A REVIEW OF POULTRY MANURE TRIALS ON SELECTED FRUITS AND LEAFY VEGETABLES IN NIGERIA (2000-2025)

BY

Esiozah Julia EDOGAMHE (Miss)
AGR2004412

DEPARTMENT OF SOIL SCIENCE AND LAND MANAGEMENT
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN
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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF SOIL SCIENCE AND LAND MANAGEMENT, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA. IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF AGRICULTURE (B.AGRIC) DEGREE IN SOIL SCIENCE.

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CERTIFICATION

This is to certify that this research was carried out by Esiozah Julia EDOGAMHE in the Department of Soil Science and Land Management, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria.

Prof. J.O. Ehigiator	**Date**
Project Supervisor	

Dr. (Mrs) V.I.O EDOSA	**Date**
Head of Department	

DEDICATION

This project is dedicated to the Almighty God who has been my strongest pillar of Strength and source of Grace and Joy and to my parents for their constant support throughout the period of my academic pursuit.

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I am forever grateful to the Almighty God for his active presence in my life throughout this academic pursuit.

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ABSTRACT

The study reviewed the effects of poultry manure (PM) on the growth and yield of selected fruit and leafy vegetables in Nigeria. With the increasing need for sustainable and eco-friendly farming practices, poultry manure has become an important organic nutrient source due to its high content of nitrogen, phosphorus, potassium, and essential micronutrients. It enhances soil fertility, improves structure and water-holding capacity, and promotes beneficial microbial activity. Findings from several experimental trials across different agro-ecological zones in Nigeria revealed that poultry manure significantly improved vegetative growth and yield parameters such as plant height, leaf area, number of fruits, and total yield. The optimal application rate generally ranged between 10–30 t/ha, depending on crop type and soil condition. Studies also indicated that integrating poultry manure with inorganic fertilizers such as NPK 15:15:15 produced superior results in nutrient availability and crop performance. In conclusion poultry manure is a sustainable, cost-effective, and environmentally friendly soil amendment capable of improving vegetable productivity and maintaining long-term soil health in Nigeria.

CHAPTER ONE

1.0 INTRODUCTION

The growing global demand for healthy, safe and sustainable food production has sparked renewed interest in organic farming, especially in developing countries such as Nigeria. Organic agriculture encourages the use of renewable sources while conserving soil and water, minimizing or completely removing synthetic or inorganic fertilizer. A fundamental element of organic farming is the application of organic manures such as poultry manure which is nutrient dense and environmentally friendly (Adu *et al.,* 2019). Organic production is important in cultivating fruit vegetables such as, tomatoes, okra, cucumbers, peppers, garden egg etc. and leafy vegetables such as cabbage, lettuce, water leaf, basil, scent leaf, amaranth etc. (Udom, 2005).

In Nigeria, poultry manure has become an important organic manure due to the growing expansion of the poultry sector and the need to manage its waste products properly. Poultry manure is rich in macro-nutrients such as nitrogen (N), phosphorus (P), potassium (K), and contains moderate levels of secondary nutrients and micronutrients (Adekiya and Agbede, 2009) which are greatly important for healthy growth and development of fruits and leafy vegetables (Ogunlade *et al.,* 2011). Unlike inorganic fertilizers which can be leached and deplete the quality of the soil overtime, poultry manure improves the soil structure, supports microbial life and improves the soil water holding capacity which makes it of great importance.

The production of vegetable is crucial for food security and nutrition in Nigeria. Key crops such as tomatoes (*Solanum lycopersicum*), peppers (*Capsicum spp*.), cabbage (*Brassica oleracea*), lettuce (*Lactuca sativa*), bitter leaf (*Vernonia amygdalina*), form important parts of local diets, supplying important vitamins, minerals and dietary fiber (Nwajuba *et al.,* 2012). Vegetable

production is faced with various setbacks such as decline in soil fertility, deep reliance on synthetic or inorganic inputs and soil health degradation. Therefore, integrating poultry manure into organic farming practices offers a sustainable solution to these issues.

Different experimental trials carried out across various agro-ecological zones in Nigeria have shown the relevance and benefits of using poultry manure in the production of vegetables. For example, Ayeni (2010) found out that applying poultry manure at the rate 30 t/ha significantly increased tomato yield (Ayeni *et al*., 2010). Madina (2023) also reported significant increase in yield of cabbage when poultry manure was applied at the rate 20 t/ha (Madina *et al*., 2023) and lettuce when poultry manure was applied at the rate 10 t/ha (Madina *et al*., 2024). Sanni and Adesina, (2012) found out that poultry manure application at the rate 25t/ha greatly improved the yield of Ewedu. There are also disease and pest suppression benefits with the application of poultry manure. A recent study in Abeokuta, Nigeria, showed that applying poultry manure at 18 t/ha reduced incidence of Fusarium wilt in tomato and increased fruit yield in two tomato varieties, indicating that the benefits of poultry manure are not only nutritional but also contribute to crop health (Ajiwe, *et al*., 2023).

Given the increasing demand for fruits and leafy vegetables driven by population growth, income growth, urbanization, and nutrition awareness, it is critical to evaluate how poultry manure can be integrated optimally into crop production systems in Nigeria. Understanding the rates will be vital to derive sustainable, productive and cost-effective practices that improve yield, quality, and soil health, therefore, the need for this review.

1.1 OBJECTIVE OF THE STUDY

The objective of this study was to review the relevance of the application of poultry manure on the production of selected fruit and leafy vegetables.

CHAPTER TWO

2.0 LITERATURE REVIEW

This literature review systematically explores the theoretical and contextual significance of the selected fruits and leafy vegetables, chemical composition of poultry manure, application techniques, and integrate findings from previous research on the effectiveness and contribution of poultry manure in enhancing crop productivity.

2.1 NUTRIENT CONTENT OF POULTRY MANURE

Poultry manure is considered a nutrient rich organic fertilizer because it contains both solid and liquid excreta which prevents the loss if urine and thereby retains more nutrients within the manure (Amanullah *et al*., 2007). The composition of poultry manure is influenced by the species of poultry, the nutritional content of their diet and management practices employed in rearing the birds (Brown, 2015). Poultry manure is a good source of organic matter which has been considered as the life wire of soil as well as store house of chemical nutrients (Okoli andNweke, 2015).

2.1.1 Nitrogen content

Poultry manure is nutrient dense and its nitrogen content ranges from 2.5 to 4.5%, depending on factors like poultry type, methods and management practices (Brown, 2015). The nitrogen is mostly in an organic form that gradually becomes available to plants on decomposition. Nitrogen in poultry manure is very important in photosynthesis and boosts yields (Akinrinde *et al*., 2018), the vegetables showed improved leaf chlorophyll content.

2.1.2 Phosphorus Content

Poultry manure has a balanced supply of plant essential nutrients especially N, P andK. The phosphorus content in poultry manure ranges from 1.5% to 3.0% depending on certain factors. Phosphorus is important for root growth m flowering and fruiting. In a research carried out by Adebayo *et al*., (2013), showed that uptake of phosphorus in certain vegetables promoted stronger roots and plant development on application of poultry manure.

2.1.3 Potassium Content

Potassium levels in poultry manure ranges from 1 to 2%. Potassium plays an important role in plant growth, water regulation m photosynthesis and enzyme activation. For vegetables, potassium has proven to be highly beneficial.

Studies by Akinrinde *et al.,* (2018) showed that potassium improves water use efficiency of plants, Adebayo *et al*., (2013) discovered the vegetables treated with poultry manure exhibited better stress tolerance and disease resistance which improved yield.

2.1.4 Micronutrients

Poultry manure doesn't only provide macronutrients but also micronutrients like, zinc, iron, copper and boron which are vital for growth and development of plants. Zinc is essential for chlorophyll production and enzyme activity (Adeyemo *et el.,* 2020), iron is important for photosynthesis and respiration (Eze *et al*., 2021), manganese contributes to photosynthesis and nitrogen metabolism (Olaniyi *et al*., 2019), copper aids photosynthesis and lignin formation (Rocha *et al*., 2021) and boron helps to build cell walls and reproductive development (Adebayo *et al*., 2019).

2.2 PREVIOUS POULTRY MANURE TRIALS ON SELECTED VEGETABLES

Numerous trials have shown the beneficial effects of poultry manure on the growth, yield and quality of vegetables.

2.2.1 Tomatoes (*Solanum lycopersicum*)

Tomatoes (*Solanum lycopersicum*) is a widely cultivated fruit vegetable that belongs to the family Solanaceae and genus *lycopersicon*. Tomato is one of the most popular and versatile vegetables in the world and organic production with high yields of desirable quality are a target of many producers (Agaba *et al*., 2023). Tomato is an important vegetable grown commercially in large scale because it is a cheap source of vitamin C (Ilobidia *et al*., 2015). Tomato is rich in minerals, vitamins, sugars, dietary fibers, essential amino acids, and lycopene (Ud Din *et al*., 2023), and it also contain high levels of other bioactive compounds such as phenolics, vitamin C, and antioxidants that protect and possibly prevent stressful environmental conditions (Najat *et al*., 2018).

In a study conducted by Adekiya (2017) to maximize the economic value of plant nutrients in poultry manure and enhance tomato yield, field experiments were carried out in Owo, southwestern Nigeria, during the early cropping seasons of 2012 and 2013. The research examined the effects of two fertilizer application methods, broadcasting on the soil surface and incorporation into the soil, as well as four different application times: three weeks before transplanting, at transplanting, three weeks after transplanting, and six weeks after transplanting. These treatments were applied to evaluate the influence of poultry manure on soil chemical properties, leaf nutrient concentrations, and the growth and yield of tomato plants.

The eight treatment combinations were arranged in a factorial design using a randomized block layout with three replications. The findings showed that incorporating poultry manure at a rate of

30 t/ha significantly increased soil organic matter and the concentrations of nitrogen, phosphorus, potassium, calcium, and magnesium in both soil and leaf samples. This treatment also resulted in greater plant growth and higher tomato yield (0.9 t/ha) compared to the broadcasting method. Poultry manure applied three weeks before transplanting led to higher leaf nutrient concentrations, improved growth, and increased yield compared to applications at transplanting, three weeks after transplanting, and six weeks after transplanting. The higher yield observed with the three weeks before transplanting treatment was attributed to better synchronization between nutrient release and crop nutrient demand. When averaged over the two years, applying poultry manure three weeks before transplanting increased tomato fruit yield by 4.0, 2.8, and 1.5 t/ha compared to applications six weeks after transplanting, three weeks after transplanting, and at transplanting, respectively.

In 2008, Ewulo *et al,* (2008), conducted field experiments at the Federal College of Agriculture and the Federal University of Technology, both located in Akure within the rainforest zone of southwestern Nigeria. The study examined the effects of poultry manure application on nutrient availability, soil physical and chemical properties, and tomato yield. Five application levels of poultry manure were used: 0, 10, 25, 40, and 50 t/ha. The soils at both experimental sites were slightly acidic and low in organic matter, nitrogen, phosphorus, and calcium. The addition of poultry manures significantly increased soil organic matter as well as nitrogen and phosphorus contents. It also reduced soil bulk density and improved moisture retention as the level of manure increased. Poultry manure application enhanced the leaf concentrations of nitrogen, phosphorus, potassium, calcium, and magnesium in tomato plants, as well as plant height, number of branches, root length, and both the number and weight of fruits. The application rate of 25 t/ha

produced the highest leaf concentrations of phosphorus, potassium, calcium, and magnesium, and resulted in the greatest yield.

In another field experiment by Ewulo (2016), to investigate the effects of urea and poultry manure (PM) on tomatoes' growth yield parameters and soil chemical properties. The field experiment involved three levels of both Urea and poultry manure, resulting in nine-treatment combinations, which are, 0 kg Urea/ha + 0t PM/ha, 0 kg Urea/ha+ 4t PM/ha, 0 kg Urea/ha+ 8t PM/ha, 50 kg Urea/ha + 0t PM/ha, 50 kg Urea/ha+ 4t PM/ ha, 50 kg Urea/ha + 8t PM/ ha, 100 kg Urea/ha+ 0t PM/ha, 100 kg Urea/ha+ 4t PM/ ha, 100 kg Urea/ha+ 8t PM/ha. Treatments were arranged in Randomized Complete Block Design (RCBD) with three replications. Growth data (plant height, number of branches, number of leaves and stem girth) were collected fortnightly, beginning from 2 weeks after treatment application (WAT). At harvest, fruit weight and fruit number were recorded. The results of the experiment showed that the combination of 50kg Urea + 8tonnes PM and 100kg Urea + 4 tonnes PM is very good for cultivation of tomato and maintenance of soil properties.

Field experiments were conducted in two ecological zones of central southern Nigeria, namely Agbede (derived savanna) and Obadan (forest zone) in Edo State, to assess the effects of poultry manure and NPK fertilizer, as well as their residual impacts, on the performance of tomato (Solanum lycopersicum L.). The experimental design included three levels of poultry manure (0, 4, and 6 t/ha) and four levels of NPK fertilizer (0, 50, 100, and 150 kg/ha). A factorial arrangement in a randomized complete block design was adopted to ensure statistical reliability and minimize environmental variability.

The results indicated that the application of 6 t/ha of poultry manure, either alone or in combination with 50 or 100 kilograms per hectare of NPK 15:15:15 fertilizer, significantly increased plant height and leaf area across both locations and study years. Similarly, the application of 4 t/ha of poultry manure alone, and its residual effects observed in the subsequent season of 2005, substantially enhanced vegetative growth parameters in both agroecological zones. In Obadan, the highest fruit yields of 3.42 and 2.85 t/ha were recorded from plots that received the combined application and residual effects of 6 t/ha of poultry manure plus 100 kilograms per hectare of NPK 15:15:15 fertilizer. In contrast, at Agbede, the optimum fruit yields of 1.44 and 1.55 t/ha were obtained from the initial and residual effects of 6 t/ha of poultry manure combined with 50 kilograms per hectare of NPK fertilizer. These findings highlight the positive interaction between organic and inorganic nutrient sources in improving tomato growth and yield under the varying ecological conditions of southern Nigeria (Isitekhale *et al*., 2013).

Ilodibia *et al*, 2015, carried out a study at the Teaching and Research Farm of Department of Agricultural Education, Nwafor Orizu College of Education Nsugbe, Anambra State during 2013 cropping season. The treatment rates were 0.0, 5.0, 7.5 and 10.0 tha^{-1} poultry manure. The experimental design was a randomized complete block design with four replications. The parameters measured were number of branches per plant, number of trusses, flowers and fruits per plant, plant height and fruit and seed weight. The result showed that 10 tha^{-1} poultry manure performed better than others in both growth and yield parameter while the plants in control plots gave the least performance.

Four field trials were conducted during the years 2006 and 2007 at Owo, the forest-savanna transition zone in southwest Nigeria, to study the effect of poultry manure (PM), NPK 15-15-15 fertilizer and NPK 15-15-15 fertilizer + poultry manure on the growth and yield of tomato. Seven

treatments were applied to the soil: 0, 10, 20, 30, 40 tha^{-1} poultry manure, 300 $kgha^{-1}$ NPK 15-15-15 fertilizer and 150 $kgha^{-1}$ NPK 15-15-15 fertilizer + 10 tha^{-1} poultry manure. These were laid out in a randomized complete block design and replicated three times. The treatments were compared on the basis of their effect on soil chemical properties, leaf nutrient content, growth and yield of tomato. All levels of poultry manure and NPK 15-15-15 fertilizer + poultry manure increased leaf N, P, K, Ca and Mg levels. The soil chemical properties except pH increased with amount of poultry manure. NPK 15-15-15 fertilizer alone did not increase the soil and leaf Ca and Mg. All levels of poultry manure, NPK 15-15-15 fertilizer alone and NPK 15-15-15 fertilizer + poultry manure increased the number of leaves, plant height, leaf area, number of fruits and fruit weight significantly. Among poultry manure levels, 30 tha^{-1} poultry manure gave the highest fruit yield. Among the seven treatments, NPK 15-15-15 fertilizer + poultry manure gave the highest yield. On an average over the two years, 10, 20, 30, 40 tha^{-1} poultry manure, 300 $kgha^{-1}$ NPK 15-15-15 fertilizer alone and 150 $kgha^{-1}$ NPK 15-15-15 fertilizer + 10 tha^{-1} poultry manure treatments increased fruit weight by 19, 36, 51, 14, 20 and 83%, respectively.

Results revealed that poultry manure is a suitable source of nutrients for tomato especially if applied at 30 tha^{-1} in the forest-savanna transition zone of southwest Nigeria. The combined use of NPK 15-15-15 fertilizer and poultry manure increased tomato yield compared to the application of NPK 15-15-15 fertilizer or poultry manure alone and is therefore recommended for sustainable productivity. In addition, lesser quantities of poultry manure and NPK 15-15-15 fertilizer would be required, therefore, reducing the amount of money spent on chemical fertilizer (Adekiya and Agbede, 2009).

A greenhouse experiment was conducted at the Federal College of Forestry, Ibadan, using polyethylene bags filled with 5 kilograms of soil collected from two depths, 0 to 15 centimeters

and 15 to 30 centimeters, at the college's botanical garden. The experiment followed a completely randomized design with four replications. The treatments consisted of poultry manure applied at 5 t/ha, biochar applied at 10 t/ha, a mixture of poultry manure and biochar in a 1:1 ratio, and an untreated control. Tomato seeds of the UC82B variety were obtained from the National Horticultural Research Institute (NIHORT), Ibadan, and raised in a germination basket. Data were collected weekly on plant height, collar diameter, number of leaves, days to 50 percent flowering, and yield of tomato plants starting from two weeks after transplanting. The collected data were statistically analyzed using analysis of variance (ANOVA), and mean separation was carried out using the least significant difference (LSD) test at the 5 percent probability level.

In the 0-to-15-centimeter soil depth, growth variables such as plant height, number of leaves, and collar diameter increased across all treatments. The highest tomato plant height was recorded with the application of biochar at 10 t/ha. All treatments significantly influenced the number of tomato leaves at all weeks after transplanting, with poultry manure at 5 t/ha producing the highest number of leaves at seven weeks after transplanting. Collar diameter was significantly affected by the different treatments from two to five weeks after transplanting, with the combined application of poultry manure and biochar in a 1:1 ratio recording the highest values, while the control plot consistently recorded the lowest. At the 15-to-30-centimeter soil depth, there was a significant difference in the number of tomato leaves among all amended soils from five to seven weeks after transplanting. The highest number of leaves was obtained from soil amended with poultry manure at 5 t/ha, which was comparable to other treatments. The interaction between poultry manure and biochar in a 1:1 ratio, as well as the sole application of poultry manure at 5 t/ha, resulted in the greatest tomato plant height from three to seven weeks

after transplanting compared with the control, although the difference was not significant relative to the sole application of biochar at 10 t/ha. The combined application of poultry manure and biochar in a 1:1 ratio, together with poultry manure alone at 5 t/ha, produced the highest values for tomato flowering and fruit yield (Musa *et al*., 2020).

Another study was conducted to evaluate the effect of different organic fertilizer on the growth and yield of tomato, the organic manures used for the study were poultry waste, cow dung and pig waste. Field experiment was carried out in the teaching and research farm of Federal College of Education (Technical), Asaba during the 2024 planting season. The tomato variety used for the study was platinum 701FI. The experiment was factorial experiment set in randomized complete block design, (RCBD) and was replicated 3 times. Data on vegetative growth were collected on plant height, number of branches, number of leaves and leaf area (cm^2). This was taken at 2, 4 and 6 weeks after transplanting. Tomatoes were harvested twice weekly at the pink to red-ripe stage to measure the yield. Findings from the research revealed that application of 18kg of poultry manure per tomato plot measuring 3mx4m recorded better growth and yield of tomato. The study recommended the application of 18kg of poultry manure on tomato plot measuring $3m^2$ x $4m^2$ per plot (1.5t/ha) (Prof. Anene-Okeakwa, 2025).

