Growth and Yield of Bambara groundnut (*Vigna Subterranean)* in a Soil Amended with Different Rates of Pig and Cow Manure in Humid Tropical Region of Nigeria.

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ABSTRACT

Organic manure is crucial for enhancing soil fertility and promoting plant growth, particularly in nutrient-deficient soils. This study was conducted at the Teaching and Research Farm of the Crop Science and Horticulture Department, Nnamdi Azikiwe University, Ifite-Ogwari Campus, Anambra State, to evaluate the effects of different types and rates of organic manure on the growth and yield of Bambara groundnut (*Vigna subterranea*). The experiment employed a completely randomized design (CRD) with treatments consisting of various manure applications: pig manure (PM) at rates of 5t/h, 10t/h, and 15t/h, cow manure (CM) at equivalent rates, and a control (no manure applied), replicated three times. Results revealed that pig manure at 10t/h significantly enhanced the leaf area and branches per plant, with means of 269.0 (cm^2) and 89.7 respectively recorded at 12 weeks after sowing (WAS). Furthermore, cow manure at 15t/h showed comparable effects, particularly on leaf area and stem girth, indicating its potential for improving growth metrics. The interaction of pig and cow manure also positively influenced all growth parameters measured at 12 WAS, with notable increases in leaf area (254.9 cm^2) and plant height (27.8 cm). Overall, pig manure demonstrated superior efficacy in boosting pod and seed yields, with recorded values of 510 g/plant and 195 g/plant respectively at the highest application rate. The findings suggest that integrating organic manure, particularly pig manure, is effective for optimizing growth and yield in Bambara groundnut cultivation, thereby promoting sustainable agricultural practices in similar agro-ecological zones.

Keywords: Bambara groundnut (*Vigna subterranea*), organic manure, pig manure, cow manure, crop yield, soil fertility.

INTRODUCTION

Bambara groundnut (*Vigna subterranea*) is a legume crop that belongs to the family *Fabaceae* and a widely cultivated crop in sub-Saharan Africa due to its positive economic potential (Obidiebube *et al*., 2020; Oyeyinka and Ade-Omowaye, 2021; Khan *et al*., 2021; Olarewaju *et al*., 2022). It is a herbaceous annual plant with creeping stems at ground level and is believed to have originated in Africa, specifically in the West African sub-region (Oyeyinka and Ade-Omowaye, 2021; Tenkodogo *et al.,* 2023). Different geographical locations and ethnic groups in the world give it various names; for example, in Nigeria, the Igbos in the Southeast call it Okpa, while the Hausas in the north refer to it as Gurujia. In South Africa, it is called Njugo bean, Nzama in Malawi, and Ntoyo in Zambia. Other African names for it include Congo groundnut, Congo goober, Madagascar groundnut, earth pea, Baffin pea, and underground bean (Oyeyinka and Ade-Omowaye, 2021).

The Bambara groundnut is considered the third most common major legume after groundnuts (*Arachis hypogea*) and cowpeas (*Vigna unguiculata*) on the African continent (Khan *et al.,* 2021; Olanrewaju *et al.,* 2022; Effa *et al.,* 2019). Bambara groundnut is believed to be the most resilient to drought among grain legumes and can be produced in difficult soil and climate conditions, where other pulses fail to survive (Olanrewaju *et al.,* 2022; Tenkodogo *et al.,* 2023). This crop is efficient at promoting nourishment, boosting

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food assurance, fostering pastoral improvement, and supporting sustainable land uses (Khan *et al.,* 2021). The fresh leaves and stems are so nutritious and palatable to farm animals with the pods even when dried. Bambara groundnuts can be grown with inorganic fertilizers, but due to the negative effects of products grown with inorganic fertilizers on the health of man and animal, people resort to alternatives (Khan *et al.,* 2021).

There is an increase in consumer demand for organically produced crops which appears to be driven primarily by the perception that organically grown produce is safer and more nutritious to eat than those grown conventionally. Similarly, the use of inorganic fertilizer has been observed to cause the destruction of soil texture and structure, which often leads to soil erosion and acidity as a result of the leaching effect of nutrients (Feng *et al.,* 2024; Assefa, 2019). All these give rise to reduced crop yields as a result of soil degradation and nutrient imbalance. Organic manure-applied soil has higher organic matter levels, lower bulk density, higher porosity and hydraulic conductivity, and greater aggregate stability than soils fertilized conventionally. Improvements in all of these soil quality indicators would optimize crop growth. Thus, one of the most significant benefits of manure as an organic nutrient source is the potential to maintain or increase soil organic matter level (Assefa, 2019).

