieving 10 t ha−1 on a smaller area rather than spreading a thin rate over a larger area, and should combine manure with good agronomic practices such as timely planting, correct spacing, and weed control (Olaniyan, 2015; Adekiya et al., 2020). Where poultry manure is scarce, integrating a lower manure rate with a modest inorganic fertilizer supplement, as shown by Ayoola and Makinde (2007) and Amanullah et al. (2010), may be a practical alternative, but that integration was beyond the scope of this single-season trial and warrants further testing in Awka.

Practical considerations also matter. Cured manure should be applied two weeks before planting and incorporated to minimise N loss and odour, as done in this study (Agbede et al., 2008). Fresh manure should be avoided because of ammonia toxicity and weed seeds (Brady and Weil, 2017). Farmers should also be aware that excessive manure application over many seasons can lead to P accumulation and runoff risk in high-rainfall areas, so soil testing every 2–3 years is advisable (Lal, 2015; Brady and Weil, 2017). Extension services in Anambra State can use the 10 t ha−1 recommendation as a starting point, with local adaptation based on soil test results, manure quality, and farmer resources.

5.4 Limitations and Future Research

This study was conducted in one season at one location, so the results should be interpreted as site- and season-specific, as is typical for field trials (Gomez and Gomez, 1984; Steel et al., 1997). Rainfall, temperature, and manure composition can vary between seasons, and multi-season, multi-location trials would strengthen the recommendation (Vanlauwe et al., 2015). The study did not measure soil properties after harvest, nutrient uptake, or economic returns in monetary terms, nor did it compare poultry manure with inorganic fertilizer or with integrated nutrient management. Future work should therefore: (i) repeat the trial over at least two more seasons and in other locations in southeastern Nigeria; (ii) assess residual effects and changes in soil organic matter, pH, and nutrient status; (iii) evaluate integrated poultry manure plus NPK treatments for cost-effectiveness; and (iv) conduct a full partial-budget and marginal-rate-of-return analysis to confirm the economic optimum for different farmer categories (Adeboye et al., 2021; Agegnehu et al., 2016).

6. Conclusion

Poultry manure application significantly improved the growth and yield of maize (Oba Super 6) in Awka, southeastern Nigeria. Plant height, leaf area index, cob length, 100-seed weight, and grain yield all increased with manure rate, with the highest values at 15 t ha−1 (214.6 cm, 3.82, 19.1 cm, 28.1 g, and 4.28 t ha−1, respectively). However, grain yield at 15 t ha−1 did not differ significantly from that at 10 t ha−1 (4.05 t ha−1), indicating a plateau in response. Applying 10 t ha−1 of cured poultry manure is therefore recommended as the economically viable rate for optimal maize production in the Awka agro-ecological zone. Adoption of this practice, combined with good agronomic management and periodic soil testing, can help smallholder farmers improve maize productivity, restore soil fertility, and reduce dependence on costly inorganic fertilizers.

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Conflict of Interest

The authors declare no conflict of interest.