An experiment was also conducted to study the effects of organic fertilizer on the growth and yield of tomato irrigated with fish effluent and normal water at the premises of Faculty of Agriculture, University of Abuja, Nigeria. The investigation consisted of two factors which are irrigation water type, fish effluent, and normal water and poultry manure doses, namely 0 t/ha, 10 t/ha, 20 t/ha, and 30 t/ha. The 8 treatments were replicated thrice and the experiment consists of 24 plots in total. The seedlings were raised in the nursery and transplanted at 21 days onto

aerated pots containing 15 kg of soil mix of different ratios of poultry manure. The fish effluent showed consistent increase in plant height, number of leaves, leaf area, and number of branches than those irrigated with normal water. The application of 20 t/ha poultry manure had significant effect on the fat content. The result obtained from the trial revealed that tomato responded well to the application of poultry manure and it may be recommended as adequate for maximum growth and yield of tomato in the study location (Emeghara *et al*., 2023).

2.2.2 Peppers (*Capsicum spp.*)

Pepper is a fruit vegetable that belongs to the genus Capsicum in the Solanaceae family. Pepper is divided into types, *Capsicum annuum* (shombo), *Capsicum chinense* (Red Pepper) and *Capsicum annuum* var. *longum* (yellow peppers or Nsukka pepper), Eze *et al.,* 2024. Peppers are also classified into three primary categories based on their colour, red pepper, green and yellow and they are used as a vegetable or spice, whether fresh or dried (Gu *et al*., 2017). Poultry manure is an important organic manure that influence growth and yield of several crops, including peppers. Studies have demonstrated the effects of poultry manure on growth and yield of pepper.

A pot experiment was conducted at the Botanical Garden of University of Ilorin to evaluate the influence of different concentration of poultry manure on the growth and yield of bell pepper (*Capsicum annuum*). The experiment was a Randomized Block Design with six treatments and three replicates. Eighteen 6l calibrated plastic pots were perforated at three points at the bottom to ensure drainage and well filled with 12.5 kg of soil each. The eighteen pots were randomly allotted to the six experimental treatments; T1 = Control T2 = 0.5 kg poultry dropping, T3 =1.0 kg poultry dropping, T4 =1.5 kg poultry droppings, T5 = 2.0 kg poultry droppings, T6 = 2.5 kg

poultry droppings. Data were collected on Plant height, stem girth, Number of leaves, Leaf area, Number of flowers, chlorophyll contents as well as yield parameters was carried out at the end of the experiment. The result depicts a significant increase in the plant height, numbers of leaves per plant, leaf area, stem girth as well as yield parameter in the plant treated with 2.0 kg poultry manure when compared to the control plants (Owoeye *et al*., 2024).

In an experiment carried out by (Babatola and Uche, 2020) at Department of Agronomy, University of Ibadan between November, 2017 and April, 2018 growing season. Two varieties of pepper (*Capsicum annum* and *Capsicum frutescens*) were used, with four treatments consisting of different rates of poultry manure. Controls of 0 g of poultry manure(T1), 12.5 g (T2), 25 g (T3) and 37.5 g (T4) were laid out in a complete randomized design and replicated four times. Storage experiment was carried out in the Department and at Nigeria Stored Products Research Institute (NSPRI), Ibadan in June, 2018. The storage experiment comprised of four treatments with ambient condition (open shelf), wet basket, Evaporative Coolant Structure (ECS/Pot-in-pot), and plastic crates used as storage structures, laid out in a completely randomised design and replicated three times. The physical parameters obtained in days in storage (DIS) included weight loss (%), firmness, freshness, among others. Data observed were analyzed using analysis of variance (ANOVA) and means separated using least significant difference (LSD) at $p>0.05$. The result obtained showed that pepper growth was enhanced using Capsicum frutescens under 25 g poultry manure application rate which resulted to superior pepper yield.

This research was done at Michael Okpara University of Agriculture Umudike Student's Farm, with an objective to evaluate the effects of poultry manure rates on the growth and yield of pepper (Capsicum annum) during the 2015 cropping season. Pepper (Capsicum annum), a vegetable crop which belongs to the Solanaceae family and Capsicum genus, has served many

purposes over time. The yield obtained by small-scale farmers in southeastern part of the country is often very low due to various production constraints attributed to poor soil, fertility etc. The treatments used were 10 t/ha, 15 t/ha and 25 t/ha as well as control. The experiment was laid out on a randomized complete block design (RCBD) with three replications. All data obtained were subjected to analysis of variance (ANOVA) using the GenStat package at 0.05 probability level and means compared using least significant difference (LSD). The result from the experiment showed an increase in both growth and yield parameters at different manure rates. Poultry manure rate of 15 t/ha recorded the highest yields for number of leaves per plant, stem girth, plant height while the control recorded the lowest yield. The work showed that an increase in the rate of 25 t/ha did not affect yield rather there was a drop in the yield, hence it is safe to recommend 15 t/ha to farmers in this region. The application of poultry manure to the farm will result in long term nutrient availability for crops as well as increased yield. There is the therefore the need to treat the poultry manure before application to avoid disease development. The findings suggest further studies especially in other localities (Chigozie *et al*., 2023).

(Ansa and Woke, 2018) In 2017 a field experiment was conducted at the Teaching and Research Farm of the Department of Agriculture, Ndele Campus, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, to study the effects of poultry manure rates and crop spacing on growth, yield and quality of Cayenne pepper. The study adopted a 3 x 3 factorial experiment arranged in a randomized complete block design (RCBD). The main plots were three poultry manure rates (0, 10, 20t/ha) and sub plots, three spacing (50cm x 50cm, 100cm x 50cm and 100cm x 100cm). Data collected were plant height, number of leaves per plant, leaf area; number of fruits per plot, fruit weight per plot, fruit yield per hectare, fruit lycopene and vitamin C contents. Results showed plant height increased with reducing planting distance and increasing

Poultry manure rate; 50cm by 50cm fertilized at 20t/ha applied 2 weeks after planting produced the tallest plants with the greatest number of leaves but least leaf area LA. Number of fruits, fruit weight and yield per plot, per hectare increased with increasing planting density and increasing Poultry manure rates lycopene and vitamin c contents increased with Poultry manure levels within the different spacing.

The field experiment was conducted in the research farm of the Department of Crop Science, University of Nigeria, Nsukka, Nigeria. fruits are predominantly yellow and are exported to Nigerian cities where they command premium price. The need to develop appropriate technologies for adaptation and cultivation of 'Nsukka Yellow' pepper in cities where there is scarcity of agricultural lands motivated evaluation of the pepper as a potherb using three poultry manure (PM) rates (0, 5 and 10 t/ha). Three-week-old seedlings were transplanted into 11 L containers and laid out in a completely randomized design replicated 10 times. Growth, yield and nutritional quality of fruits (at different ripening stages) were determined in response to applied manure. Plant height, number of leaves and number of branches increased with increasing level of PM, which translated to increased number of fruits and fruit weight per plant. Plants that received 10 t/ha of PM produced the highest fruit yield. Mature green, half ripe and fully ripe fruits were analyzed for ash, carbohydrate, fat, crude fiber, moisture, protein, alkaloid, flavonoid, tannin and volatile oil contents using standard methods. Both yellow fruits and red fruits (off type from mutated branches) were harvested and analyzed for nutritional quality. Fruits harvested from 10 t/ha PM had the highest percent fat, crude fiber, moisture content, alkaloid, flavonoid, tannin and volatile oil. However, 5 t/ha produced fruits with the highest ash and protein contents; fruits from plants without manure had the highest percent carbohydrate. Fully ripe fruits had the highest percent carbohydrate, (Bayeri *et al*., 2016).

A field experiment was carried out in 2023, to assess the growth and yield of bell pepper to different combination ratios of Poultry Manure (PM) and NPK 15:15:15. The experiment was carried out at a research farm of the Department of Agronomy, University of Ibadan, Nigeria. The treatments, consisting of Control (no fertilizer), 100% NPK, 50% NPK + 50% PM, 33% NPK + 67% PM, 67% NPK + 33% PM and 100% PM were laid out in a randomized complete block design (RCBD) with four replications. Five plants from the same treatment were randomly sampled out of 12 plants per bed and tagged for data collection on growth parameters at 3, 4, 5 and 6 weeks after transplanting as well as number of fruits, fruit length and fruit yield. Data collected were subjected to analysis of variance (ANOVA) and significant means separated using Duncan Multiple Range Test (DMRT) at $p < 0.05$. Results from this study revealed that plants with application of 33% NPK + 67% PM were significantly ($p \geq 0.05$) taller and had more leaves and branches than other treatments and control. Likewise, plants which received 33% NPK + 67% PM treatment had significantly higher fruit yield than control and other treatments. It can therefore be concluded that a high level of poultry manure in combination with lower level of NPK (33% NPK + 67% PM) had the best performance in terms of growth and fruit yield of bell pepper and is therefore recommended (Hassan *et al*., 2024).

A field study was conducted by Gani *et al*., (2024) at Federal University Wukari Teaching and Research Farm during the 2022 cropping season to investigate the effects of poultry droppings and cow dung on the growth and yield of sweet pepper in Wukari. The randomized complete block design was adopted for the experiment and replicated thrice, on a 3 m × 2 m plot. The treatments consist of different rates of cow dung and poultry droppings of 5 t/ha, 10 t/ha and 15 t/ha, which were compared to the untreated control samples. The growth parameters were measured at 2, 4 and 6 weeks after transplanting while the yield parameters were taken at

maturity. Results showed that using both cow dung and poultry droppings significantly increased the growth parameters of sweet pepper compared to the control. At six (6) weeks after transplanting, the highest growth parameters were obtained in the 15 t/ha poultry droppings treatment with 101.1±1.31 leaves, 33.4±2.20 cm plant height, 2.8±0.15 cm stem girth, 21.3±3.69 secondary branches, 32.8±4.18 flower pods and 20.1±5.32 cm2 leaf area. The yield of sweet pepper also significantly ($p \geq 0.05$) increased using of both poultry droppings and cow dung. The mean number of fruits per plant was highest in the 15 t/ha poultry droppings treatment (21.9±2.76) and lowest in the control - no treatment (6.7±1.28), the mean yield per plant was highest in the 15 t/ha poultry droppings treatment (3.32±0.22 kg), and lowest in the control - no treatment (0.78±0.02 kg) and the mean yield per plot was highest in the 15 t/ha poultry droppings treatment (38.75±2.18 kg) and lowest in the control - no treatment (8.76±1.21 kg). These findings revealed that applying poultry droppings at the rate of 15 t/ha or more will enhance the growth and yield of sweet pepper significantly and might be viable alternative to chemical fertilizers.

The study was carried out by (Abdulbaki, 2019) at the University of Ilorin teaching and research farm located at 4°38.920'E to 4°39.971'E and 8°27.810'N to 8°28.230'N. The soil used to fill the pot is a surface soil (0 – 15cm), but dark in colour indicating the presence of humus. As at the time of collection, the land was lying to fallow. The pepper seeds used in this study were gotten from an Agro-allied store at Maraba, Ilorin, Kwara state. Poultry manure, on the other hand, was obtained from the University of Ilorin faculty of agriculture poultry farm. The study was carried out between May and August, 2015. The research followed a randomized complete block design (RCBD) involving five treatments and three replicates for each species. The five treatments were: 0g (control), 2g, 4g, 6g 8g of poultry manure per pot. There were 30 pots altogether, each species

having 15 pots. The experimental pots contained approximately well-sieved 3kg of soil. Poultry manure was applied to the soil two days before planting so as to certify and guarantee the decomposition of poultry manure before planting. Four seeds of C. anuum and C. frutescens each were planted in their respective pots. 8g PM gave the highest yield.

To assess the impact of poultry manure fertilization on the yield and capsaicinoid content of sweet pepper cultivars, field experiments were carried out during the 2018 rainy seasons at two locations within the Sudan savanna agro-ecological region: the Teaching and Research Farm Bayero University Kano and Kadawa Irrigation Scheme Bunkure. The experiment was a 4 x 3 factorial laid out in a randomized complete block design with four replicates comprising four levels of poultry manure (PM) (0, 1.0, 2.0, and 3.0 t/ha) and three cultivars of sweet pepper (Tattasai Dan Damasak, Yolo wonder and Nsukka yellow). The result reveals that the growth, yield and capcisinoid content of sweet pepper cultivars were greatly influenced by the application of PM. The application of 3.0 t/ha of PM significantly gave taller plants, more branches, larger leaves, and a higher number of fruits (Rufai *et al*., 2024).

This study was conducted to provide agronomic information needed for optimum growth and yield of green pepper in Southern Nigeria where it demand and uses is very high.Thus, the evaluation of green pepper cultivation under nine poultry manure rates (0,1,1.5,2,2.5,3,5,7,and 9) t/ha were conducted in Teaching and Research Farm, Obubra Campus Cross River University of Technology, Cross River State, Nigeria in 2020 and 2021 cropping seasons. The experimental design was a Randomized complete block design with nine rates of poultry manure replicated four times. Result indicated that plant height, number and dry weight of leaves, branches and stem increased significantly (P>.05) with increasing rates of poultry manure translating to high fruits number and weight.Plots that received 5.0 t/ha poultry manure produced the highest (7.04

and 7.11) t/ha fresh fruits yield of green pepper in 2020 and 2021 seasons respectively. The used of 2.0 t/ha poultry manure prolong post harvest (shelf life) of green pepper by delayed time of shrinkage, onset of ripening and rot of fruits. Farmers are advised to use 2.0 – 5.0 t/ha poultry manure to cultivate green pepper for maximum fruit yield and prolong post-harvest shelf life of the fruits (Agba *et al*., 2023)

In a study by Fabiyi *et al*., (2014). Organic (poultry manure) and inorganic (Urea) fertilizers were comparatively studied with the aim of improving the performance of sweet pepper, Capsicum annum (called 'Tatase' in Nigeria) in two ecological zones of Nigeria (Ado Ekiti, Ekiti state and Omu-Aran, Kwara State). Poultry manure applied at the rate of 8t/ha gave higher fruit yield than urea at the rate of 0.2t/ha twice equally at two weeks after transplanting (WAT) and at fruiting. Although higher leaf number and branches were produced in the plots that received inorganic fertilizer, the yield produced was lower. It is indicative from this study that pepper can be successfully produced organically using poultry manure in the two ecological zones under study. It also suggests that our soils can be protected from the level of acidity associated with synthetic fertilizer use. Pepper fruits produced from such will be purely organic and safer for human consumption.

Field experiment to evaluate the effect of poultry manure and N.P.K 15:15:15 fertilizer on the growth and yield of Nsukka yellow pepper (Capsicum annum) was carried out during the 2018 cropping season at the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm of Enugu State University of Science and Technology Enugu, Southeastern Nigeria. The University lies between latitude 060 50/ N – 060 57/ N and longitude 070 15/ E – 070 18/ E with a mean elevation of 450 m above sea level. The experiment was carried complete block design (RCBD) with four (4) treatments replicated five (5) times. The experimental area

measured 14 m x 11 m (154 m2). Each plot (experimental unit) measured 2 m x 2 m (4 m2), separated by 1m pathway, with plant spacing of 50 cm x 50 cm. the pepper seedlings were raised in a nursery before they were transplanted into the field. Treatments were; (i) No poultry manure and no N.P.K 15:15:15 fertilizer. (ii) Poultry manure (6.4 t/ha) (iii) N.P.K 15:15:15 fertilizer (200 kg/ha) (iv) Poultry manure (3.2 t/ha) + N.P.K 15:15:15 fertilizer (100 kg/ha). Data were collected on percentage (%) plant survival, plant height (cm), number of leaves per plant, leaf area index, number of days to 50% flowering, number of fruits per plant and fruit yield (kg/ha). The data collected were subjected to analysis of variance for randomized complete block design (RCBD) experiment as outlined by Obi 2002 using Genstat Re le a s e 10.3DE (PC. windows) 2012 software. Differences between treatment means were detected using fisher's least significant difference (F – LSD) as outlined by Steel and Torrie (1980). Effect of poultry manure and N. P.K15:15:15 fertilizer on percentage (%) plant survival, plant height (cm) and leaf area index. The result of the experiment showed significant effect (P = 0.05) of poultry manure and N.P.K 15:15:15 fertilizer on percentage (%) plant survival and plant height (cm), and non-significant effect (P = 0.05) on leaf area index. Poultry manure recorded the highest mean number of 92.50% survived plants, followed by poultry manure + N.P.K 15:15:15 fertilizer that had mean number of 90.00% survived plants and lastly, no poultry manure and no N.P.K 15:15:5 fertilizer that had mean number of 67.50% survived plants. On plant height plots treated with N.P.K 15:15:15 fertilizer recorded the highest mean plant height of 42.70 cm, followed by plots treated with poultry manure + N.P.K 15:15:15 fertilizer that recorded mean plant height of 38.13 cm and lastly plots treated with no poultry manure and no N.P.K 15:15:15 fertilizer that had mean plant height of 29.83 cm. Although there was non- significant effect of the treatments on leaf area index, poultry manure recorded the highest mean leaf area index of 3.66 followed by poultry

manure + N.P.K 15:15:15 fertilizer that recorded mean leaf area index of 3.29 and lastly no poultry manure and no N.P.K 15:15:15 fertilizer treatment that had mean leaf area index of 1.73 (Table1) (Awere amd Omeje, 2019).

2.2.3 CUCUMBER (*Cucumis sativa* L.)

Cucumber (Cucumis sativa L.) which is thought to be one of the oldest vegetable crop (Vishal *et al*., 2017) is a monoecious annual vegetable crop that belongs to Cucurbitaceae family which comprises of 118 genera and 825 species (Ume *et al*., 2017). Cucumber is a creeping vine that grows on the ground or trellises to suspend their fruits. Cucumber is an annual vegetable crop grown for its vitamins and mineral-rich fruits. Although inorganic fertilizer improves crop yield, its consistent usage leads to soil acidity.

A study was conducted to assess the effects of poultry manure (PM) and its combination with NPK fertilizer on the growth and yield of cucumber. The layout was a 3 x 3 factorial scheme with three replicates at the research field of Federal University of Technology, Owerri in 2017. Three treatments consisting PM (5t/ha), PM (2.5t/ha) + NPK (60kg/ha) and NPK (120kg/ha) were applied. At 6 weeks after planting (WAP), Poultry manure and its combination with NPK positively influenced growth parameters such as vine length and number of leaves. Fruit length, fruit circumference, fruit number and fruit weight were significantly increased by PM. Cu999 performed significantly better than other varieties for fruit length and fruit number while Cu102 had the highest fruit weight (William *et al*., 2022).

The application of poultry manure had been extensively studied, with research revealing its beneficial effects on soil properties and crop yields. The objective of another research was to examine the impact of poultry manure on the productivity of cucumber (*Cucumissativum* L.) and the health of the soil in an alfisols located in Jericho, Ibadan, Nigeria, using appropriate standard techniques. Data obtained show that the physicochemical properties of soil pH is (5.46); TOC (8.1 g/kg); TOM (13.97 g/kg), TN (1.3 g/kg), available P (12mg/kg), Ca (1.26 cmol/kg), Mg (3.88 cmol/kg, Na (0.19 cmol/kg), K (0.34 cmol/kg), Mn (78 mg/kg), Fe (206.00mg/kg), Cu (7.5 mg/kg), Zn (1.8 mg/kg), sandy loam texture as 740 g/kg of sand, 100 g/kg of clay, and 160 g/kg of silt, with bulk density at 1.25 g/cm^3, saturated hydraulic conductivity at 16.54 cm/hr, and total porosity at 53% for soil and for poultry manure are TOC (5.99%), TOM (10.32%), TN (5.2), available P (0.1264%), Na (0.146%), Ca (1.088%), Mg (1%), K (0.82%), Mn (0.043%), Cu (0.009%), Fe (0.05%), and Zn (0.046%). Furthermore, addition of poultry manure to soil enhanced the microbial biomass and the activities of essential soil enzymes, including protease, phosphatase, urease, and dehydrogenase, which serve as indicators of soil biological health. For instance, protease activity rose from 73.1 in the control group to 110.3 in the treatment with 20 t/ha of poultry manure. The highest cucumber yield recorded was 139.39 kg from the treatment that received 40 t/ha of poultry manure, while the control plot yielded the lowest at 74.07 kg. These findings suggested that incorporating poultry manure into cucumber cultivation systems could significantly enhance both soil health and cucumber yield (Ishola *et al*., 2025).