Soil organic matter affects soil's physical, chemical, and biological properties and is thus agronomically important because these factors affect crop yields. Organic amendments such as manures, composts, and plant residues are frequently used in crop production systems as alternatives to inorganic fertilizers, to restore degraded soils and ameliorate physicochemical constraints (Corinne *et al.,* 2019). Applications of manure as a crop nutrient source may provide a portion, or all of the plant nutrient requirement, dependent on the rate of application and the relative content of the nutrients. Application rate decisions are usually based on either the nitrogen or the phosphorus content of the manure and environmental concerns are typically based on the amount of nitrogen, phosphorus, zinc, or copper added to the soil (Camberato, 2016). Crops that require and remove a lot of nitrogen are favoured for receiving pig manure because more manure can be applied to less land. This approach reduces the hauling costs of implementing a manure management plan but often results in a large accumulation of phosphorus and other nutrients in the soil (Camberato, 2016).

In some countries in Africa, low intake of protein makes people susceptible or prone to diseases, especially in areas of malnutrition, heart and kidney diseases, shortage of blood, fever and higher death rate. In Nigeria, the daily food intake mainly consists of root and tubers, cereals, and to a lesser extent, fruits, while the consumption of animal protein remains low in almost every household. However, protein intake can be supplemented with vegetable proteins from legumes, such as Bambara groundnut. The seeds of this crop have been found to be useful in many diets (Nweke, 2013; Bosu, 2014; Kurmi *et al.,* 2023). Bambara groundnuts can be mixed with maize or plantain and boiled, ground into flour and used to prepare porridge, or pre-soaked and ground into a paste used for preparing fried or steamed dishes. Maize flour for traditional preparation can also be enriched by adding Bambara groundnut. Thus, the crop produces a balanced food with high protein content and serves as a source of plant protein for the digestive system (Nweke, 2013; Oyeyinka and Ade-Omowaye, 2021). This crop has the potential to improve the nutrition of the people and is less costly than animal protein. Moreover, Bambara groundnut has been found to improve soil conditions because of its nitrogen fixation (Nweke, 2013). However, there is very little data available on Bambara groundnut growth and yield potentials as it concerns pig and cow dung. Crop growth and yield however require mineral nutrition which is supplied to the desired crop as manure.

Therefore, the broad objective of this research is to evaluate the effect of pig and cow dung rates on the growth and yield of *Vigna subterranean.*

The specific objectives are to:

i. Determine the effect of pig manure rates on the growth and yield of *Vigna subterranean.*

ii. Assess the response of Bambara groundnut growth and yield to cow dung rates

iii. Evaluate the interaction effects of pig and cow manure on the growth rate and yield of *Vigna subterranean.*

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MATERIALS AND METHODS

Experimental Area

The experiment was conducted at the Teaching and Research Farm of the Crop Science and Horticulture Department, Nnamdi Azikiwe University, Ifite-Ogwari Campus, Anambra State. The area is between latitude 06°36'07.2" N and longitude 060°67'01.6" E. It has a minimum and maximum average temperature of planting period of 25.4^{o}C and 30.6^{o}C respectively, with annual and monthly total rainfall of 5798.78mm and 1739.62mm.

Planting Materials and Medium Preparation

The seeds of Bambara groundnut were sourced from a reputable seed marketer. Manures were sourced from a reputable livestock farm. The sourced manures were subjected to a curing process, by allowing them to mature and stabilize, resulting in a more balanced nutrient composition and reduced risk of pathogen contamination. Raised seedbeds of 2m x 2m (28 beds) were prepared, with furrow spaces of 50cm. Seeds were sown directly into seedbeds at 10cm x 20cm plant spacing and 2 seeds per hole with a sowing depth of 5cm.

Soil and organic manures sampling and analysis

Soil samples from 15cm depth of the experimental site were taken by simple random sampling method and the physio-chemical properties of the soil at the start of the experiment were analyzed in the laboratory. Five sub-samples were randomly taken and mixed thoroughly to form a composite sample. The composite soil sample was pre-treated by air drying and passed through a 2mm sieve before analysis. Samples of the organic manure types were collected, shade-dried, and taken to the laboratory for analysis.

Experimental Design: The experiment was a 2 x 4 factorial experiment comprising two main treatments: manure types (pig manure and cow dung) and application rates (0t/ha, 5t/ha, 10t/ha, and 15t/ha). The 7 treatment combinations were laid out in a Randomized Complete Block Design (RCBD) and replicated 4 times.