References

- Adeboye, S., Olaniyan, A. and Ojo, O. (2021). Maize production and food security in Nigeria: Trends, constraints and policy options. Journal of Agricultural Policy, 6(2), pp. 45–58.
- Adekiya, A.O., Agbede, T.M., Aboyeji, C.M., Dunsin, O. and Ugbe, J.O. (2020). Poultry manure and biochar effects on soil properties and maize yield. Communications in Soil Science and Plant Analysis, 51(7), pp. 921–933.
- Adeyemo, A.J., Akingbola, O.O. and Ojeniyi, S.O. (2019). Growth and yield of maize as affected by fertilizer types in the southern Guinea savanna, Nigeria. Nigerian Journal of Soil Science, 29(1), pp. 12–20.
- Agbede, T.M., Ojeniyi, S.O. and Adeyemo, A.J. (2008). Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest Nigeria. American-Eurasian Journal of Sustainable Agriculture, 2(1), pp. 72–77.
- Agegnehu, G., Nelson, P.N. and Bird, M.I. (2016). Crop yield, soil carbon and nitrogen dynamics in tropical soils amended with biochar and manure. Soil Research, 54(5), pp. 567–577.
- Ahn, P.M. (1993). Tropical Soils and Fertiliser Use. Harlow: Longman Scientific and Technical.
- Akpan, E.A., Udo, I.A. and Essien, J. (2021). Effects of different organic manures and NPK fertilizer on growth and yield of maize. Journal of Agriculture and Environment, 17(1), pp. 33–42.
- Amanullah, M.M., Alagesan, A., Somasundaram, E. and Vaiyapuri, K. (2010). Poultry manure to crops: A review. Agricultural Reviews, 31(3), pp. 182–191.
- Ayoola, O.T. and Makinde, E.A. (2007). Fertilizer treatment effects on performance of cassava/maize intercrop. International Journal of Agricultural Research, 2(6), pp. 505–512.
- Badu-Apraku, B. and Fakorede, M.A.B. (2017). Advances in Genetic Enhancement of Early and Extra-Early Maize for Sub-Saharan Africa. Cham: Springer.
- Boateng, S.A., Zickermann, J. and Kornahrens, M. (2006). Poultry manure effect on growth and yield of maize. West African Journal of Applied Ecology, 9(1), pp. 1–11.
- Brady, N.C. and Weil, R.R. (2017). The Nature and Properties of Soils. 15th ed. Upper Saddle River: Pearson.
- Chastain, J.P., Camberato, J.J. and Skewes, P. (2001). Poultry manure production and nutrient content. In: Proceedings of the National Poultry Waste Management Symposium. Clemson: Clemson University, pp. 12–18.
- Enwezor, W.O., Udo, E.J., Usoroh, N.J., Ayotade, K.A., Adepetu, J.A., Chude, V.O. and Udegbe, C.I. (1989). Fertilizer Use and Management Practices for Crops in Nigeria. Lagos: Federal Ministry of Agriculture.
- Fageria, N.K. (2009). The Use of Nutrients in Crop Plants. Boca Raton: CRC Press.
- FAO (2023). FAOSTAT Crops and Livestock Products. Rome: Food and Agriculture Organization of the United Nations.
- Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd ed. New York: Wiley.
- IITA (2022). Maize: Improved Varieties for West Africa. Ibadan: International Institute of Tropical Agriculture.
- Lal, R. (2015). Soil degradation and its impact on food security. In: Lal, R. et al., eds. Soil Degradation and Restoration. Boca Raton: CRC Press, pp. 1–22.
- Marschner, P. (2012). Marschner's Mineral Nutrition of Higher Plants. 3rd ed. London: Academic Press.
- Nwite, J.C., Keke, C.I. and Obi, M.E. (2011). Effect of tillage and poultry manure on soil properties and maize yield in Abakaliki. Nigerian Journal of Soil Science, 21(1), pp. 89–96.
- Obi, M.E. and Ebo, P.O. (1995). The effects of organic and inorganic amendments on soil physical properties and maize production in a severely degraded sandy soil in southern Nigeria. Bioresource Technology, 51(2–3), pp. 117–123.
- Olaniyan, A.B. (2015). Maize: Panacea for hunger in Nigeria. African Journal of Plant Science, 9(3), pp. 155–174.
- Sanchez, P.A. (2002). Soil fertility and hunger in Africa. Science, 295(5562), pp. 2019–2020.
- Steel, R.G.D., Torrie, J.H. and Dickey, D.A. (1997). Principles and Procedures of Statistics: A Biometrical Approach. 3rd ed. New York: McGraw-Hill.
- Vanlauwe, B., Descheemaeker, K., Giller, K.E., Huising, J., Merckx, R., Nziguheba, G., Wendt, J. and Zingore, S. (2015). Integrated soil fertility management in sub-Saharan Africa. International Journal of Agricultural Sustainability, 13(1), pp. 3–15.