A field experiment was conducted at the Teaching and Research Farm of Enugu state polytechnic, Iwollo, Southeastern Nigeria in 2020 to evaluate the profitability of the use of poultry manure for cucumber production in the area. The study was carried out in a randomized complete block design (RCBD) with four replications. The treatment comprised different rates of poultry manure

viz; 0 (control), 5, 10, 15 and 20 t/ha. The growth and yield parameters investigated were vine length, number of branches per plant, number of leaves per plant, leaf area index, number of fruits per plant, fruit yield per plant and fruit yield per hectare. The data collected on growth and yield parameters were subjected to analysis of variance (ANOVA) and treatment means were separated using Fisher's least significant difference (F-LSD) at 5% level of probability. Gross margin (GM) as well Return on Investment (RoI) was calculated to determine the profitability. The results showed that poultry manure significantly ($p<0.05$) induced higher vine length, number of branches per plant, number of leaves per plant, leave area index, number of fruits per plant, fruit yield per plant and fruit yield per hectare compared to control (0 t/ha) with optimum values obtained in 20 t/ha. The profitability of the use of poultry manure increased with increase in the rate of poultry manure. The highest gross margin (# 3,233,860) was obtained from 20 t/ha of poultry manure followed by 15 t/ha (# 2,021,020), 10 t/ha (# 1,381,748), 5 t/ha (# 588,300) and 0 t/ha (#14,660). Similarly, the highest RoI was obtained in 20 t/ha of poultry manure (325.95%) followed by 15 t/ha (237.49%); 10 t/ha (185%); 5 t/ha (93%) and the lowest was in 0 t/ha (2.76%). It could be concluded from the study that the use of poultry manure for cucumber production in Iwollo is profitable and most profitable when 20 t/ha is used (Adinde *et al*., 2021).

Field experiment was conducted at the Teaching and Research farm, Akwa Ibom State University, Obio Akpa Campus to assess the effect of poultry-based organic manure combinations on growth and yield of cucumber in Obio Akpa, 2023. The experiment was laid out in a randomize complete block design and replicated three times. The treatments used were T1 (Poultry manure); T2 (Poultry manure + Piggery droppings); T3 (Poultry manure + Cattle droppings); T4 (Poultry manure + Rabbit droppings); T5 (Poultry manure + Piggery droppings + Cattle droppings); T6 (Poultry manure + Piggery droppings + Cattle droppings + Rabbit droppings) applied at 40g and

control. Result showed Significant differences (P<0.05) among the Poultry manure combinations at 4, 6, 8 Weeks After Planting (WAP) on the growth parameters (vine length, vine girth, number of leaves and number of vines) whereas the yield showed significant differences (P<0.05) among the Poultry manure combinations on all the components. Longest vine length (112.23cm, 145.21cm) were obtained at 6 and 8 WAP with T4 and T3 respectively. T4 produced high vine girth (3.69cm, 3.94cm) at 6 and 8 WAP whereas highest number of vines were produces at 6 and 8 WAP. The treatment T6 gave higher values of number of vines at 2, 4, 6, 8 WAP. Application of T6 produced significant larger fruit yield of 22.71 t/ha while treatment combination of T5 produced 22.60 t/ha fruit yield. Treatment with T4 had 19.25 t/ha fruit yield, while T2 had 18.23 t/ha fruit yield. The treatment of sole application of Pm produced fruit yield of 16.20 t/ha fruit yield compared to the least fruit yield of 7,10 t/ha recorded in control treatment. Considering that the fruit yield of 22.71 t/ha obtained from T6 was not significantly different when compared with 22.60 t/ha recorded in treatment of T5. Therefore, T6 was recommended to cucumber farmers (Udounang *et al*., 2025).

Field experiments were conducted in 2011 and 2012 cropping seasons in the Teaching and Research Farm of Delta State University, Asaba Campus, Nigeria to evaluate the growth and yield responses of cucumber to five different rates of poultry manure. The study was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure in t/ha were 0, 5, 10, 15 and 20, while the parameters investigated were vine length, number of leaves per plant, fruit diameter (cm), fruit length (cm), and fruit weight of cucumber at harvest. Data collected were subjected to analysis of variance (ANOVA), and means separated using Duncan Multiple Range Test (DMRT). The results of the study showed that parameters assessed were significantly influenced by the application of poultry manure. At 4, 6 and 8 weeks after

planting, plants that received highest rate of poultry manure (20 t/ha) were superior in the parameters tested with mean vine length of 116.2 cm, 144.5 cm, and 167.3 cm, respectively, mean number of leaves of 14.6, 46.3, and 56.4, respectively, mean fruit diameter of 16.7 cm, mean fruit length of 22.6 cm and mean fruit weight of 49.3 t/ha in 2011 and 2012. Based on the findings of the study, it was recommended that farmers in the study area apply 20 t/ha of poultry manure for increased growth and yield of cucumber. (Enujeke, 2013).

The three different organic manure sources are poultry manure, cow dung and pig slurry with a control coded as 0t, PM (15t/ha), CD (15t/ha) and PS (15t/ha) respectively and two varieties of cucumber (Murano F1 and Market-More) coded as V1 and V2 were considered in the experiment. This study evaluated the effect of different organic manure sources (poultry manure, cow dung, pig slurry) on the growth and yield of two cucumber varieties (Murano F1 and Market-more) in Anyigba, Kogi State, Nigeria. The objective was to identify optimal organic amendments for cucumber production in the region's sandy loam soil. The field experiment, conducted at Kogi State University's research farm using a Randomized Complete Block Design with 3 replications, measured vine length, number of leaves, leaf area, stem girth, days to flowering, fruit length, fruit diameter, number of fruits per plant, and fruit yield (t/ha). Results showed that poultry manure application significantly produced the longest vines (118.06 cm at 6 WAS), largest leaf area (346.10 cm^2), thickest stems (5.87 cm), earliest flowering (28 days to first flower), and highest fruit yield (31.98 t/ha). Pig slurry resulted in the highest number of leaves (37.45). Variety Murano F1 produced significantly longer fruits (24.54 cm) than Market-more (22.29 cm), but other varietal effects were minimal. The study concludes that poultry manure is the most effective organic amendment for enhancing cucumber growth and yield in

Anyigba's soil conditions. Farmers are recommended to prioritize poultry manure application for optimal cucumber production (Musa *et al*., 2025).

Information on optimum rates of poultry manure is very important in the correction of soil nutrient deficiencies for crop production. A study was carried in the field to establish optimum rates of poultry manure for cucumber (Cucumis sativum) production. The investigation took place at the Teaching and Research Farm of Department of Agricultural Technology, Enugu State Polytechnic, Iwollo, southeastern Nigeria. The treatments were; four levels of poultry manure (10, 20, 30, 40 t/ha) and no poultry manure (control), laid out in a randomized complete block design with three replications. The parameters measured were; seedling emergence, vine length at 30 and 60 days after planting (DAP), number of leaves per plant at 30 and 60 DAP, days to 50% flowering, number of fruits plot-1 and fruit yield. The results indicated that growth, yield and yield components of cucumber increased significantly ($p < 0.01$) with various rates of poultry manure over control. Seedling emergence was not significantly influenced by application of poultry manure. However, significantly longest vine length at 30 (59.8 cm) and 60 (68.9 cm) days after planting, number of leaves per plant at 30 (253) and 60 (254) days after planting, number of fruits perp plot (106) and fruit yield (5.2 t/ha) were obtained where poultry manure was applied at 40 t/ha. Number of days to 50% flowering (30) was significantly ($p < 0.05$) lower in 40t/ha poultry manure treated plots. The overall response of cucumber crop was significantly higher by the application of poultry manure at 40 t/ha to the soil (Agu *et al*., 2015).

The experiment was conducted at the Federal College of Forestry Mechanization, Afaka-Kaduna, to determine the effect of poultry manure and NPK fertilizer on the growth, fruit and yield of cucumber. Two (2) treatment of poultry manure (10t/ha and 15t/ha) and two (2) treatment NPK fertilizer (150 kg/ha) and (200 kg/ha) were used. Experiment was laid out in a Randomized

Complete Block Design (RCBD) and parameters measured include number of leaves, leaf diameter, vine length, number of flowers, fruit weight and fruit diameter the data was collected at 3, 6 and 9 WAP and subjected to analysis of variance and Duncan's Multiple Range Test (DMRT) at the end of the experiment, the results showed a significant effect ($P < 0.05$) of above treatment generally, poultry manure (15t/ha) has the highest yield ($P < 0.05$), while the control plant has the lowest ($P < 0.05$) yield. It is recommended that the horticulturist in the study area should adopt poultry manure (15 t/ha) for effective growth and good fruit yield of cucumber. (Sodimu, 2020).

An experiment was carried out at the Teaching and Research Farm of Crop Science and Horticulture, Nnamdi Azikiwe University Awka, Anambra State, to determine the effects of different poultry manure rates on the growth, yield, disease incidence and severity of one variety of cucumber (Cucumis. sativus L.). The experimental site was cleared and the beds were made. Plot size was 3 m×1.5 m, while distance between each bed was 1m. The treatments comprised cucumber '999' which received four poultry manure rates (0 t/ha, 5 t/ha, 10 t/ha and 15t/ha). The experiment was laid out in a 1×4 factorial in Randomised Complete Block Design in four replicates. Data collected included plant height, vine length, leaf area per plant, number of flowers per plant, number of fruits per plant, fruit length, fruit circumference, fruit weight, yield per hectare, disease incidence and severity. Results showed that poultry manure significantly increased growth and yield of cucumber plants, with 15 t/ha giving the highest yield (20,183 t/ha) followed by 10 t/ha which produced 15,422 t/ha, while the least was zero application which gave 9,789 t/ha. Manure rates did not significantly affect some growth and yield attributes such as plant height, number of leaves, number of flowers and fruit circumference especially during the first two weeks after planting. Increased poultry manure rates led to increased incidence of

Fusarium wilt of cucumber but this did not affect yield. Poultry manure rate of 15 t/ha could be recommended for farmers in the study area for increased growth and yield of cucumber plants (Iwuagwu *et al*., 2021).

The application of organic and inorganic fertilizer on agricultural farming as a management practice has tremendously brought about a great boost to crop yield due to improvement in soil fertility. The thrust of this experiment was to compare the effect of organic and inorganic fertilizer on the growth, yield and nutritional qualities of cucumber (*Cucumis sativus*).

A research was conducted at the Teaching and Research Farm of Ekiti State University, Ado-Ekiti in 2019 using a randomized complete block design with three replications. The treatment consisted of sole application of NPK fertilizer, sole application of goat manure, sole application of poultry, NPK + goat manure, NPK fertilizer + poultry manure and control. Parameters assessed include vine length (cm), stem girth (cm), number of leaves, fruit weight (g), length of fruit (cm), fruit diameter (cm) and number of fruit plant^{-1}. The results revealed that poultry manure (PM) significantly influenced all the agronomic parameters and yield of cucumber than other treatments. There were significant differences among the agronomic parameters measured including yield in all the treatments except the number of fruits plant^{-1}. Poultry manure had the highest fruit yield followed by goat manure, NPK fertilizer and poultry manure respectively. For the proximate test, it was observed in the results that there were slight differences in the composition of the proximate of cucumber based on the treatments, suggesting that fertilization can influence the proximate of fruit and vegetables. The overall assessment of the research suggested that poultry manure is the best fertilizer for cucumber growth and yield performance. The experimental area was 12.5m by 9.8 m. A randomized completely block design was used as an experimental design and replicated three times. Treated cucumber seeds planted was Darina

variety obtained from a licensed and registered Agro-based store in Ado-Ekiti. 3seeds were sown at a rate of one seed per hole at the depth of 2 cm. The spacing adopted was 0.5m by 0.5m. The treatments used were 15-15-15 (NPK), Goat manure (GM), Poultry manure (PM) and Poultry + NPK 15-15-15 (PM+NPK), Goat manure + NPK 15-15-15 (GM+NPK) and a control. The PM and GM were applied to the field two weeks before planting (2WBP) at the rate of 40t/ha and NPK was applied at 2 weeks after planting (2WAP) at the rate150kg/ha by side dressing. Also, Poultry and Goat manure were applied at the rate of 20t/ha at 2WBP and side dressed with NPK (15-15-15) fertilizer, 2 WAP at the rate of 75kg/ha for both PM + NPK and GM+NPK. (Kehinde-Fadare *et al*., 2022).

The growth and yield of Ashley variety of cucumber in response to the effect of farmyard manure and inorganic fertilizer NPK 20:10:10 was evaluated at the Teaching and Research Farm of the Ambrose Alli University, Ekpoma, Nigeria Lat 6°45'N and long 6°08'E. The farmyard manure was applied at the rates of 0, 5 and 10 t/ha and the inorganic fertilizer at 0, 100, 200, 300 and 400 kg/ha. The layout was a 3 × 5 factorial scheme with three replicates. The combined rates of farmyard manure at 10 t/ha × 400 kg/ha fertilizer increased the growth characters such as the vine length and the number of leaves. At 8 weeks after planting (WAP), the application of 10 t/ha of farmyard manure × 400 kg/ha of fertilizer gave the longest vine length of 276.93 cm and the highest number of leaves. The fruit length, fruit girth, fruit weight per plant and fruit weight per hectare were significantly influenced by the application of farmyard manure × fertilizer. The highest weight of 2.43 kg per plant and yield per hectare of 43,259 kg/ha were obtained with 10 t/ha farmyard manure and 400 kg/ha of fertilizer which were 166.42% higher than the control (Eifediyi and Remison, 2010).

2.2.4 GARDEN EGG (*Solanum melongen*)

Garden egg (*Solanum melongena*) is one of the major vegetables grown in West Africa. It belongs to the family of Solanaceae and genus Solanum. Garden egg is known by several names like “bringal” in South East Asia and known as garden eggs in West Africa (Khald *et al*., 2014). They are also a rich source of K, Mg, Ca and Fe and they are low in calories having a mineral composition beneficial for human health (Aderemi *et al.,* 2024). It is eaten almost every day and it is a source of income for rural families (Owusu-Ansah *et al.,* 2021). With the growing consumption of garden eggs, there is a need to ensure high quality fruits with minimal or no sacrifice of quality and at the same time leaving the soil undegraded chemically, physically and biologically (Eifediyi *et al*., 2016). Garden egg is a vegetable valued for its nutritional and economic benefits. Its production is often constrained by poor soil fertility and weed competition interference. Improving soil fertility could enhance crop tolerance to weed competition.

A study investigates the influence of poultry manure (PM) on garden egg's resilience against weed competition. In a 4×2 factorial combination, PM at 0, 15, 30, and 45 kg N/ha represented as control, low, moderate, and high soil fertility conditions, respectively, and weed management (weedy check and regular weeding) were evaluated in a randomized complete block design replicated three times. Garden egg (L01 variety) seedlings were transplanted at 40,000 plants/ha. Data on growth and yield were subjected to ANOVA, and significantly different means were separated using Duncan's Multiple Range Test at $p<0.05$. The results showed that applying 45 kg N/ha of PM significantly increased plant height, number of leaves, and canopy spread compared to the other treatments in the first and second seasons. Weeded plots had 1274.67 and 1359.98 cm^2 leaf area, while non-weeded plots had 862.89 and 905.16 during the first and second seasons, respectively. The combination of 45 kg N/ha and regular weeding resulted in the highest fruit yield (6502.47 and 6004.10 kg/ha) and the lowest in the control treatment (0.00 and 125.00 kg/ha)

in the first and second seasons, respectively. Applying poultry manure at 45 kg N/ha, with regular weeding, is more effective for garden egg production. (Henry and Tajudeen, 2025)

Field research was conducted at the University of Uyo Teaching and Research Farm in 2003 to determine the effect of goat and poultry manure application on selected soil Physico-Chemical properties, and yield of garden egg (Solanum melongena). The experiment was laid out in a Completely Randomized Design (CRD) with four replicates. Animal manure treatments were applied at 4 levels; Control [0 t/ha], Goat Manure GM [l0 t/ha], Poultry manure PM. [l0 t/ha], and GM+ PM [5+5 t/ha] applied at 4 weeks after transplanting (WAT). Soil Samples were collected at 0-20 cm depth from treated plots at 1, and 3 months after transplanting [MAT] for laboratory analysis. Soil parameters analyzed were; pH, organic matter, total Nitrogen, available Phosphorus, exchangeable Potassium, Calcium, Cation exchange capacity and base saturation percentage. Plant parameters sampled were; plant height urn), number of branches and leaves per plant, leaf area index (cm), and fruit yield (kg/ha). The result showed that poultry, goat manure and their combination [GM+PM] generally increased soil pH, with a range of 5.48-5.72 from initial pH of 4.24 in control plot. Poultry manure treatment alone, increased soil pH up to 5.87 representing 35.44 percent, and soil organic matter status by 6.66 % representing 126.53 percent over control respectively. Application of goat manure alone increased soil total Nitrogen status by 0.24 % representing 166.67 percent over control. Application of GM and PM alone improved base saturation percentage generally with PM giving a higher percent over control, application of GM, PM alone and their combination significantly affected garden egg fruit yield. (Okon *et al*., 2016).

Ogbonna and Ogbonna, (2010) carried out a study in the experimental farm of the Department of Crop Science, University of Nigeria, Nsukka in the period of September 2003 and February 2004

to determine the effect of different rates of poultry manure and NPK 15.15:15 fertilizer and their interaction on fruit yield of Solanum melongena. The study was repeated in the months of July to November, 2007, in the same area. Four rates of poultry manure 0, 5, 10 and 15 t/ha and four rates of NPK: 15:15:15 fertilizer, 0, 200, 350 and 400kg/ha and their combinations were tested in a factorial in Randomized Completely Block Design (RCBD) experiment. The result revealed that application of poultry manure significantly increases fruit yield in the crop. Fruit yield/ha increased by 54.03% 90.65% and 145.97% as manure was increased from 0 t/ha to 5, 10 and 15 t/ha, respectively, in 2004. In the 2007 experiment it increased by 147.98%, 166.67% and 176.94 as manure was increased from 0 t/ha to 5, 10 and 15 t/ha, respectively. Fertilizer application also significantly increased fruit yield. Fruit yield increased by 23.86%, 29. 51 % and 30.78% in 2004 and by 129.28% 157.4% and 144.61% in 2007 as NPK 15:15:15 application was increased from 0kg/ha to 200, 350 and 400kg/ha, respectively. Poultry manure by NPK 15:15:15 interaction was not statistically significant in the plant yield attributes studied, however, the combination of 15t/ha of PM and 350kg/ha NPK 15:15:15 gave the highest fruit yield /ha in both years.