Treatments: The treatments were comprised of the treatment combinations of the two organic manure types and five application rates:

TI Control (No manure application)

T2 Pig manure at 5t/ha

T3 Pig manure at 10t/ha

T4 Pig manure at 15t/ha

T5 Cow dung at 5t/ha

T6 Cow dung at 10t/ha

T7 Cow dung at 15t/ha

Field Layout: Each treatment combination had 4 seedbeds representing its 4 replicates making a total of 28 seedbeds. The seedbeds were of dimension 2m x 2m and 50cm furrow space.

Agronomic Practices:

Manuring: The different types of organic manure were applied to the soil at their respective rates two weeks before sowing the Bambara groundnut seeds to ensure proper decomposition and prevent toxic effects on seedlings.

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Weeding: Weeding was done four times by hand-picking as weeds emerged.

Harvesting: The pods were harvested at 4 months after sowing (MAS).

Data Collection: Data was collected on emergence, and subsequently collected at two-week intervals till harvesting.

Growth Parameters:

Number of branches: This was gotten by counting number of branches from base of the sampled plants on each seedbed from the fourth week after seed sowing (WAS), and subsequently at 4-week intervals till harvesting.

Leaf area (cm^2): The leaf area was obtained by measuring the leaf length and leaf width of 3 leaves (largest, medium and smallest sized) and average found and multiplied the correction factor 0.75 (Nwagwu *et al.*, 2023). It was taken from the fourth WAS, and subsequently at 4-week intervals till harvesting.

Plant length (cm): The length of the plant vine was obtained by measuring the distance from the soil level to the tip of the longest vine from 4 WAS, and subsequently at 4-week intervals till harvesting. A flexible measuring tape was used to obtain the accurate measurement.

Canopy width: Canopy width was measured from 4 WAS by using a thread to trace the canopy from one end to another end; then found out the width on a meter rule. Tagged samples were measured and average found and recorded.

Yield Parameters:

Biomass weight: It was measured using a sensitive scale to measure harvested plants both shoots and pods together.

Number of pods per plant at harvest: This was done through counting. Pods from the three sampled plants in each bed were counted and the average estimated.

Weight of dry pods and seeds: The weights of dry pods and seeds in g/plant from different treatments were measured with a sensitive scale after oven drying (dehydration) to a constant weight. The dried pods were then shelled, the weights of the seeds were taken, and the average was estimated.

Hundred pods and seeds weight: One hundred dry pods from each treatment were randomly selected and their weights were taken using a sensitive scale. The hundred dried pods were shelled according to the treatments and weighed for a hundred dry seeds weight.

Seed yield (ton/ha): This was measured after harvest and dried pods shelling. Seeds were weighed using a sensitive scale and converted to ton/ha.

Instruments Used: Automated weighing balance, flexible meter rule, leaf area meter, and data collection paper chat were used in measuring and for the recording of data.

Statistical Analysis

The GenStat software (2013) was used for analysis of variance (ANOVA). In cases where significant differences were seen, the least significant difference (LSD) test was employed to compare the treatment means at a 5% probability level.

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RESULTS AND DISCUSSION

Effect of Organic Manure Types and Rates on Growth Parameters of Bambara Groundnut

The results from Tables 1 to 4 and Figure 1 demonstrated significant trends associated with the application of pig and cow manure on growth parameters, such as the number of leaves, branches, stem girth, and biomass accumulation, The findings revealed that the application of pig manure, particularly at rates of 10 t/ha and 15 t/ha, significantly enhanced various growth parameters, including plant height, branches, leaf canopy, as well as leaf area (Tables 1 - 4). The pig manure treatment at 10 t/ha showed the highest leaf area (28.1 cm), branches (89.0) and leaf area (269.0 cm^2), suggesting that pig manure positively influences leaf development and plant vigor. These findings align with previous research, which indicates that pig manure improves soil fertility and plant growth due to its high nutrient content (Le *et al.*, 2019; Kalid *et al.*, 2020). Also, it is in consonant with the work of Ahmed *et al* (2025) who found out that the highest 164kg/ha poultry manure(T4) gave the tallest plant height, highest number of leaves/plants, largest leaf area/plant at all the sampling periods though the quantity was small but that was the highest they used. This also aligned with the study of Ledan *et al* (2025) who in their research with poultry manure on Bambara groundnut found that application of 6 tons/ha of poultry manure produced the tallest Bambara groundnut plants compared to lower rates and the untreated.

Specifically, the number of branches observed in treatments with cow manure (82.7) at 10ton/ha was comparable to that of pig manure, indicating that both types of manure can be effective for enhancing growth metrics. This observation supports the work of Akintokun *et al.*, (2021), who highlighted that cow dung has a positive effect on the growth parameters of various legumes due to its organic matter content, which aids in soil moisture retention and nutrient release.

The interaction effects between pig and cow manure were notably significant, particularly at higher application rates (Figure). The combined application of both types of manure resulted in the highest values for branches (85.0), leaf area (254.9 cm^2) and plant height (27.8 cm). This synergistic effect may be attributed to the complementary nutrient profiles of pig and cow manure, which together enhance nutrient availability in the soil, leading to improved plant growth which is in line with the findings of Bunemann *et al.*, (2018) who found out that combined effect of pig and cow manure was greater which influenced the growth of plants in ecosystem.

Table 1: Effect of Organic Manure on Plant Height (cm)

Treatment	4WAS	8WAS	12WAS	16WAS
Control	27.5	27.1	26.7	26.9
PM 5t/ha	27.8	26.2	27.0	26.3
PM 10t/ha	27.2	27.7	28.1	28.8
PM 15t/ha	27.4	27.5	28.5	28.7
CM 5t/ha	25.9	26.8	26.2	26.9
CM 10t/ha	26.9	27.1	27.3	27.5
CM 15t/ha	28.0	28.2	28.5	28.8
$LSD_{0.05}$	**NS**	*	*	*

Table 2: Effect of Organic Manure on Number of Branches per Plant

Treatment	4WAS	8WAS	12WAS	16WAS
Control	75.0	76.0	77.7	79.0
PM 5t/ha	66.3	74.0	76.0	79.0
PM 10t/ha	82.3	84.0	87.3	89.7
PM 15t/ha	86.0	86.7	88.0	88.3
CM 5t/ha	70.0	72.0	72.3	73.0
CM 10t/ha	78.3	82.0	82.3	82.7
CM 15t/ha	80.0	81.3	83.7	87.3
$LSD_{0.05}$	*	*	**NS**	**NS**

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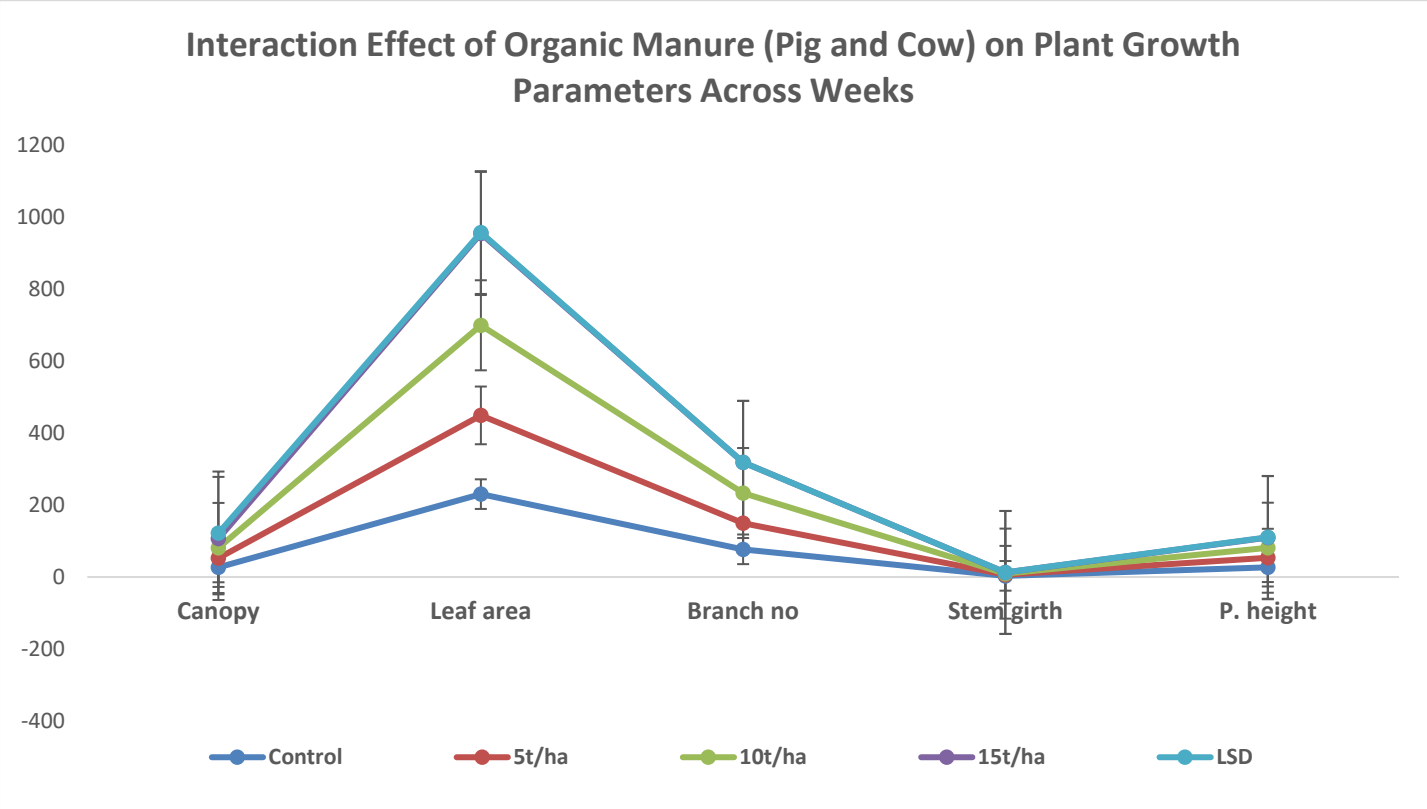
Table 3: Effect of Organic Manure on Leaf Area per Plant (cm^2)