A field experiment was conducted at the Teaching and Research Farm of the University of Agriculture, Makurdi (Latitude 70, 45'N and Longitude 80 53' E) in the Southern Guinea Savanna Zone and the Cross River University of Technology Obubra Campus(Latitude 60 06'N and Longitude 80 18' E) in the Rainforest zone of Nigeria, during the 2009 cropping season This was factorial in Randomized complete block design (RCBD) consisting of 2 factors: 10 sources of organic manures (M) as M0, M1, M2, M3, M4, M5, M6, M7, M8, M9, and 2 varieties of Garden egg: V1, and V2 M0, = control, M1, = 5 t/ha moringa leaf, M2, =10 t/ha moringa leaf, M3, = 20 t/ha moringa leaf, M4, = 5 t/ha poultry dropping, M5, = 10 t/ha, M6 = 15 t/ha poultry manure M7 = 1 t/ha ' Fertiplus' M8 = 2 t/ha 'fertiplus' M9, 3 t/ha ' Fertiplus while V1 = Gilo and

V2 = Kumba. This gave a treatment combination of 20 treatments which were replicated 3 times with each plot size measuring 4m x3m (12m2) with an alley of 1m as block boundaries and 0.5m as plot boundaries and gross experimental plot of 35m x38m (980m2) or 0.098 ha. droppings, 1,2,3 t/ha fertiplus) were laid out in a randomized complete block design (RCBD) in three replications. All organic manure resources significantly ($P < 0.05$) increased the growth and yield of the garden egg cultivars over control. Poultry droppings at 15 t/ha produce tallest plants, highest number of fruits per plant and highest yield of 9.18 t/ha and 8.65 t/ha respectively for Makurdi and Obubra, this was followed by Moringa 20 t/ha (7.22 and 6.68 t/ha) respectively for Makurdi and Obubra and Fertiplus 3 t/ha with yield of 6.78 and 5.77 t/ha respectively for Makurdi and Obubra. Moringa 20 t/ha produce the highest dry matter of the plants. The least fruit number of fruits per plant than Kumba and fruit yield in t/ha was higher in Gilo. There was no significant interaction between varieties and manure. Yield of both varieties was higher in Makurdi than Obubra *Moringa Oleifera* leaf biomas and poultry droppings are promising soil conditioners for optimum production of garden egg. (Kekong *et al*., 2013).

Field trials were conducted during the growing seasons of 2016 and 2017 at the Experimental farm of National Horticultural Research Institute Mbato out-Station Okigwe Imo State, Nigeria to investigate the effect of different organic fertilizer types and rates on production of garden egg (*Solanum gilo*).The treatments were three organic fertilizer types (Poultry manure, *Tithonia diversifolia* leaves and Moringa oleifera leaves) and three application rates of 0 t/ha (control), 10 t/ha and 20 t/ha. The experiment was laid out as a 3 x 3 factorial in Randomized Complete Block Design replicated four times. Each plot size measured 3 m x 3 m. Garden egg seedlings were transplanted at spacing of 1 m x 1 m apart. The manure types were incorporated into the soil two weeks before transplanting the garden egg seedlings. Data were collected on growth parameters

such as plant height (cm), canopy spread (cm), number of leaves and stem girth (cm) at 4 and 8 weeks after transplanting (WAT). Also, number of fruits and fruit weight were determined. All data collected were subjected to analysis of variance (ANOVA) and means were separated using fishers LSD at 5% probability level. The result of the trial shows that poultry manure gave the highest mean number of leaves value at both 4 and 8 WAT with values of 43 and 53 respectively. This was followed by *Moringa oleifera* with *Tithonia diversifolia* recoding the least number of leaves. However, application of 20 t/ha recorded the highest mean number of leaves values of 39 and 46 at 4 WAT and 8 WAT respectively. The interactions of the fertilizer types and rates on a number of leaves were significant. A similar trend of results was also recorded on the effect of different fertilizer types and rates on the canopy spread of garden egg. Poultry manure showed highest mean values of 38 cm and 41 cm at 4 WAT and 8 WAT respectively, with 20 t/ha rate of application also recording highest means. The number of fruits was highest in plots treated with poultry manure with 97 followed by *M. oleifera* (96). There were significant interactions between the fertilizer types and rates on a number of fruits. Similarly, the fruit weight followed the same trend with number of fruits with poultry manure plots having highest fruit weight than *M. oleifera* and *T. diversifolia* plots. Highest mean fruit weight of 2.56 t/ha was recorded in poultry manure plot, followed by 2.49 t/ha in *M. oleifera* plots. In terms of soil amendment using these fertilizer types, poultry manure is recommended at 20 t/ha based on its outstanding performance (Onyegbule *et al*., 2018).

Studies in Ghana also show that poultry manure yielded the most fruit at 0.921 kg/ha, followed by cattle and goat manure at 0.709 kg/ha and 0.698 kg/ha. In conclusion, poultry manure may be a better alternative to synthetic NPK with yield performance similar to garden eggs and long-term soil health benefits similar to other manure sources (Adjei *et al*., 2023).

Mpanga *et al*., 2021, also found that the application of poultry manure improved the growth of garden egg (dry matter by 73%) and increased yield by 66%.

2.2.5 ONIONS (*Allium cepa*)

Onion (*Allium cepa* L.) is a vegetable that is widely consumed due to its flavoring and health-promoting properties. Onions have many possible health benefits including reducing the risk of obesity, heart disease, and cancer. Onion bulb is a rich source of minerals like phosphorus, calcium, magnesium, iron, manganese and carbohydrates. (Yoldas *et al*., 2017). Research by Alabi *et al.,* 2020, showed that onions treated with poultry manure had significantly greater plant height and leaf numbers compared to those receiving chemical fertilizers or no fertilizer at all.

Onion (*Allium cepa* L.) is one of the most widely cultivated vegetable crops in Nigeria and a major component of local diets due to its distinctive flavor, nutritional value, and medicinal properties. The crop plays a vital role in income generation for smallholder farmers across diverse agro-ecological zones. However, onion production in Nigeria is constrained by low soil fertility, limited use of organic inputs, and poor nutrient management practices. Sustainable nutrient management through the use of organic and inorganic fertilizers has been identified as a viable means to improve yield, bulb quality, and soil health. Recent studies conducted across various ecological zones in Nigeria have explored the effects of poultry manure, farmyard manure, cow dung, NPK fertilizer, and their combinations on the growth, yield, and quality of onion.

An experiment conducted at the Federal Polytechnic Damaturu Teaching and Research Farm (2022/2023) evaluated the effects of inorganic and farmyard manure on the growth and yield of onion. The study involved four treatments: NPK fertilizer, poultry manure, cattle dung, and a

control, each applied at 24 t/ha in a randomized complete block design (RCBD) replicated three times. Results showed significant differences among treatments, with poultry manure (T2) producing the highest growth and yield parameters, including plant height (37.91 cm), total yield per plot (30.1 kg), and bulb diameter (6.99 cm). The study concluded that poultry manure significantly ($p \geq 0.05$) onion growth and yield under the given conditions (Abdullahi and Muhammad, 2023).

A field experiment in Makurdi, Benue State, investigated the effects of organic manure and variety on onion growth and yield. Treatments included poultry droppings (20 t/ha), goat manure, and a control, with two onion varieties, Bombay Red and Red Creole arranged in an RCBD with three replications. Results showed that onion significantly ($p \leq 0.05$) improved with manure application, with poultry droppings producing superior results across all parameters: plant height (44.34 cm), number of leaves (7.74), days to maturity (117.23), leaf length (21.23 cm), bulb diameter (5.46 cm), bulb fresh weight (44.19 g), and total yield (7.00 t/ha). Among varieties, Bombay Red outperformed Red Creole in growth and yield attributes, with bulb diameter (5.93 cm) and total yield (7.23 t/ha). The study recommends poultry droppings and the Bombay Red variety for optimal onion production in Makurdi (Madina *et al*., 2024).

Two field experiments were conducted during the 2010/2011 and 2011/2012 dry cropping seasons at the University of Benin to assess the effects of NPK 15:15:15 fertilizer and poultry manure on onion growth and yield. The experiment combined four NPK levels (0, 40, 80, and 120 kg/ha) with four poultry manure rates (0, 5, 10, and 15 t/ha) in an RCBD with three replicates. There was a significant interaction between NPK and poultry manure on growth and yield. The combination of 80 kg/ha NPK and 15 t/ha poultry manure resulted in the highest bulb yield (29.55 t/ha in 2011/2012 and 28.17 t/ha in 2012/2013). Shoot yield was highest (7.06 and

6.89 t/ha) at 120 kg/ha NPK combined with 15 t/ha poultry manure. The results indicate that integrating NPK fertilizer with poultry manure improves onion growth, yield, and nutrient use efficiency (Falodun *et al*., 2013).

A spacing and manure study conducted over two years evaluated the effects of three plant spacings (15 cm × 15 cm, 20 cm × 20 cm, and 25 cm × 25 cm) and four poultry manure rates (0, 5, 10, and 15 t/ha) on onion growth, yield, and quality. Wider spacing (20 cm × 20 cm and 25 cm × 25 cm) significantly ($p \geq 0.05$) increased leaf thickness, bulb weight, and shoot fresh weight compared with narrower spacing. The 20 cm × 20 cm spacing produced the highest total dry yield (1.82 and 1.58 t/ha), shoot yield (2.31 and 1.32 t/ha), and total fresh yield (13.69 and 12.55 t/ha) across two seasons. Poultry manure application improved nutrient uptake and proximate composition, with 10 t/ha producing the best results for most growth and yield components (Falodun and Egharevba, 2018).

A field trial conducted at Tatari Ali Farm, Azare, Bauchi State, assessed the effects of poultry manure, cow dung, NPK (15:15:15), and urea on onion growth and yield. Treatments included poultry manure (10 t/ha), cow dung (10 t/ha), NPK (400 kg/ha), urea (200 kg N/ha), and a control, arranged in an RCBD with three replications. All treatments significantly ($p<0.05$) improved onion performance compared to the control. Poultry manure produced the highest bulb diameter (6.16 cm) and fresh bulb weight, while NPK and urea resulted in higher leaf numbers and photosynthetic rates. The yield hierarchy was poultry > cow dung > NPK > urea > control. ‘Kwadon local’ cultivar performed best across parameters, and was therefore recommended for optimum onion production (Mohammed, 2024).

A two-season study (2019–2020) conducted at the University of Nigeria, Nsukka, examined the effect of poultry manure rates on onion growth and yield during wet and dry seasons. Treatments were 0, 10, 20, and 30 t/ha poultry manure, replicated three times in an RCBD. Growth and yield were higher in the wet season, with 30 t/ha poultry manure producing the best growth attributes number of leaves (14.22), leaf length (53.67 cm), and leaf diameter (0.88 cm). The 20 t/ha rate yielded the highest plant height (60.86 cm) and bulb fresh weight (2 kg/plant). During the dry season, 20 t/ha remained superior with plant height (57.64 cm) and bulb weight (0.63 kg/plant). The study recommends 20 t/ha poultry manure for optimum onion growth under wet season conditions (Ishieze *et al*., 2022).

A related experiment at the Federal University Wukari, Taraba State, compared the effects of poultry manure, cow dung, organic manure, NPK fertilizer, and urea on onion growth and yield. Treatments were poultry manure (10 t/ha), cow dung (10 t/ha), organic manure (10 t/ha), NPK (400 kg/ha), urea (200 kg N/ha), and a control, arranged in an RCBD with three replications. All treatments significantly ($p<0.05$) improved onion growth and yield. Poultry manure produced the highest number of leaves (50.60), shoot weight (20.96 g), and bulb weight (50.60 g). The yield order was poultry > organic manure > cow dung > NPK > urea > control. Poultry manure application was therefore recommended as the best organic nutrient source for onion production (Adeyeye *et al*., 2017).

Two field trials conducted during the 2012/2013 dry season in Lake Alau (Maiduguri) and Pelachiroma (Hawul LGA, Borno State) studied the effects of organic manures and irrigation intervals on onion yield. Treatments combined four organic manures, cow dung (20 t/ha), goat dung (20 t/ha), poultry litter (15 t/ha), and a control, with five irrigation intervals (3, 6, 9, 12, and 15 days) in a split-plot design with three replications. Poultry litter at 15 t/ha with a 6-day

irrigation interval produced the highest bulb yield across locations, while control plots gave poor results under all irrigation schedules. The study concluded that combining 15 t/ha poultry litter with 6-day irrigation is optimal for onion bulb production in the region (Gwari *et al*., 2014).

Field experiments at the Kebbi State University of Science and Technology, Aliero (2011–2013), evaluated the response of onion to organic and inorganic amendments in the Sudan savanna. Six soil amendment treatments supplied 120 kg N/ha using NPK 15:15:15, farmyard manure (5 t/ha), poultry manure (1 t/ha), and their combinations in various ratios. Results showed that plant height, bulb diameter, bulb weight, and total yield were significantly improved by 100% NPK (800 kg/ha) and by integrating NPK with poultry manure at a 50:50 ratio (400 kg/ha NPK and 0.5 t/ha poultry manure). The study concluded that combining NPK fertilizer with poultry manure at 50:50 ratio enhances onion yield while improving soil structure and fertility (Muhammad *et al*., 2016).

2.2.6 CARROT (*Daucus carota*)

Carrot ranks among the ten (10) top vegetable crops that play a major role in human nutrition because of its high dietary fibre (Dawid *et al*., 2015). It is an important root vegetable grown widely in Nigeria for its nutritional and economic value. It is rich in vitamins, minerals, and dietary fiber, contributing to food and nutritional security. This versatile root vegetable is consumed in various ways, such as raw in salads or cooked in soups and other dishes (Rahman *et al*., 2020). Environmental degradation problems associated with the sole use of inorganic fertilizers and the low and slow nutrients release from sole use of organic manure prompted integrated nutrients management research (Adeleye *et al.,* 2024). Carrot (Daucus carota L.) has historically been classified as a northern crop because it predominantly grows in the northern

regions of Nigeria. Transportation of harvested roots to the south has consequently resulted to decay, shrinkage, loss of roots due to high temperature and long distant travels, high cost of produce etc. (Anozie and Baiyeri, 2022).

However, carrot productivity in tropical regions is often constrained by poor soil fertility, low organic matter, and inappropriate agronomic practices such as unsuitable tillage methods and fertilizer application. The use of poultry manure as an organic fertilizer has proven effective in improving soil structure, nutrient availability, and crop yield. Recent studies across various regions in Nigeria have examined the effects of poultry manure rates, tillage practices, and integrated nutrient management on carrot growth, yield, and quality.

A related study assessed the potential of poultry manure in improving carrot growth, root yield, nutritional quality, and soil fertility in the rainforest agroecology of southwest Nigeria. Poultry manure was applied at 0, 5, and 10 t/ha in a randomized complete block design with three replications. Results revealed that the experimental soil was acidic (pH 5.5) and low in nitrogen (0.1 g/kg). Application of poultry manure significantly ($p<0.05$) improved carrot growth, yield, and soil nutrient content compared to the control. The effects of 5 t/ha and 10 t/ha poultry manure on gross and marketable yields were not significantly different ($p>0.05$), although 10 t/ha produced the highest values and greatest residual soil fertility improvement. Thus, 10 t/ha poultry manure was recommended for enhancing carrot yield and soil quality under similar ecological conditions (Adeleye *et al*., 2025).

The objective of a study conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka, was to determine the variety and tillage method that would enhance carrot production, as well as the appropriate poultry manure rate for optimal yield. Two

carrot varieties (Touchon Mega and Kurado) were evaluated under three poultry manure rates (0, 5, and 10 t/ha) and two tillage methods (ridge and bed) in a field experiment. Data collected on seedling emergence, root weight, leaf weight, whole plant biomass, and marketable yield showed that poultry manure significantly ($p<0.05$) increased carrot yield. Ridge tillage produced higher marketable yield than bed tillage, while Kurado had the highest percentage of marketable roots, although the varietal difference was not significant ($p>0.05$). The study concluded that for carrot production in the area, Kurado variety combined with ridge tillage and 10 t/ha poultry manure is most effective for high yield and root quality (Anozie and Baiyeri, 2022).

Field trials at Igba in the rainforest agroecological zone of Nigeria evaluated the effects of integrating poultry manure and NPK fertilizer on carrot yield and nutritional quality. The treatments consisted of NPK fertilizer at 0, 100, and 200 kg/ha combined with poultry manure at 0, 5, and 10 t/ha in a 3×2 factorial design, arranged in a randomized complete block design with three replications. Results showed that integrated application of poultry manure and NPK fertilizer significantly increased plant height, leaf length, gross and marketable root yield, crude protein, and fiber content compared to sole application of either amendment. The combination of 10 t/ha poultry manure with 200 kg/ha NPK produced the best growth and yield results In the second cropping season, sole NPK application led to reduced yields, whereas integrated treatments-maintained performance. Hence, combining poultry manure with NPK fertilizer enhances carrot yield and nutritional quality more effectively than using NPK alone (Adeleye *et al*., 2024).

Carrot cultivation in southeastern Nigeria has potential to reduce dependence on supplies from northern regions. To assess this, a field experiment was conducted in Nsukka with four carrot varieties (Carotte Touchon, Touchon Mega, Super Mega, and Touchon France) and three poultry

manure rates (0, 10, and 20 t/ha), arranged in a randomized complete block design with three replications. Carotte Touchon recorded the highest root production (11.6 t/ha) with 20 t/ha poultry manure, followed by 7.5 t/ha at 10 t/ha manure rate, while Touchon Mega produced the lowest yield (1.4 t/ha) in the control plots. Proximate composition was largely unaffected by variety, except for fat content, but significant variations were observed in vitamins A, C, and E, as well as in minerals such as Fe, Mg, Na, and K. The study concluded that Carotte Touchon variety combined with 10–20 t/ha poultry manure offers optimal yield and nutritional value, highlighting carrot's potential for nutritional improvement and local production in southeastern Nigeria (Eze *et al*., 2024).

An experiment conducted in Jos and Makurdi, Benue State, Nigeria, investigated the effects of organic manure sources on carrot growth and yield. Treatments included poultry dropping, cow dung, goat manure, refuse dump soil (each at 20 t/ha), and a control with no manure. The experiment was arranged in a randomized complete block design with three replications and spacing of 15 cm × 75 cm. Results revealed that all measured parameters plant height, number of leaves, aerial weight, root weight, root length, diameter, and harvest index responded significantly ($p \leq 0.05$) to organic nutrient sources. Poultry droppings produced the highest growth and yield values, including a root yield of 5.10 t/ha, while carrots grown in Jos outperformed those from Makurdi. The study recommended poultry droppings as the most effective organic amendment for carrot production in the region (Madina *et al*., 2022).

A field trial in Samaru, Zaria, evaluated the response of two carrot varieties (Touchon and Madona) to poultry manure applied at 0, 5, 8, and 10 t/ha. The experiment, arranged in a randomized complete block design, revealed that Touchon variety produced the highest stand count, total dry matter, root length, and marketable yield compared to Madona. Among manure

rates, 10 t/ha yielded the best growth and yield parameters. The study therefore recommended Touchon variety with 10 t/ha poultry manure for optimal carrot production under irrigated conditions (Mohammed *et al*., 2019).

Field experiments during the 2010 and 2011 dry seasons at the Irrigation Research Farm, Institute for Agricultural Research, Kadawa, evaluated the effects of organic manure, inorganic fertilizer, and irrigation interval on carrot productivity. Treatments included three NPK fertilizer levels (0, 80, and 100 kg/ha), three irrigation intervals (5, 8, and 12 days), and three poultry manure rates (0, 5, and 10 t/ha), arranged in a split-plot design with three replications. Inorganic fertilizer at 100 kg NPK/ha and poultry manure at 10 t/ha significantly increased growth and yield parameters. The combination of 5 t/ha poultry manure with 80 kg/ha NPK produced the highest carrot yield, while irrigation intervals had no significant effect. These findings indicate that integrating organic and inorganic fertilizers enhances carrot productivity under irrigated systems (Sani *et al*., 2022).

A study conducted at the Teaching and Research Farm of Rufus Giwa Polytechnic, Owo, during 2014 and 2015 examined the effects of poultry manure and NPK fertilizer on soil properties and carrot yield in the forest–savanna transition zone of Nigeria. Treatments included no manure (control), 10, 20, and 30 t/ha poultry manure, and 300 kg/ha NPK fertilizer in a randomized complete block design with three replications. Poultry manure applications significantly improved soil physical properties, reduced bulk density and temperature, and increased soil moisture and porosity. Carrot plants treated with 20 and 30 t/ha poultry manure exhibited superior growth and yield compared to other treatments. Application of 20 t/ha poultry manure was identified as the most beneficial for improving both soil quality and carrot productivity (Agbede *et al*., 2017).

2.2.7 OKRA (Abelmoschus esculentus L.)

Okra (Abelmoschus esculentus (L) Moench) is an annual herbaceous vegetable cultivated in the tropical, sub-tropical, and warm temperate regions of the world (Purseglove, 2008). It belongs to the family Malvaceae with its origin in Africa. It is a pleasant sauce eaten in Africa, Europe, and Asia (Mornya and Mansaray, 2022). It belongs to the family marlraceale and is a member of order marvels. Okra is also a vegetable crop commonly grown by peasant farmers in West Africa (Ogundiran, 2013). It serves as a vital source of vitamins, minerals, and dietary fiber, and is consumed in both fresh and processed forms.

However, poor soil fertility remains a major constraint to its productivity, necessitating the use of nutrient management practices that are efficient, sustainable, and environmentally friendly. Poultry manure, being rich in essential macro and micronutrients, has gained recognition as an effective organic fertilizer that enhances soil fertility and improves crop yield. Knowledge of optimum rates of poultry manure application is of immense significance in the correction of the soil nutrient deficiencies for crop production. Manure application is of importance to both the soil amendment and in the growth and yield of crops. Several studies have investigated the influence of poultry manure and other organic and inorganic fertilizers on the growth and yield of okra across various agroecological zones in Nigeria.

A study was conducted to examine the growth and yield responses of okra (Abelmoschus esculentus (L.) Moench) to different rates of poultry manure in Rivers State. Three rates of poultry manure were employed, (0 t/ha as control, 5 t/ha, and 10 t/ha) arranged in a completely randomized block design with three replications. Growth parameters measured included plant height, stem thickness, leaf area, and number of leaves per plant, while yield parameters included

pod length, number of seeds per pod, total number of pods, and pod yield per hectare. Results revealed that poultry manure application significantly ($p \geq 0.05$) enhanced okra growth and yield, with the 10 t/ha rate producing the best performance. Therefore, the study recommends the application of 10 t/ha poultry manure for high-quality and high-yield okra production in Rivers State (Adesira and Wiro, 2020).

A study was conducted at the experimental farm of the Federal College of Agriculture, Ibadan, Nigeria, to determine the effect of poultry manure tea on soil chemical properties, vegetative growth, and yield of okra. The experiment was arranged in a randomized complete block design with three replications. Treatments consisted of 2 kg of poultry manure soaked in 50, 75, and 100 liters of water, as well as an NPK 20-10-10 fertilizer treatment. Results indicated that 2 kg of poultry manure in 100 liters of water significantly improved soil chemical properties, while 2 kg in 75 liters of water enhanced vegetative growth and yield of okra. Although NPK fertilizer increased growth parameters, poultry manure tea was significantly superior (Ojo *et al*., 2014).

The aim of another experiment was to evaluate the effects of time and rate of poultry manure application on the performance of an early maturing okra variety (Clemson Spineless VGTH-014K). The experiment was conducted at the University of Calabar Teaching and Research Farm from June to September 2016 using a randomized complete block design with three replications. Treatments consisted of poultry manure at 5 and 10 t/ha incorporated into the soil at one and two weeks before planting, at planting, and two weeks after planting, with 0 t/ha serving as control. Results indicated that 10 t/ha poultry manure significantly improved vegetative and yield parameters irrespective of application time. Early application at two weeks before planting produced the tallest plants (39.70 cm), highest number of leaves (22.67), branches (9.67), and greatest leaf area index (44.96). The highest fresh (1.43 t/ha) and dry pod yield (0.55 t/ha) as well

as dry seed yield (308 kg/ha) were obtained from 10 t/ha applied before planting, indicating this rate and timing as optimal for okra production (Ntia *et al*., 2017).

Field trials conducted during the 2018 rainy season at the Federal University Dutsin-Ma Teaching and Research Farm evaluated the influence of different levels of NPK fertilizer (0, 40, 80 kg/ha) and poultry manure (0, 4, and 8 t/ha) on okra growth. The experiment was laid out in a randomized complete block design with three replications. Application of 4 and 8 t/ha poultry manure significantly influenced the number of plants per plot, plant height, number of leaves, leaf area, and stem girth. Increasing levels of poultry manure and NPK fertilizer enhanced all measured parameters. Okra variety Clemson Spineless produced taller plants and larger organs. Both NPK fertilizer and poultry manure significantly ($p \geq 0.05$) improved okra growth and yield (Muhammad *et al*., 2020).

A trial was conducted at the Teaching and Research Farm of Ibrahim Badamasi Babangida University during the 2012 and 2013 cropping seasons to investigate the effect of poultry manure on the growth and yield of okra. The factorial experiment included two okra varieties (NH Ae 47-4 and LD88-1) and five poultry manure rates (0, 5, 10, 15, and 20 t/ha) with NPK 20:10:10 fertilizer applied at 200 kg/ha. The experiment, arranged in a randomized complete block design, revealed that poultry manure at 20 t/ha and NPK fertilizer significantly increased plant height, leaf number, and fruit yield. The highest fruit yield (13 t/ha) was recorded with 20 t/ha poultry manure in 2013. Varietal differences were not significant for most parameters, and poultry manure at 20 t/ha was recommended for optimal yield (Gudugi and Abdulmaliq, 2015).

Field trials at the University Orchard, Aliero, Kebbi State University of Science and Technology, during the 2017 and 2018 dry seasons, investigated the effect of sole and combined applications

of NPK (15:15:15) and poultry manure on okra varieties LD88, NHAE47-4, and Dogo. Treatments included 800 kg/ha NPK, 6.6 t/ha poultry manure, 50% NPK + 50% poultry manure (400 kg/ha NPK + 3.3 t/ha poultry manure), and a control. Results showed significant increases in plant height, number of leaves, number of pods, mean pod weight, pod length, and fruit yield when 120 kg N/ha was supplied using either NPK alone or a 50:50 NPK–poultry manure combination, particularly with the NHAE47-4 variety. The integration of NPK and poultry manure at a 50:50 ratio with NHAE47-4 was recommended for higher pod yield (Muhammad and Sanda, 2019).

The effect of combined application of poultry manure and sawdust on soil properties, growth, and yield of okra was evaluated at Tai Solarin University of Education, Ijagun, Ogun State, during the 2010/2011 dry season. Treatments included 0, 5, and 10 t/ha poultry manure and 0, 2, and 5 t/ha sawdust, arranged in a randomized complete block design with three replications. Results indicated significant increases in plant height, stem girth, and number of leaves with increasing poultry manure rates, with 10 t/ha producing the highest fruit yield. Combined applications of poultry manure and sawdust did not significantly affect yield or fruit number but slightly influenced plant height. Poultry manure was therefore recommended for improved okra growth and yield in the region (Ogundiran, 2013).

Response of soil nutrient properties and yield of okra to NPK 15:15:15 fertilizer and poultry manure was evaluated at Oyo State College of Agriculture and Technology Research Farm, Igboora, during the 2018 and 2019 cropping seasons. Treatments consisted of 120 kg/ha NPK, 10 t/ha poultry manure, 5 t/ha poultry manure, 2.5 t/ha poultry manure + 60 kg NPK, and a control. Results showed that 2.5 t/ha poultry manure + 60 kg NPK produced the highest okra pod weight and yield (up to 101.60 kg/ha) in the second season. Combined application of poultry manure

and NPK significantly increased soil nutrient contents and yield, suggesting that integrated use of organic and inorganic fertilizers enhances productivity while reducing dependence on chemical fertilizers (Bello *et al*., 2023).

A 2020 trial evaluated the fertility potential of green manure and conventional fertilizers on okra production in the Southern Guinea Savannah region of Nigeria. Treatments included *Leucaena leucocephala, Gliricidia sepium*, *Moringa oleifera, Azadirachta indica, Hyptis suaveolens,* poultry manure, NPK fertilizer, and a control, arranged in a randomized complete block design with three replications. Results showed that NPK fertilizer produced the highest vegetative and yield parameters, though not significantly different from poultry manure. The mean green manure yield (2.1 t/ha) increased okra fruit yield by 23.5% over the control (1.7 t/ha). It was concluded that applying poultry manure at 8 t/ha or combining 4 t/ha poultry manure with 200 kg/ha NPK fertilizer enhances okra yield and market value (Mustapha *et al*., 2024).

Field trials conducted during 2002 and 2003 at the University of Calabar Teaching and Research Farm evaluated four poultry manure levels (0, 5, 10, and 15 t/ha) on two okra varieties (a local and an improved variety, NHAE47-4). A 2×4 factorial in randomized complete block design with three replications was used. Increasing poultry manure rates significantly enhanced plant height, number of branches, fruit size, and fruit yield, with 10 t/ha producing the highest fresh fruit yield. However, 15 t/ha slightly reduced fruit set and yield. The improved variety outperformed the local one, and 10 t/ha poultry manure was recommended for optimum fresh fruit production (Uko *et al*., 2009).

Field trials at the Fadama Teaching and Research Farm, Jega, Kebbi State University of Science and Technology, during the 2017 and 2018 dry seasons, assessed okra yield as influenced by cow

dung and poultry manure applications. Treatments included cow dung at 12 t/ha and poultry manure at 6.6 t/ha, designed to supply 120 kg N/ha, applied to three okra varieties (LD88, NHAE47-4, and Dogo) in a randomized complete block design with three replications. Results showed significant increases in pod number, pod weight, pod length, and yield when 6.6 t/ha poultry manure was used with variety NHAE47-4. This combination was recommended for improved okra production in the Sudan Savannah region (Muhammad *et al*., 2019).

2.2.8 CABBAGE (*Brassica oleracea*)

Cabbage (*Brassica oleracea* L.), is valued for its high nutritional content and economic importance. As a cool-season crop belonging to the family Brassicaceae, it is consumed fresh or cooked and constitutes a major source of income for smallholder farmers (Ijoyah and Sophie, 2009). However, its productivity in tropical regions is often limited by declining soil fertility and high dependency on inorganic fertilizers, which pose environmental and economic challenges. Consequently, the integration of organic manure such as poultry manure, cow dung, and pig slurry has gained attention as a sustainable soil fertility management practice. Several studies have been conducted across Nigeria to evaluate the effects of various organic and inorganic nutrient sources on the growth, yield, and soil improvement potential in cabbage production.

Field trials were conducted during the dry seasons of 2010 and 2011 at the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria, to comparatively evaluate the effect of NPK and poultry manure on the growth and yield of cabbage. The experiment consisted of five treatments: a control (no fertilizer), poultry manure applied at 20 t/ha, and NPK fertilizer applied

at 50, 100, and 150 kg N/ha. Treatments were arranged in a randomized complete block design (RCBD) and replicated four times. Data were collected on plant height, root length, number of leaves, and total dry weight at five and ten weeks after transplanting (WAT), while economic yield data were obtained at 16 WAT. Results revealed that fertilizer application significantly improved plant growth and yield parameters. At five WAT, values ranged from 7.00–15.30 cm for plant height, 6.80–10.00 for leaf number, 11.80–143.00 g for total dry weight, and 4.30–13.50 cm for root length. At ten WAT, plant height ranged from 13.00–32.30 cm for control and NPK at 100 kg N/ha, while leaf number varied from 6.80–18.80 for control and NPK at 150 kg N/ha. Total dry weight ranged from 183.30–923.30 g. These parameters contributed to greater cabbage girth and yield. The highest yield (63.80 t/ha) was recorded in plots treated with NPK at 150 kg N/ha, which was significantly higher than that obtained from poultry manure at 20 t/ha. Production cost increased with fertilizer rate, ranging from ₦146,400 to ₦226,350, while revenue and net profit rose from ₦171,600 and ₦25,200 to ₦825,500 and ₦599,150, respectively. However, poultry manure at 20 t/ha produced the most favorable benefit-cost ratio and was therefore recommended for cabbage cultivation (Ogedegbe and Law-Ogbomo, 2013).

The experiment aimed to evaluate the effect of organic manure and variety on the growth and yield of cabbage (Brassica oleracea L.) grown in Jos, Plateau State, Nigeria. The study was arranged in a randomized complete block design with three replications. Treatments consisted of various organic manure sources, poultry droppings, cow dung, goat manure, dump site soil, and a control. Two cabbage varieties, Copenhagen and Gloria, were planted at a spacing of 50 × 50 cm. Growth parameters such as plant height and number of leaves, as well as yield attributes including dry weight, plant girth, root length, head diameter, head length, and total yield, were measured. The results showed that all parameters responded significantly ($P \leq 0.05$) to the

nutrient sources. Poultry manure applied at 20 t/ha produced the best performance in both growth and yield parameters, including plant height (10.00 cm), number of leaves (20.11), dry weight (10.17 g), girth weight (48.22 g), root length (8.61 cm), head diameter (15.40 cm), head length (28.71 cm), and yield (30.10 t/ha). Among the varieties, Gloria outperformed Copenhagen in all growth and yield characteristics. Based on these findings, the use of poultry manure at 20 t/ha is recommended for achieving optimal cabbage yield in the study area (Madina *et al*., 2023).

This study investigated the effects of graded levels of organic manure on the growth and yield performance of cabbage (Brassica oleracea) in the Nsukka Agricultural Zone. The experiment employed a randomized complete block design with five treatments replicated three times and was conducted at the research farm of the Department of Agricultural Education, University of Nigeria, Nsukka, from May to August 2023. Fifty cabbage stands were planted, with 25 purposively selected for data collection. The results revealed varied growth and yield responses under different organic manure levels. Cabbage treated with 0.5 kg + 28 kgTs poultry manure (T1) showed superior performance in terms of number of leaves, vine length, and stem girth, while plants treated with 1 kg + 28 kgTs poultry manure (T2) recorded the highest head length and diameter. However, cabbage nourished with 1 kg + 28 kgTs pig manure achieved the greatest head weight. The study therefore recommends 0.5 kg + 28 kgTs poultry manure as the most effective treatment for cabbage production in sacks within the Nsukka Agricultural Zone between May and August (Ali and Ogbonna, 2025).

A field experiment was conducted in Akure, within the rainforest zone of Nigeria, to determine the effects of poultry manure, wood ash, and rice bran on soil fertility, growth, and head yield of cabbage (Brassica oleracea L.) during the 2011 and 2012 cropping seasons. Treatments included poultry manure, wood ash, and rice bran each applied at 6 t/ha, an NPK 15:15:15 reference

treatment at 300 kg/ha, and a control, arranged in a randomized complete block design with three replications. The results indicated significant ($P < 0.05$) increases in growth and yield parameters with organic fertilizer applications compared to the control. Poultry manure produced the highest plant height, stem girth, leaf number, leaf area, head weight, head length, and head girth, followed by NPK, wood ash, and rice bran. Application of poultry manure increased these parameters by 17–19% compared to NPK and by 23–45% compared to wood ash. Poultry manure also enhanced soil organic matter and provided moderate values of P, K, Ca, and Mg, contributing to balanced nutrient availability. The poultry manure applied at 6 t/ha was therefore the most effective treatment for improving soil fertility, growth, and head yield of cabbage due to its balanced nutrient composition and low C:N ratio (Moyin-Jesu, 2015).

The study was carried out at the Prince Abubakar Audu University Student Research and Demonstration Farm, Anyigba, during the 2024 farming season to evaluate the impact of organic manure on cabbage production. The experiment followed a randomized complete block design with four replications. Treatments consisted of poultry manure applied at 4 and 8 t/ha, pig slurry applied at 4 and 8 t/ha, a combination of 4 t/ha poultry manure + 4 t/ha pig slurry, and a control. The results showed that cabbage (*Brassica oleracea* L.) responded significantly ($P < 0.05$) to organic manure application. The combination of 4 t/ha poultry manure + 4 t/ha pig slurry produced the tallest plants at 2 and 4 weeks after transplanting (WAT) with mean values of 4.00 cm and 13.30 cm, while 8 t/ha poultry manure gave the tallest plants at 6, 8, and 10 WAT with mean values of 20.13, 20.47, and 25.67 cm, respectively. The highest number of leaves was recorded under 8 t/ha poultry manure at all growth stages, with a corresponding yield of 59.33 t/ha. The application of organic manure supplied sufficient nutrients that enhanced metabolic and

enzymatic activities, resulting in increased growth and yield. Therefore, 8 t/ha poultry manure is recommended for optimal cabbage production in Anyigba (Musa *et al*., 2024).

2.2.9 WATER LEAF (*Talinum triangulre*)

Waterleaf (*Talinum triangulare* Willd.) of the family Portulacaceae is one of the more than twenty vegetables cultivated by farmers and home gardeners across Nigeria. It is a small leafy plant commonly grown in Southeastern Nigeria and is a major component of local dishes, particularly in Akwa Ibom and Cross River States (Eyo *et al*., 2001). Waterleaf (*Talinum fruticosum*) is also an important leafy vegetable widely consumed in West Africa. While previous research has examined the effects of different rates of poultry manure (PM) applied in single doses, little is known about the crop's response to split PM applications, especially under continuous foliage harvesting regimes (Efretuei *et al*., 2023). Apart from its nutritional importance, waterleaf also serves as a source of income and employment for many smallholders, particularly female, farmers.

Population density plays a major role in determining a crop's growth and yield performance, and the use of organic fertilizers has become essential in sustainable agricultural systems. A study was conducted in Calabar, Nigeria, to determine the effects of poultry manure and plant spacing on optimal waterleaf (*Talinum fruticosum*) production. The trial was arranged as a 3 × 5 factorial in a Randomized Complete Block Design (RCBD). Treatments included three levels of poultry manure (0, 5, and 10 t/ha) and five plant spacings (3×5 cm, 5×5 cm, 5×8 cm, 5×10 cm, and 10×10 cm), replicated three times. The 10 t/ha PM treatment significantly increased plant height, number of leaves, leaf area, and both fresh and dry weights compared with the other manure rates. However, the increase in leaf number was significant only in 2009. Plants with wider

spacing (10×10 cm) grew taller and developed larger leaves, while closer spacing (3×5 cm) resulted in greater fresh and dry weights. The combination of 3×5 cm spacing and 10 t/ha poultry manure produced the highest yield, and thus, this combination was recommended for optimum waterleaf production (Uko *et al*., 2013).

An experiment was fitted in a Randomized Complete Block Design (RCBD) with four treatments and six replications was conducted to assess the effects of split poultry manure applications on waterleaf performance. Treatments consisted of 10 t/ha applied once (T1), four split applications in the ratio 25:25:25:25 (T2), two split applications in the ratio 50:50 (T3), and a control (0 t/ha) (T0). Poultry manure application had no significant effect on growth parameters such as leaf number per plant, plant height, or branch number; however, it significantly affected fresh weight yield across different harvests. At the first harvest, fresh weight reached 6.83 t/ha but declined thereafter. Plants that received poultry manure yielded about 1 t/ha more than the control at the third and sixth weeks after planting (WAP). At the ninth WAP, T2 recorded the highest fresh weight (2.4 t/ha), while at the twelfth WAP, T2 and T3 produced 1.87 and 1.83 t/ha, respectively. The study demonstrated that applying poultry manure in four split doses of 25:25:25:25, or two split doses of 50:50, can effectively enhance fresh weight yield during successive harvests (Efretuei *et al*., 2023).

Field experiments conducted during the 2016 and 2017 cropping seasons assessed the effects of different organic manures and their combinations on waterleaf growth and yield in a humid rainforest environment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Treatments included sole poultry manure (PM) at 10 t/ha, cow dung (CD) at 10 t/ha, oil palm bunch ash (OPBA) at 8 t/ha, and their combinations, 5 t/ha PM + 4 t/ha CD, 5 t/ha PM + 4 t/ha OPBA, 5 t/ha CD + 4 t/ha OPBA and a control (no manure). Data

collected included plant height, number of leaves and branches, leaf area, and fresh and dry weights. Results indicated that waterleaf fertilized with 10 t/ha PM and with 5 t/ha PM + 4 t/ha OPBA performed best across all measured parameters. Therefore, 10 t/ha PM was recommended as the most effective organic manure for waterleaf production in Calabar (Uko *et al*., 2019).