Treatment	4WAS	8WAS	12WAS	16WAS
Control	199.0	222.0	229.0	237.0
PM 5t/ha	225.0	231.5	236.0	247.7
PM 10t/ha	247.0	252.0	262.0	269.0
PM 15t/ha	258.0	260.0	262.0	264.0
CM 5t/ha	210.0	212.0	215.7	216.3
CM 10t/ha	235.0	241.0	245.7	248.0
CM 15t/ha	242.0	244.0	246.0	261.0
$LSD_{0.05}$	**NS**	**NS**	*	*

Table 4.: Effect of Organic Manure on Leaf Canopy per Plant (cm)

Treatment	4WAS	8WAS	12WAS	16WAS
Control	25.0	26.6	27.2	27.3
PM 5t/ha	24.0	25.0	25.7	26.0
PM 10t/ha	25.0	26.0	27.2	28.7
PM 15t/ha	26.0	27.0	27.7	28.4
CM 5t/ha	24.0	25.5	26.0	26.5
CM 10t/ha	24.2	25.3	26.2	26.7
CM 15t/ha	24.7	25.5	26.0	26.7
$LSD_{0.05}$	**NS**	*	**NS**	**NS**



Response of Bambara Groundnut Yield to Pig and Cow Dung Rates

The application of cow dung also positively impacted the growth and yield of Bambara groundnut. The cow manure treatments, particularly at 10 t/ha and 15 t/ha, produced favorable outcomes in terms of the seed yield/plant and biomass accumulation (Table 5) which compared reasonably with that of pig manure, which is in consonant with the findings of Nafiu *et al.*, (2020) who indicated that cow dung can enhance soil fertility and microbial activity, leading to improved nutrient uptake plant growth and yield.

The pod yield was economically and significantly higher in the treatment receiving 10 t/ha of pig manure (510 g), which corroborates earlier studies showing that organic amendments can enhance crop yields through improved nutrient availability and soil structure (Nkongolo *et al.,* 2016). It was also in line with the findings of Ladan *et al*., (2025) who declared pods per plant, seeds/kernels per plant and even hundred seeds weight significantly high with the highest rate of manure (6 tons/ha) applied.

On 100 seed weight (g), both types of manure were high especially at 10 tons and 15 tons/ha, (305.5 & 273.3; 270.0 & 280.1 for pig and cow manures respectively), though pig manure at 10 tons/ha was significantly higher ($P<0.05$) than that of cow. This aligned with the findings of Ladan **et al.**, (20225) whose results beard highest on 100 kernels weight (g) with the highest ton/ha(6 tons) used in their study

Table 5: Response of Bambara Groundnut Yield to Pig and Cow Dung Rates

Treatment	Pod yields (g)	Seed yield (g)	100 Seed (g)	Total Biomass (g)	TMDY (g)
Control	410	150	240.0	700	310
PM 5t/ha	460	170	245.0	750	400
PM 10t/ha	510	195	305,5	800	430
PM 15t/ha	490	180	273.3	780	415
CM 5t/ha	450	160	139.0	740	380
CM 10t/ha	470	175	270.0	770	390
CM 15t/ha	480	180	280.1	790	395
$LSD_{0.05}$	*	*	*	*	*

CONCLUSION

The experiment conclusively demonstrates that the application of organic manures, particularly pig and cow dung, significantly enhances the growth and yield of *Vigna subterranea*, with optimal results observed at higher application rates. These findings underscore the potential of using organic fertilizers as sustainable agricultural practices to improve crop productivity while promoting soil health.

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