An experiment was conducted at the University of Uyo Teaching and Research Farm, Use Offot, Uyo, Akwa Ibom State, Nigeria, between March and June during the 2009 and 2010 cropping seasons. The study was laid in a Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of various combinations of organic and inorganic fertilizers: NPK (15:15:15) at 400 kg/ha, poultry manure (PM) at 5 t/ha, PM at 2.5 t/ha + NPK at 200 kg/ha, PM at 3.75 t/ha + NPK at 100 kg/ha, PM at 1.25 t/ha + NPK at 300 kg/ha, and a control (no amendment). Poultry manure significantly ($P < 0.05$) increased plant height, number of branches, number of leaves, stem girth, leaf area, and total foliage yield in both years. Generally, the use of PM alone or in combination with NPK enhanced growth and yield more effectively than NPK alone or the control. The treatment 100 kg/ha NPK + 3.75 t/ha PM produced the highest foliage yield (56.03 t/ha and 54.36 t/ha in 2009 and 2010, respectively), exceeding other treatments by 35–78%. Given the high cost and environmental concerns of mineral fertilizers, the study concluded that integrating organic manure with mineral fertilizer especially 100 kg/ha NPK + 3.75 t/ha PM or 200 kg/ha NPK + 2.5 t/ha PM is a more sustainable practice for waterleaf production. Moreover, applying 5 t/ha PM alone was found to be more beneficial than using 400 kg/ha of NPK fertilizer on Ultisol soils (Ndaeyo *et al*., 2013).

Also, the effects of cassava peel poultry manure compost and their sole applications on soil properties, growth, and yield of waterleaf were investigated at the University of Calabar Teaching and Research Farm during the 2013 and 2014 cropping seasons. The experiment was

laid in a Randomized Complete Block Design (RCBD) with three replications and seven treatments, consisting of composted mixtures of cassava peels and poultry manure, sole composted cassava peels, and poultry manure applied at 4 and 8 t/ha, along with a control (no amendment). Results revealed significant improvements ($P \leq 0.05$) in soil pH, total nitrogen, available phosphorus, exchangeable potassium, magnesium, and calcium compared with the control. Compost applied at 8 t/ha had the highest positive effect on these soil properties. Growth parameters such as plant height, leaf area, number of leaves, branches, stem girth, and fresh yield also increased significantly under compost treatments. The 8 t/ha compost treatment recorded mean fresh yields of 17.86, 22.92, and 22.34 t/ha at 4, 7, and 10 weeks after planting (WAP), surpassing the control by 66.41%, 77.53%, and 77.44%, respectively. The study demonstrated that using cassava peels in compost formulation is an economical and environmentally friendly approach for sustainable waterleaf production (Agbor *et al*., 2018).

During the 2015/2016 cropping season, an experiment was conducted to assess the response of waterleaf to different organic manures. Among the treatments, poultry manure applied at 10 t/ha produced the greatest increases in leaf length and plant height, outperforming other organic manure types (Oluwole *et al*., 2019).

2.2.10 LETTUCE (*Lettuce sativa*)

Lettuce (*Lactuca sativa* L) is popularly consumed as salad; it belongs to the Asteraceae family, and is found in different variety, sizes and shapes. Lettuce is grown globally as a commercial vegetable (Bayeri *et al*., 2022). Lettuce (*Lactuca sativa* L.) is an annual plant of the daisy family, Asteraceae and said to be one of the most important commercial vegetables Nyam *et al*., 2021). Lettuce is also an exotic vegetable to Africa which is valued for its nutritional and medicinal

properties (Ojo *et al*., 2023). It is most often eaten in salads, sandwiches, wraps and soups, or grilled (Hugh,2013).

Lettuce production is constrained by poor soil fertility among other factors. Thus, organic (poultry manure (PM) and inorganic fertilizers (NPK) were evaluated singly or in combinations on the growth and yield of the crop. Fertilizer treatments were: Control, 300 kg NPK 20-10-10, 300 kg NPK 15-15-15, 300 kg NPK 20-10-10 + 5t/ha PM, 300 kg NPK 15-15-15 + 5t/ha PM, 150 kg NPK 20-10-10 + 10t/ha PM, 150 kg NPK 15-15-15 + 10t/ha PM and 20t/ha PM. A second cycle experiment utilized 50% of the initial fertilizer dosage. Growth and yield data measured were subjected to analysis of variance and significant treatment means were separated using Fisher's Least Significant Difference (F-LSD) at 5% probability level. Data on number of leaves, leaf area and vigor index measured during six weeks after treatment application were significantly ($P < 0.05\%$) influenced by the fertilizer treatments during the two cropping cycles. Survival count varied significantly only in the second cycle planting. Similarly, whole plant biomass yield, and below and above ground biomass yields distinctly varied with fertilizer treatments in the two cropping cycles. In all cases, 20 t/ha PM or 150 kg/ha NPK 20:10:10 + 10 t/ha PM outperformed all other treatments in the first cropping cycle. The second cropping cycle revealed that the highest biomass yield was obtained in plots that received 10 t/ha PM, and 75 kg/ha NPK 20:10:10 + 5 t/ha PM. Under the growing conditions in Nsukka, application of 20 t/ha PM or 150 kg/ha NPK 20:10:10 + 10 t/ha PM is recommendable for production of lettuce. (Baiyeri *et al*., 2022).

An experiment was aimed to evaluate effect of organic manure on the growth and yield of lettuce (*Lactuca sativa* L.) grown in Jos Plateau State, Nigeria. The treatments used are organic manure source (Poultry dropping at 20t/ha, Cow dung, goat manure, dung site and control) and time of

inclusion (5, 10 and 15 days before transplanting) was adopted for the experiment. The experiment is laid in a randomized complete block design with three replications, with 12 plots in a block and 45 plots for the whole experiment. Data were collected from the following parameters, plant height, plant diameter, number of leaves, leaf area (LA), net assimilation rate (NAR), crop growth rate (CGR), fresh weight, and dry weight. Poultry manure significantly ($p \leq 0.05$) improved the study parameters of lettuce, organic manure, days of inclusion and season. Poultry droppings produce plant height (25.73), plant diameter (8.42), number of leaves (32.02), leaf area index (16.75), net assimilation rate (4.67), crop growth rate (3.20), fresh weight (6.65 ha-1), and dry weight (4.23 ha^{-1}) when compared with other sources of nutrient. Similarly maximum plant height (23.32), plant diameter (6.66), number of leaves (31.86), leaf area (15.19), net assimilation rate (3.32), crop growth rate (3.54), fresh weight (5.79 ha^{-1}), and dry weight (4.00 ha-1) was recorded in lettuce plant treated with organic manure of 5 days of inclusion. On seasons, higher plant height (25.83), plant diameter (8.23), number of leaves (31.34), leaf area (15.32), net assimilation rate (4.00), crop growth rate (3.61), fresh weight (7.01 ha^{-1}), and dry weight (5.99 ha^{-1}) was obtained in 2021 as against 2020 season. Based on the results obtained, it can be recommended to lettuce farmers in the locality the use of poultry manure and 5 days of inclusion for optimum growth and yield of lettuce (Madina *et al*., 2023).

An experiment was carried out at the Kwis family garden in Kuru, Jos South Local Government Area of Plateau state to determine the effects of different organic manures on the growth and yield of two varieties of lettuce between April and May 2019. The experiment was laid out in a complete randomized block design with three replicates. 8 kg/m^2 (20 tonnes/hectare) of organic manure was added on each bed and allowed to decompose for 2 weeks before transplanting. The parameters measured included plant height, leaf length, number of leaves, leaf width, stem girth,

root length, and root girth. Results show that significantly ($p \geq 0.05$) differences existed between the organic manures and control with respect to plant height, leaf length, leaf width stem girth, root girth, and weight of leaves. The average maximum plant height, leaf length, stem girth, root girth, and weight of leaves was observed with poultry manure while the lowest was the control. There was no significant difference between the organic manures with respect to number of leaves and root length. However, differences existed between the two varieties with respect to plant height, leaf length, leaf width, stem girth, root girth, and weight of leaves. The average maximum plant height, number of leaves, and leaf length were observed in variety lettuce Great Lakes. The average maximum leaf width and stem girth were observed in variety lettuce optima. There was no significant difference among the two varieties with respect to weight of leaves, root length, and root girth. Variety lettuce Great Lakes and poultry manure have shown to perform better for most of the parameters and are, therefore, recommended for farmers to use to obtain relatively higher yield. (Nyam *et al*., 2021).

A study was conducted in 2023 at the nursery of the Teaching and Research farm of the Department of Crop production of Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria. The experimental treatments were two (2) varieties of lettuce (ice berg and Butter head) and three (3) organic manure sources (Poultry dropping, cow dung, goat manure) and a control. An experiment was set up as a 2 x 4 factorial design fitted in a randomized complete block design (RCBD) with three replications. Data were collected from the following parameters, plant height, plant diameter, number of leaves, leaf area index (LAI), crop growth rate (CGR), roof weight, and fresh weight. All the study parameters of lettuce were significantly ($P \leq 0.05$) different, on both organic manure, and variety. The iceberg variety surpassed the butter head variety, with statistically significant ($P \leq 0.05$) differences observed in several parameters: plant

height (20.32 cm), number of leaves (23.85), leaf area index (15.19 cm^3), crop growth rate (1.54 g m^3 per day), chlorophyll content (23.32 mg/g), fresh weight (83.86 g), root weight (20.23 g), and yield (3.19 t/ha) Similarly, poultry droppings obtained significantly ($P \leq 0.05$) higher results in terms of plant height (21.73 cm), number of leaves (23 92), leaf area Index (16.75 cm^2), crop growth rate (3.70 g m^3 per day), chlorophyll content (25.73 mg/g), fresh weight (632.02 g), root weight (22.13 g) and yield (3.75 t/ha) as compared to other organic manure sources such as cow dung, goat manure and control (Madina *et al*., 2024).

A two-year study was conducted to test the effect of various organic fertilizers on the growth and yield of lettuce (*Lactuca sativa* L.). The treatments which were laid out in a randomized block design and replicated three times consisted of a zero-manure control, cow dung, poultry and rabbit manures applied at 30 t/ha. Poultry manure consistently and significantly produced the tallest plants (by 24 % and 49 %) and more leaves (by 45 % and 101 %) at 2 and 10 weeks after transplanting respectively compared to the control. The study showed that lettuce leaves can be harvested as from 6 weeks of age (with about 16 leaves) and fed to rabbits. Lettuce grown with organic manure did not contain parasitic pathogens and can therefore not become a direct source of infection to animals fed on the produce. In the absence of poultry manure, rabbit manure is a satisfactory substitute for leaf lettuce production. Organic vegetable producers should be mindful of the possibility that pathogenic parasites in their growing media may contaminate the greengrocery (Ogedegbe *et al*., 2012).

A pot experiment was conducted at the Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria (Latitude 8°101N; Longitude 4°161E) to determine growth and yield response of lettuce (*Lactuca sativa*) to compost applied at the rate of 0, 5 and 10 t/ha. The experiment was laid out in a completely randomized design with ten replications. The

experiment was laid out in a completely randomized design with ten replications. Data were collected on number of leaves, canopy diameter, leaf area, fresh shoot and root weight, dried shoot and root weight, leaf area index, yield, correlation of growth and yield parameters were determined. Data collected were subjected to analysis of variance (ANOVA) and correlation using GENSTAT 12th edition (commercial version) while significant mean separation was done by the use of Least Significance Difference (LSD) at 5% level of probability (Wahua, 1999). Results showed that application of compost supported growth and yield of lettuce. Lettuce applied with compost at the rate of 5 and 10 t/ha produced more leaves, bigger leaves, higher shoot and root weight (fresh and dry), higher percentage of leaf area index and higher yield when compared with untreated lettuce. However, there was no significant difference between lettuce applied with 5 and 10 t/ha compost in all parameters. The study concluded that application of 5 t/ha compost was optimum for the growth and yield of lettuce. (Ojo *et al*., 2023).

2.2.11 BITTER LEAF (*Vernonia amygdalina*)

Vernonia amygdalina, a member of the Asteraceae family, is a small shrub that grows in tropical Africa (Ijeh and Ejike, 2011). Vegetables especially Ukpor (*Mucuna flagellipes*) and Bitter leaf (Vernonia amygdalina) have many economic importance as food and medicinal herbs, spice and raw materials for cosmetics and pharmaceutical industries. Their commercial production is very low and regular supply in large quantity is lacking, (Agba, 2021). The antioxidants in bitter leaf can neutralize harmful radicals that contribute to tissue damage (Edo *et al.,* 2023)n the organic extracts shows cytotoxic effects on the nasopharyngeal cancer cells in humans (Hussain *et al*., 2022) which makes bitter leaf a potential treatment for health conditions like cancer, diabetes etc. (Hladik *et al*., 2005).

Local and global nutritional and pharmaceutical utilization of bitter leaf is on the increase but there is scarcity of information on recommended production requirements of the crop especially in Anambra state where the leaves are used to prepare special delicacy. A preliminary study was therefore conducted to study the growth and yield response of bitter leaf (Vernonia amygdalina) to poultry manure rates (0, 5, 10, 15, 20, 25 and 30 t/ha) with the objective of determining the optimum rate. The research was carried out as a pot experiment at the Teaching and Research Farm of Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. The experiment was laid out as a completely randomized design with ten replications. There was a significant increase in growth and leaf yield with increase in poultry manure rate with the peak at 10 t/ha poultry manure application. Specifically, at 6 months after planting, tallest plants (38.3 cm), widest stems (8 mm), fresh leaf yield (31.6 g) and dry leaf yield (12.78 g) were obtained from plants the received 10 t/ha poultry manure. The dry leaf yield was statistically at par with 20 and 30 t/ha. The application of 10 t/ha poultry manure, in container production, was recommended for optimum growth and yield of bitter leaf in Awka, Nigeria. (Nudukwe *et al*., 2020)

A study investigated the effects of four poultry manure rates: 0,3, 7 and 12t /ha on two indigenous vegetables Ukpor (*Mucuna flagellipes*) and Bitter leaf (*Vernonia amygdalina*) early growth and proximate composition. The experimental design was a 2 x 4 factorial of two vegetables and 4 poultry manure rates, laid out in randomized complete block design with eight treatments combinations replicated three times. The proximate composition of these vegetables was determined using standard methods of Association of Official Analytical Chemist (AOAC). The results indicated that the growth and proximate (g/100g) in fresh weight basis significantly (P>0.05) varied with poultry manure treatments and range: leaf (moisture 62.86, 71.43%s), fat

(3.45, 4.27%), fibre (11.70, 10.28%), Ash (15.10, 16.16%), and carbohydrate (36.45, 35.26) in Ukpor (*Mucuna flagellipes*) and Bitter leaf (*Vernonia amygdalina*) respectively. Poultry manure at 10t/ha gave the tallest plants height (175.11cm, 70.59cm), dry weight: leaf (63.01g, 91.14g), Stem (44.26g, 91.14g) per plant in Ukpor (*Mucuna flagellipes*) and Bitter leaf (*Vernonia amygdalina*) respectively at 12 weeks after planting. Minerals content: calcium, magnesium, potassium, phosphorus, and sulphur were higher in plots treated with poultry manure than the untreated plots. Farmer are advised to use 5 or 10 t/ha poultry manure to cultivate Ukpor *(Mucuna flagellipes*) and Bitter leaf (*Vernonia amygdalina*) for increase high proximate composition and early growth to provide regular supply (Agba, 2021).

Recommended agronomic practices for sustainable production of bitter leaf, especially in Anambra state, Nigeria where the leaves are used to prepare special soup delicacy, is scarce despite the local and global nutritional and pharmaceutical utilization of the crop. A preliminary study was therefore conducted to study the growth and yield responses of bitter leaf, grown as pot-plants, to poultry manure rates with the objective of determining the optimum manure rate under the aforementioned production system. The poultry manure rates were 0, 5, 10, 15, 20, 25 and 30 t/ha. The research was carried out as a pot experiment at the Teaching and Research Farm of Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. The experiment was laid out as a completely randomized design with ten replications. There was a significant ($p \leq 0.05$) increase in growth and leaf yield with increase in poultry manure rate with the peak at 10 t/ha poultry manure application, specifically, at 6 months after planting, tallest plants (38.3 cm), widest stems (8 mm) were obtained from plants the received 10 t/ha poultry manure compared to other poultry manure rates (Ndukwe *et al*., 2022).

2.2.12 AMARANTH (*Amaranthus spp.*)

Amaranthus species, commonly referred to as amaranth, are important leafy vegetables widely cultivated for their nutritional and medicinal benefits in human diets. In Nigeria, amaranth serves as a valuable source of vitamins, minerals, and proteins, making it a key component of local diets, especially in the Sahelian and northern Guinea savanna regions. Despite its importance, the growth and yield of amaranth are often constrained by poor soil fertility, low organic matter content, and limited availability of effective fertilizers, which restrict the productivity of smallholder farmers.

Amarathus is an important leafy vegetable that is nutritionally and medically very relevant in human diet, thus the effect of poultry droppings (0t/ha, 5t/ha, 10t/ha, 15t/ha and 20t/ha) was studied. In an experiment data collected on weekly basis were plant height, number of leaves, leaf area, fresh shoot weight, fresh root weight, dry shoot weight and dry root weight. Results obtained from the study showed no significant (P=0.05) difference among the higher rates of poultry manure (10t/ha, 15t/ha, and 20t/ha), but performed competitively better than the lower rates of 5t/ha and 0t/ha, in most of the parameters assessed. The growth and yield parameters measured increased with increasing rate of the poultry manure applied. The plants treated with 20t/ha rate of poultry manure recorded the highest value in all the parameters studied. Thus, for maximum increase production of amarathus in the studied area, 20t/ha of poultry manure should be used. (Okoli and Nweke, 2015).

Field study was conducted in the dry season of 2013 (January-April) on the Teaching and Research farm of College of Education, Science and Technology, Bama, Borno State, Nigeria, to study the effect of different levels of poultry manure on the performance of *Amaranthus caudatus* (L). Data collected were analyzed using Analysis of Variance (ANOVA), significant means were separated using Duncans Multiple Range Test. The application of 15 t/ha of poultry

manure was significantly (P≤0.05) higher in all the parameters measured (mean plant height, stem diameter, leaf width and length, leaves per plant, branches per plant and fresh harvest per hectare). The highest leaf length (15.80 cm), leaves per plant (85.56), branches per plant (16.30), plant height (80.60 cm) and fresh weight of biomass harvest (21.70 t/ha) were obtained at 15 t/ha poultry manure. It was followed by 20 t/ha, 10 t/ha and 25 t/ha in descending order. While the highest dose of 30 t/ha was only significantly ($p \leq 0.05$) higher compared to the control treatment (Mshelia and Degri, 2014).

To evaluate the effect of different types of organic fertilizers on growth performance of *Amaranthus caudatus* (Samaru local variety) and *Amaranthus cruentus* (NH84/452). A randomized complete block design (RCBD) was used for the experiment. The field experiment was carried out in the nursery of a homestead garden at No 20, Isaiah Balat Street, Sabo GRA, Kaduna State, Nigeria. The study consists of seven treatments which includes control (no fertilizer), 5 t/ha and 10 t/ha poultry manure, 5 t/ha and 10 t/ha sewage sludge, 35 kg/ha and 70 kg ha-1 NPK compound fertilizer and also with *Amaranthus caudatus* (Samaru local variety) and *Amaranthus cruentus* (NH84/452) in factorial arrangement fitted into a randomized complete block design (RCBD) and replicated three times. Growth performance data were collected on plant height, number of leaves, leaf area and leaf area index from 2 weeks after transplanting (WAT) to 6 weeks after transplanting (WAT). The plant height and number of leaves of the two varieties were found in the range of 18.30 - 135.67cm and 13.33 - 78.33cm respectively. Leaf area and leaf area index of the two varieties had values in the range of 41.71 - 258.29cm2 and 1.76 - 41.72 respectively. At 6 WAT, 10 t/ha poultry manure recorded the highest value for all the growth parameters for both varieties except for leaf length, leaf width and leaf area of *Amaranthus caudatus* (Samaru local variety), where 10 t/ha sewage sludge and 70

kg/ha NPK compound fertilizer were highest. The experimental results of this study have shown that poultry manure had higher growth performance on the two varieties of Amaranth when compared with sewage sludge and NPK compound fertilizer. The application of poultry manures at 10 t ha-1 is therefore recommended for farmers to use to obtain higher yields of Amaranth. (Kahu *et al.,* 2019).

Another study was carried out between the months of February and May 2020, in a portion beside the botanical garden in the University of Benin, consisted of three (03) treatments namely PM1 (10%), PM2 (20 %), and PM3 (30 %) with poultry manure and control (PM0) in a randomized complete block design (RCBD) and replicated three times. Data for growth parameters (height, number of leaves, leaf area, and number of branches) were collected from 1 to 6 weeks after transplanting (WAT). At 6 WAT, PM1 recorded the highest values for growth. At that time, PM1, PM2 and PM3 recorded leaf area values of 111.66±24.11 cm2, 74.33±3.17 cm2, 64.66±22.34 cm2, respectively compared to the control with 5.33±0.33 cm2. PM1 showed enhancing effect on proximate composition of ash, lipid, crude protein, crude fibre and dry matter compared to control. Carbohydrate and moisture content were higher in PM0. *A. caudatus* grown in 10 % poultry manure treatment (PM1) elicited high levels of Ca, Mg, K, Na, P, Zn and Fe. Total lead in *A. caudatus* plants derived from PM1 was higher than PM0. The results of this study shows that PM1 elicited higher yield in *A. caudatus* when compared with other treatments and is therefore recommended for growing the plant (Edegbai and Omoruyi, 2022).

Field trials were conducted in 2007 and 2008 to determine the influence of planting density and poultry manure application on the growth and yield of *Amaranthus cruentus* (Linnaeus). This study was conducted at the teaching and research farms of Benson Idahosa University, Benin City using two planting densities (111111 and 62500 plants per hectare) and three levels of

poultry manure (0.0, 6.0 and 12.0 t/ha) in a 2 x 3 factorial arrangement fitted into randomized complete block design with three replicates. Results showed that planting density and poultry manure significantly (P = 0.05) affected the number of leaves, leaf area index, total dry matter and the crop growth rate positively in favour of increasing planting density and poultry manure application rate leading to higher herbage yield. The results showed that the combination of 62500 plants per hectare and application of poultry manure of 12 t ha-1 provided the highest yield (15.74 t ha-1) (Law-Ogbomo and Ajayi, 2009).

Data on the Yobe state Sahelian soils'-based resources and potentials are among the most limiting information in the Nigerian soil science literature. A study consists of 3 treatments, which include control (no manure), cow dung, and poultry droppings. These were laid out in a randomized complete block (RCBD) design, replicated three times. Seedling emergence and growth performance data were collected on plant height (cm), number of leaves, and leaf area index (cm2) at seedling emergence, 20 days after germination, and 40 days after germination. From the results, the poultry dropping was recorded to have the highest value for all the growth parameters; plant height (14.23cm), number of leaves (17.00) and leaf area index (8.60cm2). The experimental results of this study have shown that the application of poultry droppings has the tendency to induce higher growth performances and, therefore, it is recommended for farmers to use it so as to obtain higher growth indices of amaranths in the Sahel. (Sani *et al., 2022).*

A field experiment was conducted 2010 cropping season at the Institute for Agricultural Research Farm, Samaru, (110, 11' N, 070 38'E). Experimental site was 686 m above sea level in the northern Guinea savanna ecological zone of Nigeria. Study focused on to assess the effects of poultry manure rates (0, 4, 8 and 12 t/ha) and seedling age (2, 3 and 4 weeks after sowing) at transplanting on growth and yield of amaranth (*Amaranthus caudatus* L.). Treatments consisted

of factorial combinations of four levels of poultry manure and three transplant ages in a randomized complete block design (RCBD) with three replicates. Results indicated that plant height (cm), shoot fresh weight (kg) and number of leaves and branches per plant were significantly ($P<0.05$) higher with the application of 8 t/ha of poultry manure compared with no–manure than the other treatments. However, in most cases, the difference in growth characters using poultry manure rates varying from 4 to 12 t/ha were non-significant. Seedlings transplanted at 4 weeks of age were significant taller with shoot fresh weight than 2-weeks old seedlings at the initial growth stage. Transplant age had no effect on these parameters at later stage. All the other growth parameters were not affected ($P<0.05$) by transplant age. Study suggested that marketable yield increased significantly with increasing poultry manure (4 t/ha) with transplanting age (2-3 weeks) after emergence to benefit farmers the highest. (Barau *et al.,* 2018).

A field experiment was conducted at the experimental garden of the Department of Agric Education, Federal College of Education, Katsina between the month of June-July, 2014 to study of effect of varying levels of poultry manure obtained from battery cage and deep letter systems on the growth and yield of *Amaranthus cruentus*. The treatments consisted of 3-levels each of poultry manure (0, 10 and 15 t/ha), the treatments were arranged in Randomized complete block design (RCBD) and replicated three times. The parameters studied were plant height; number of leaves, stem girth and leaf area/plant. The result showed that application of poultry manure obtained from deep litter system at the rate of 15 t/ha increases the growth performance of Amaranths. (Haruna, 2019).

Pot and field experiment were conducted to determine the effects of complementary and sole use of biochar, poultry droppings, urea fertilizer and their combinations on soil properties and growth parameters of *Amaranthus cruentus*. Fifteen treatments comprising of the control (no

amendment), sole applied biochar (B), poultry droppings (P), urea (U) and their combinations (½ B + ½ U, ¾ B + ¼ U, ¼ B + ¾ U, Full B + ½ U, ½ B + Full U, ½ B + ½ P, ¾ B + ¼ P, ¼ B + ¾ P, Full B + ½ P, ½ B + Full P and ½ B + ½ P+ ½ U) were laid out in a Randomized Complete Block Design (RCBD) in the screen house and field, respectively. The treatments were replicated three times. Biochar and Poultry manure were applied at a rate of 20 t/ha while urea was at 60 kg N/ha. Data collected were subjected to analysis of variance and means compared using Duncan New Multiple Range Test (DNMRT) at 5 % probability level. The results obtained from this study revealed that the combination of all three amendments reduced bulk density. It also showed that combined applications of the amendments especially the combination of biochar and poultry droppings improved soil chemical properties and growth parameters than sole application of any of them for both pot trial and field experiment. For pot trial there were improvements in TN,Av.P, exchangeable Mg, K, ECEC and BS, whereas for field experiment only Av. P was significantly improved among the soil chemical properties. Additionally, the combination of ½ B + ½ P + ½ U (10 t/ha biochar + 10 t/ha poultry droppings + 30 kg N/ha urea) as well as ½B+ Full P and ½B+ ½U were found to be consistent in improving both soil chemical properties and plant growth parameters of Amaranthus. Hence complementary use of the amendments is recommended as sustainable nutrient source for vegetable farmers (Uwah *et al*., 2024).

The availability of appropriate and effective fertilizers is one of the limitations of organic and ecological farming in Nigeria. A pot experiment was conducted in a screenhouse to determine the optimum rate of biochar-poultry manure combination for growth and nutrient uptake of Amaranthus (*Amaranthus caudatus* L.), as well as residual soil nutrients. The study comprised four treatments viz; control, 50% poultry manure and 50% biochar at 10, 20 and 30 t/ha. The treatments were laid out in a completely randomized design (CRD) with four replicates. Seeds

were sown in plastic containers filled with 25kg soil, with a drain underneath. Seedlings were thinned to 2 plants/pot at 2 weeks after planting. Plants were harvested at 6 weeks by ratooning and their growths were also harvested after 6 weeks. Soil pH increased with 50% poultry manure and 50 % biochar at 20t/ha while the organic carbon content was increased with 20t/ha. An increase in soil N, P and K was reflected in increased dry shoot weight and N, P and K uptake with biochar and compost at 20t/ha application. Application of 50% poultry manure and 50% biochar at 20t/ha gave the optimum Amaranthus nutrients uptake with optimum residual soil nutrient contents which are effective for ecological farming. (Olowoake *et al*., 2021).

2.2.13 SCENT LEAF (*Ocimum gratissimum*)

Ocimum gratissimum, commonly known as basil or scent leaf, is an economically important vegetable with significant food, medicinal, and industrial uses. Despite its high nutritional and economic value, its cultivation is often constrained by poor soil fertility and suboptimal nutrient management practices. The species belongs to the family Lamiaceae (Ugbogu *et al.*, 2021) and is native to Africa, particularly West Africa, where it is widely used as a culinary herb. It is a herbaceous plant with woody main stems branching into a sub-shrub that can attain heights of up to two meters, with a large canopy depending on soil fertility. Scent leaf is used in modern and traditional medicine to cure ailments like ulcer due to its anti-inflammatory and analgesic properties (Agholor *et al*., 2018), aches, cough, fever, inflammation, fungal infections, bacterial infections and many more (Shedoeva *et al.*, 2019; Ghaleb, 2022).

Improving the growth and yield of *Ocimum gratissimum* through organic nutrient management is of particular interest due to the plant's responsiveness to organic manures such as poultry and goat manure. Studies have demonstrated that poultry manure applied at moderate rates

significantly enhances vegetative growth and yield parameters. For example, application rates of 3–4 t/ha improved plant height, leaf number, branch production, leaf index, and fresh and dry biomass of leaves, stems, and seeds (Agba, 2019). Higher rates, such as 6.5 t/ha, increased plant height and leaf index at 16 weeks after planting but did not necessarily translate into higher yield, indicating that moderate rates may be more efficient.

Similarly, combined applications of poultry and goat manure have shown varying effects on growth and yield. Gimba (2022) reported that poultry manure produced superior plant height, leaf number, and biomass compared to goat manure and untreated control plots. This demonstrates that *O. gratissimum* responds more favorably to poultry manure under well-drained, aerated soil conditions, highlighting its potential for improving smallholder production.

2.2.14 CELOSIA (*Celosia argentea*)

Celosia argentea L., commonly known as cock's comb, is an important leafy vegetable widely cultivated in tropical regions for its succulent leaves, which are rich in protein, vitamins, and minerals essential for combating malnutrition. Its cultivation is particularly significant in rural communities where access to nutrient-dense foods is limited. The productivity of *Celosia argentea* is influenced by soil fertility and nutrient management, with both organic and inorganic fertilizers playing key roles in enhancing growth, yield, and nutrient content. Studies have shown that the application of poultry manure, compost, and mineral nitrogen significantly ($p \leq 0.05$) improve growth parameters such as plant height, leaf number, stem girth, and shoot yield, while also enhancing soil chemical properties. Optimizing the type, rate, and combination of nutrient sources is therefore crucial for achieving maximum yield and sustainable production of Celosia argentea.

Field experiments have investigated the effects of nitrogen and poultry manure on Celosia argentea productivity. For instance, a study at the Teaching and Research Farm of Federal University of Dutsin-Ma, Katsina State, during the 2016/2017 dry season evaluated three nitrogen levels (0, 40, and 80 kg N/ha) and four poultry manure rates (0, 5, 10, and 15 t/ha) in a randomized complete block design with three replications. Results showed that nitrogen application had no significant effect on growth or yield, suggesting that the rates applied may have been insufficient to influence Celosia performance. In contrast, poultry manure significantly enhanced plant height, number of leaves, stem girth, and fresh shoot yield, with 10 t ha-1 identified as the most suitable rate for the study area. Application of 5, 10, and 15 t/ha of poultry manure increased fresh shoot yield by 280.4, 433.3, and 480.7% compared to the control (Williams and Adesoji, 2021). Similarly, experiments at the University of Benin, Edo State,

indicated that Celosia grown on raised beds with 60 kg N ha/ha poultry manure (18.24 t/ha) exhibited taller plants, more leaves, thicker stems, and higher herbage yield and dry matter, demonstrating that seedbed type and manure rate influence growth performance (Law-Ogbomo *et al*., 2017).

Research on growth, dry matter partitioning, and nutrient uptake revealed that 5 t ha-1 poultry manure significantly improved plant height, leaf number, leaf area, and total fresh yield compared to unfertilized plants, while plant population had no significant effect. Interaction between 10 t/ha poultry manure and 400,000 plants/ha enhanced nitrogen uptake, and phosphorus and potassium uptake increased with 5 t/ha at the same population, suggesting that moderate manure application optimizes both growth and nutrient accumulation (Makinde *et al*., 2016). Studies have highlighted limitations of chemical and organic fertilizers, including rapid nutrient loss, residual effects, and labor-intensive preparation. Combining composted Tithonia biomass and urea improved growth, yield, and soil quality, with 3 t/ha compost and 20 kg N/ha providing comparable benefits to higher rates (Babajide and Olla, 2014).

Comparative trials with poultry manure, cow dung, and mineral fertilizers demonstrated that organic amendments significantly increased plant height, leaf number, and dry matter yield in both *Corchorus olitorus* and *Celosia argentina*, while NPK and urea enhanced specific attributes such as moisture content or dry matter yield. Poultry manure was particularly effective in promoting overall growth and nutrient uptake (Makinde *et al*., 2011). Additional studies at Osun State University showed that 6 t/ha poultry manure produced the highest shoot dry matter, comparable to 140 kg N/ha urea, confirming the potential of organic amendments for optimal crop performance (Adeyeye *et al*., 2013). Experiments evaluating high rates of poultry manure (up to 25 t/ha) demonstrated substantial increases in fresh shoot yield, with regrowth yields

exceeding initial harvests, highlighting the capacity of organic manure to sustain productivity over multiple harvests (Murtadha and Yusuff, 2017).

Investigations into composted maize stover indicated that 4 t/ha at 20 x 20 cm spacing maximized leaf area, dry matter, and cumulative shoot yield of Celosia argentea, showing that both fertilizer rate and plant spacing interact to influence growth and yield (Akinfasoye, 2008). Studies on harvesting regimes combined with poultry manure applications revealed that multiple harvests and 10-20 t/ha manure improved herbage and seed yield as well as nutrient uptake, demonstrating that management practices can further optimize crop performance (Falodun *et al*., 2022). Evaluations of different organic amendments, including poultry manure, cow dung, compost, and *Tithonia diversifolia*, confirmed that 20-25 t/ha poultry manure produced superior plant height, leaf number, stem girth, and overall yield, while also enhancing soil chemical properties such as phosphorus, calcium, cation exchange capacity, potassium, and organic matter content (Sanni *et al*., 2014; Shokalu *et al*., 2011). These findings collectively indicate that organic amendments, particularly poultry manure, are effective in improving Celosia growth, yield, nutrient uptake, and soil fertility, making them a viable strategy for sustainable vegetable production in tropical agro-ecological zones.

2.2.15 Fluted Pumpkin (*Telfairia occidentalis*)

Telfairia occidentalis Hook. F., a member of the family Cucurbitaceae, is an economically and nutritionally important leafy vegetable widely cultivated across sub-Saharan Africa, particularly in southern Nigeria. Commonly referred to as fluted gourd, fluted pumpkin, or Ugu in Nigeria, the crop is valued for its edible seeds and succulent leaves (Okubena-Dipeolu, 2015). The leaves are typically consumed fresh or minimally processed either squeezed to extract juice or lightly

blanched prior to cooking. However, the increasing use of inorganic fertilizers in its production raises concerns about potential health risks from chemical residues, including carcinogenic, neurological, and dermatological effects (Oyetunde *et al*., 2023). Consequently, recent research has focused on identifying safer, cost-effective organic alternatives that can sustain yield and improve soil fertility. Fluted pumpkin productivity is often constrained by declining soil fertility, particularly in regions practicing continuous cultivation without adequate nutrient replenishment. Organic fertilizers such as poultry manure (PM) and other animal manures have been explored as sustainable alternatives to chemical fertilizers to enhance growth, yield, and soil fertility in *T. occidentalis* production.

Akintoye *et al*. (2023) conducted a field study at the Crop Research Farm, Federal University of Agriculture, Abeokuta, Nigeria, over two consecutive cropping seasons (2018–2020) to evaluate the effects of poultry manure rate and application frequency on T. occidentalis. Using a split-plot experiment arranged in a Randomized Complete Block Design (RCBD) with three replications, they tested three PM rates (5, 10, and 15 t/ha) and four application frequencies (once, twice, three times, and at every harvest), alongside a control (no fertilizer). Results indicated that in 2018, 15 t/ha PM applied at every harvest produced the highest fresh shoot, pod, and seed yields. In 2019, 5 t/ha PM applied three times increased fresh shoot weight by 85.4% at 14 weeks after planting (WAP) compared to 15 t/ha applied once. Pod and seed yields did not differ significantly across treatments. Overall, 10 t/ha PM applied three times was recommended for optimal cumulative fresh shoot yield.

Abam *et al*. (2024) evaluated the combined effects of poultry and goat manures on soil properties, growth, and yield of T. occidentalis at the University of Cross River State, Obubra Campus. A factorial CRBD experiment with three replications involved poultry and goat manures at 0, 3,

and 6 t/ha each. The combination of 3 t/ha poultry and goat manure significantly improved soil chemical properties organic matter (4.27%), pH (5.93), available phosphorus (8.25 mg/kg), exchangeable potassium (0.34 cmol/kg), magnesium (3.23 cmol/kg), and cation exchange capacity (8.24 cmol/kg). Growth parameters, including vine length, leaf number, and fresh/dry matter yield, were also highest under this treatment, highlighting the potential of combined manures to enhance both soil fertility and crop productivity.

Iren *et al*. (2015) investigated varying levels of poultry manure on T. occidentalis in a degraded Ultisol at the University of Calabar Teaching and Research Farms during the 2011 and 2012 seasons. Treatments consisted of 0, 60, 90, 120, and 150 kg N/ha (equivalent to 0–6 t/ha) arranged in an RCBD with three replications. Results showed that increasing PM levels significantly improved soil pH, available phosphorus, and base saturation, while reducing exchangeable aluminum. The highest vine length (168.3 cm) and leaf number (79.6) were recorded at 150 kg N/ha PM, compared with the lowest values in the control. Fresh yield increased consistently with manure level, with relative yield improvements of 49.4%, 64.0%, and 71.9% at 4, 7, and 10 WAP, respectively, leading to the recommendation of 150 kg N/ha (6 t/ha) for optimal performance in degraded soils.

Godonu *et al*. (2023) examined the combined effects of Wood Shavings Biochar (WSB) and poultry manure on T. occidentalis growth and yield at Lagos State Polytechnic, Ikorodu, Nigeria. Five treatments were tested: 7.5 t/ha WSB, 7.5 t/ha PM, 2.5 t/ha WSB + 5 t/ha PM, 5 t/ha WSB + 2.5 t/ha PM, and an unfertilized control arranged in an RCBD. The combination of 2.5 t/ha WSB + 5 t/ha PM and sole 7.5 t/ha PM produced the highest vine length, leaf count, vine girth, and leaf yield. These treatments also enhanced soil nutrient status by increasing Ca, K, and Mg

concentrations and reducing soil acidity. The study recommended either 2.5 t/ha WSB + 5 t/ha PM or 7.5 t/ha PM for sustainable fluted pumpkin production and soil fertility improvement.

2.2.16 EWEDU (*Corchorus olitorius* L.)

Corchorus olitorius L., a member of the family Tiliaceae, is widely recognized by several common names, including long-fruited jute, bush okra, Ewedu or Ooyo (in Western Nigeria), and Lalo (in Northern Nigeria). The succulent leaves of *C. olitorius* soften rapidly during cooking and develop a mucilaginous texture, forming a viscous soup typically consumed with starchy foods derived from staple root and tuber crops (Sanni and Adesina, 2012).

The maintenance of soil organic matter through appropriate fertilizer use is critical to sustainable soil management, especially under continuous cropping systems. Sanni and Adesina (2012) conducted a Randomized Complete Block Design (RCBD) experiment at the Teaching and Commercial Farms of Lagos State Polytechnic, Ikorodu, Nigeria, to evaluate the agronomic performance of *C. olitorius* under organic and inorganic fertilizer treatments. The experiment comprised three treatments, poultry manure (PM) at 25 t ha^{-1} (12.5 kg per bed), NPK fertilizer at 400 kg ha^{-1} (0.2 kg per bed), and a control with no fertilizer and replicated three times. The results revealed significant ($P < 0.05$) effects of both PM and NPK on all measured parameters. Plants treated with PM exhibited the greatest height at three and five weeks after planting (18.80 cm and 49.26 cm, respectively) and showed significant improvements in leaf number and stem girth. Yield followed a similar pattern, with the highest yield recorded in the PM treatment (6.35 kg), followed by NPK (6.10 kg), both significantly higher than the control (4.46 kg). The authors recommended the application of 25 t ha^{-1} of poultry manure for optimal *C. olitorius* growth and

yield, emphasizing its dual benefits of enhancing soil fertility and providing a sustainable method for managing poultry waste in urban areas.

A related experiment by Ndatsu and Fanim (2022) was conducted at the Teaching and Research Farm of the University of Jos, Nigeria (latitude 9°47′59.99″ N, longitude 8°51′59.99″ W), to determine the effect of different nutrient sources on the growth and yield of *C. olitorius* cv. Oniyaya. The study, arranged in an RCBD with three replications, compared four treatments: a control (no fertilizer), poultry droppings, cow dung (400 g ha^{-1}), and NPK (15:15:15). Seedlings were raised in a nursery for four weeks prior to transplanting. Significant differences ($P < 0.05$) were observed among treatments for all growth and yield parameters measured. Poultry droppings produced the highest number of leaves, branches (primary and secondary), fruits, plant height, and fresh fruit weight, while the control plots consistently recorded the lowest values. The authors concluded that poultry manure was superior to other treatments in promoting vegetative growth and yield of *C. olitorius*.

Similarly, Emuh (2013) evaluated the response of *C. olitorius* to varying levels of poultry manure at the Teaching and Research Farm of Delta State University, Asaba Campus, over two consecutive years (2010–2011). The experiment was laid in a Randomized Complete Block Design with four replications, using poultry droppings at 0, 10, 20, and 30 t ha^{-1}. Seeds were sown at a spacing of 15 × 30 cm, giving a population density of 222,222 plants ha^{-1}. Data collected at 2, 4, 6, and 8 weeks after planting (WAP) included plant height, stem girth, number of primary branches, and number of leaves. Plants were harvested at 8 WAP for total biomass and dry weight determination. Results showed that plant height, stem girth, and leaf number increased with both plant age and manure level, while growth responses at 20 t ha^{-1} and 30 t ha^{-1}

were statistically similar. The study therefore recommended applying 20 t ha^{-1} of poultry manure to enhance *C. olitorius* growth and yield under similar agroecological conditions.

In a more recent study, Saka *et al*. (2025) examined the effects of high rates of animal manures on soil electrical conductivity (EC) and dry matter yield (DMY) of *C. olitorius* L. The experiment, designed as an RCBD with three replications, involved the application of cured cattle, goat, and poultry manures at 0, 5, 10, 20, 40, 60, 80, 120, and 150 t ha^{-1}, alongside a mineral fertilizer treatment (NPK 15:15:15) at 0.4 t ha^{-1} per cycle). Soil samples were collected biweekly for EC analysis, while plant dry matter yield was determined six weeks after planting. Results indicated that soil EC increased with manure application, with the greatest percentage increases observed for cattle (794%), goat (966%), and poultry (675%) manures during the first cycle. However, manure rates above 60 t ha^{-1} reduced dry matter yield during the first cycle but improved it in subsequent cycles due to residual effects. The authors concluded that high manure rates enhance soil EC and have cumulative benefits for *C. olitorius* growth over time.

These improvements are attributable to poultry manure's balanced nutrient composition and its ability to improve soil structure and moisture retention while supplying essential macro and micronutrients.

CHAPTER THREE

3.0 MATERIALS AND METHODS

The scientific papers for this review were obtained online from Google Scholar, ResearchGate Science direct and some journals databases. The selected vegetable crops reviewed were tomato, pepper, cucumber, garden egg, onion, carrot, okra, cabbage, water leaf, lettuce, bitter leaf, amaranth, scent leaf, celosia, fluted pumpkin and ewedu were reviewed and results obtained during the period of 2000- 2025.

Fertilizer trials in the selected crop and yield or growth parameters were recorded according to recommendations, method of fertilizer application and timing. Thereafter, were measured in tabular form based on the research trials.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

From the review, it was observed that these selected fruits and leafy vegetables respond positively to poultry manure applications. Table 1.0 showed the year the experiment was carried out and the recommended rate across different ecological zones.

Tomatoes recommendations in 2006/2007 was 10t/ha +150kg NPK 15:15:15, in 2008, 25t/ha PM. In 2012/2012 was recommended 30t/ha, in 2013 the recommendations were 20t/ha PM, 6t/ha PM+100kg/ha NPK and 6t/ha PM+50kg/ha NPK. In 2016, 50U+ 8t/ha PM and 100U+ 4t/ha PM, in 2020, 5t/ha PM or 2.5t/ha PM+ 5t/ha Biochar, in 2023, 20t/ha and in 2024, 1.5t/ha Pm was recommended.

Recommendations for peppers based on the research were, 8t/ha in 2014, 8g PM in 3kg soil and 15t/ha PM in 2015, 10t/ha PM in 2016, 20t/ha PM in 2017, 6.4t/ha PM, 3t/ha PM and 25g PM per pot in 2018, 2-5t/ha PM in 2021, 15t/ha PM in 2022, 2kg PM in 12.5 kg soil.

For Cucumbers, in 2010, 10t/ha PM+ 400kg NPK 20:10:10, in 2011/2012, 20t/ha PM, in 2015, 40t/ha PM, in 2017, 2.5t/ha +60kg/ha NPK, in 2019, 40t/ha PM, in 2020, 2021 and 2025, 15t/ha PM was recommended. In 2020, 20t/ha PM, in 2023 40g (poultry manure, pig, rabbit and goat droppings) and in 2025, 40t/ha PM was recommended.

For Garden egg, in 2004/2007, 15t/ha PM + 350kg/ha NPK 15:15:15, in 2009, 15t/ha PM, in 2017, 20t/ha PM and 45kg N/hg PM in 2025.

Recommendations for Onions, in 2011/2012, 120kg/ha NPK15:15:15 + 15t/ha PM, in 2013, 15t/ha PM and 400kg/ha NPK +0.5t/ha PM. In 2017 and 2018 the recommended rate was 10t/ha. In 2020, 20t/ha PM, in 2024, 15t/ha PM was recommended.

For Carrots, 10t/ha PM was recommended in 2019, 2022, 2024 and 2025, 10t/ha PM +200kg/ha NPK 15:15:15 in 2024, 5t/ha PM+80kg/ha 15:15:15 NPK in 2011, 20t/ha in 2022 and 2024. In 2014/2015 20mg/ha PM.

For Okra, the recommendations were 8t/ha PM and 6.6t/ha PM in 2018. 10t/ha PM was recommended in 2003, 2011, 2016 and 2020, 20t/ha PM in 2013, 400kg/ha NPK 15:15:15 + 3.3t/ha PM in 2018, 2.5t/ha PM + 60kg/ha NPK 15:15:15 in 2019, 8t/ha PM or 4t/ha PM+ 200kg/ha NPK 15:15:15 in 2020.

Recommendations for Cabbage were, 20t/ha PM in 2023 and 2025, 6t/ha PM in 2012, 8t/ha PM in 2024 and 0.5kg PM + 28kg top soil in 2025.

For waterleaf, the rate of 10t/ha PM was recommended in 2009, 2017 and 2023, 5t/ha PM in 2014 and 5t/ha PM in 2010.

For Lettuce, the rate of 5t/ha PM in 2023, 30t/ha PM in 2013, 10t/ha PM in 2023, 20t/ha PM in 2020/2021 and 20t/ha PM or 150kg/ha NPK 20:10:10 + 10t/ha PM.

Recommendations for bitter leaf was 10t/ha in 2020, 2021 and 2022 and 5t/ha in 2021.

Amaranth recommendations in 2008 was 12t/ha PM, in 2022 was 0.833t/ha PM, in 2010 was 4t/ha PM, in 2013 was 15t/ha PM, in 2014 was 15t/ha PM and in 2019 was 10t/ha PM.

For Scent leaf, in 2019 the recommendation was 3-4t/ha PM and in 2022 the recommendation

was 6t/ha PM.

For Celosia, in 2017 the recommended rate was 10t/ha PM. Poultry manure at the rate 20t/ha was recommended in 2007/2008 and 2022, 25t/ha PM in 2014 and 2017, 4t/ha PM and 3t/ha PM +20kgN/ha in 2008, 140kgN/ha Urea or 6t/ha PM in 2013 and 18.24t/ha PM in 2015/2016.

For fluted pumpkin, the recommended rates were 7.5t/ha PM in 2023, 6t/ha PM in 2012, 3t/ha PM in 2021 and 10t/ha PM in 2019/2020.

The recommendations for Ewedu were, 20t/ha PM in 2011, 25t/ha PM in 2012, 400g/ha PM in 2022 and 60t/ha PM +0.4t/ha NPK15:15:15 in 2025.

Table 1: Recommended rates of fertilizer for selected vegetables (Tomatoes and Pepper) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2008	Tomatoes	25 t/ha	poultry manure	Single application	Rainforest
2006/2007	Tomatoes	10t/ha PM + 150kg/ha NPK 15:15:15.	PM+ NPK	Split application	Rainforest
2012/2013	Tomatoes	30 t/ha	PM	Single application	Rainforest
2016	Tomatoes	50U + 8t/ha PM and 100U + 4t/ha PM	Urea + PM	Split application	Rainforest

2013	Tomatoes	6t/ha PM + 100kg/ha NPK	PM + NPK	Split application	Derived savanna
2013	Tomatoes	6t/ha PM + 50kg/ha NPK	PM + NPK	Split application	Forest zone
2013	Tomatoes	20t/ha PM	PM	Single application	Freshwater swamp forest
2020	Tomatoes	5t/ha of PM or 2.5t/ha PM + 5t/ha biochar	PM and Biochar	Single application	Rainforest
2024	Tomatoes	1.5t/ha PM	PM	Single application	Rainforest
2023	Tomatoes	20t/ha PM	PM	Single application	Tropical savanna
2024	Pepper	2kg PM in 12.5 kg soil	PM	single application	Guinea savanna
2018	Pepper	25g PM per pot	PM	single application	Lowland Rainforest
2015	Pepper	15t/ha PM	PM	Single application	Lowland rainforest
2017	Pepper	20t/ha PM	PM	Single application	Freshwater swamp
2016	Pepper	10t/ha PM	PM	Single application	Derived savanna
2022	Pepper	15t/ha PM	PM		Derived Savanna
2015	Pepper	8g of PM in 3kg soil	PM	Single application	Guinea savanna
2018	Pepper	3t/ha PM	PM	Single application	Sudan savanna
2021	Pepper	2-5t/ha PM	PM	Single application	Rainforest
2014	Pepper	8t/ha PM	PM	Split application	Tropical Savanna
2014	Pepper	8t/ha PM	PM	Split application	Guinea savanna
2018	pepper	6.4t/ha PM	PM	Split application	Derived savanna

Source: Author's investigation from literature review.

Table 2: Recommended rates of fertilizer for selected vegetables (Cucumber and Pepper) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2017	Cucumber	2.5t/ha PM + 60kg/ha NPK	PM and NPK	Split application	Lowland rainforest
2025	Cucumber	40t/ha PM	PM	single application	Lowland rainforest
2020	Cucumber	20t/ha PM	PM	Single application	Derived savanna
2023	Cucumber	40g (Poultry manure, pig, rabbit and goats droppings.	Poultry manure, pig, rabbit and goat droppings	Single application	Lowland rainforest
2011/2012	Cucumber	20t/ha PM	PM	Single application	Lowland rainforest
2025	Cucumber	15t/ha PM	PM	Single application	Guinea savanna
2015	Cucumber	40t/ha PM	PM	Single application	Derived savanna
2020	Cucumber	15t/ha PM	PM	Single application	Guinea savanna
2021	Cucumber	15t/ha PM	PM	Single application	Freshwater swamp forest
2019	Cucumber	40t/ha PM	PM	Single application	Tropical savanna
2010	Cucumber	10t/ha + 400kg/ha NPK 20:10:10	PM and NPK	Split application	Rainforest
2016	Garden egg	10t/ha PM	PM	Single application	Lowland rainforest
2004/2007	Garden egg	15t/ha PM + 350kg/ha NPK 15:15:15	PM and NPK 15:15:15	Split application	Derived savanna
2009	Garden egg	15t/ha PM	PM	Split application	Derived savanna
2009	Garden egg	15/ha PM	PM	Split application	Lowland rainforest
2025	Garden egg	45kg N/ha PM	PM	Single application	Freshwater swamp
2017	Garden egg	20t/ha PM	PM	Single application	Lowland rainforest

Source: Author's investigation from literature review.

Table 3: Recommended rates of fertilizer for selected vegetables (Onions and Carrot) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2024	Onions	20t/ha PM	PM	Single application	Derived savanna
2011/2012	Onions	120kg/ha NPK15:15:15 + 15t/ha PM	NPK and PM	single application	Rainforest
2018	Onions	10t/ha PM	PM	single application	Rainforest
2024	Onions	15t/ha PM	PM	Single application	Sudan savanna
2020	Onions	20t/ha PM	PM	Single application	Derived savanna

2017	Onions	10t/ha PM	PM	Single application	Guinea savanna
2013	Onions	15t/ha PM	PM	Single application	Sudan savanna
2013	Onions	400kg/ha NPK + 0.5t/ha PM	NPK and PM	Split application	Northern Guinea savanna
2025	Carrot	10t/ha Pm	PM	Single application	Rainforest
2024	Carrot	10t/ha or 20t/ha PM	PM	Single application	Derived savanna
2022	Carrot	20t/ha PM	PM	Single application	Derived savanna
2024	Carrot	10t/ha PM + 200kg/ha NPK	PM and NPK	Split application	Rainforest
2019	Carrot	10t/ha PM	PM	Single application	Sudan savanna
2011	Carrot	5t/ha PM + 80kg/ha NPK	PM and NPK	Split application	Sahel savanna
2014/2015	Carrot	20mg/ha PM	PM	Single application	Forest savanna
2022	Carrot	10t/ha PM	PM	Single application	Derived savanna

Source: Author's investigation from literature review.

Table 4: Recommended rates of fertilizer for selected vegetables (Okra and Cabbage) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2003	Okra	10t/ha PM	PM	Single application	Lowland rainforest
2011	Okra	10t/ha PM	PM	Single application	Lowland rainforest
2013	Okra	20t/ha PM	PM	Single application	Guinea savanna
2016	Okra	10t/ha PM	PM	Single application	Lowland rainforest
2018	Okra	400kg/ha NPK 15:15:15 + 3.3t/ha PM	PM and NPK	Single application	Northern Guinea savanna
2018	Okra	8t/ha PM	PM	Single application	Northern Guinea savanna
2018	Okra	6.6t/ha PM	PM	Single application	Northern Guinea savanna
2019	Okra	2.5t/ha PM + 60kg/ha NPK 15:15:15	PM and NPK	Single application	Lowland rainforest
2020	Okra	8t/ha PM or 4t/ha PM + 200kg/ha NPK 15:15:15	PM and NPK	single application	Guinea savanna
2020	Okra	10t/ha PM	PM	Single application	Freshwater swamp
2011	Cabbage	20t/ha PM	PM	Single application	Northern Guinea savanna
2023	Cabbage	20t/ha PM	PM	Single application	Northern Guinea savanna
2025	Cabbage	0.5kg PM + 28kg top soil	PM	Single application	Guinea savanna
2012	Cabbage	6t/ha PM	PM	Single application	Rainforest
2024	Cabbage	8t/ha PM	PM	Single application	Southern Guinea savanna

Source: Author's investigation from literature review.

Table 4: Recommended rates of fertilizer for selected vegetables (Water leaf, Lettuce and Bitter leaf) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2009	Waterleaf	10t/ha PM	PM	Single application	Humid forest

2023	Waterleaf	10t/ha PM	PM	Split application	Lowland rainforest
2017	Waterleaf	10t/ha PM	PM	Single application	Humid forest
2010	Waterleaf	5t/ha PM	PM	Single application	Humid forest
2014	Waterleaf	8t/ha PM	PM	Single application	Humid forest
2023	Lettuce	5t/ha PM	PM	Single application	Derived savanna
2013	Lettuce	30t/ha PM		Single application	Rainforest
2023	Lettuce	10t/ha PM	PM	Single application	Derived savanna
2020/2021	Lettuce	20t/ha PM	PM	Single application	Derived savanna
2022	Lettuce	20t/ha PM or 150kg/ha NPK 20:10:10 + 10t/ha PM	PM and NPK	Single application	Derived savanna
2022	Bitter leaf	10t/ha PM	PM	Single application	Humid forest
2021	Bitter leaf	5t/ha or 10t/ha PM	PM	Single application	Humid forest
2020	Bitter leaf	10t/ha PM	PM	Single application	Humid forest

Source: Author's investigation from literature review.

Table 5: Recommended rates of fertilizer for selected vegetables (Amaranth, Scent leaf and Celosia) on several ecological zones based on the above researches.

PERIOD/ DATE	CROP	FERTILIZER RECOMMENDATION	FERTILIZER SOURCE	METHOD OF APPLICATION	REGION ZONE
2023	Fluted pumpkin	7.5t/ha PM	PM	Single application	Derived savanna savanna
2008	Amaranth	12t/ha PM	PM	Single application	Rainforest
2019	Amaranth	10t/ha PM	PM	Single application	Northern Guinea savanna
2022	Amaranth	0.833 t/ha PM	PM	Single application	Sahel savanna
2010	Amaranth	4t/ha PM	PM	Single application	Guinea savanna
2014	Amaranth	15t/ha PM	PM	Single application	Sudan savanna
2019	Scent leaf	3-4t/ha PM	PM	Single application	Humid forest
2022	Scent leaf	6t/ha PM	PM	Single application	Northern Guinea savanna
2017	Celosia	10t/ha PM	PM	Single application	Northern Guinea savanna
2015/2016	Celosia	18.24t/ha PM	PM	Single application	Rainforest
2008	Celosia	3t/ha compost + 20kgN/ha	PM and Chemical fertilizer	Single application	Derived savanna
2013	Celosia	140kgN/ha Urea or 6t/ha compost	PM and Urea	Single application	Derived savanna
2017	Celosia	25t/ha PM	PM	Single application	Derived savanna
2008	Celosia	4t/ha compost	PM	Single application	Derived savanna
2022	Celosia	20t/ha PM	PM	Single application	Rainforest
2014	Celosia	25t/ha PM	PM	Single application	Humid forest
2007/2008	Celosia	20t/ha PM	PM	Single application	Derived savanna

Source: Author's investigation from literature review.

Table 5: Recommended rates of fertilizer for selected vegetables (Fluted pumpkin and Ewedu)

2012	Fluted pumpkin	6t/ha PM	PM	Single application	Humid forest
2021	Fluted pumpkin	3t/ha PM	PM	Single application	Humid forest
2019/2020	Fluted pumpkin	10t/ha PM	PM	Single application	Derived savanna
2025	Ewedu	60t/ha + 0.4t/ha NPK 15:15:15	PM and NPK	Split application	Derived savanna
2011	Ewedu	20t/ha PM	PM	Single application	Rainforest
2012	Ewedu	25t/ha PM	PM	Single application	Derived savanna
2022	Ewedu	400g/ha PM	PM	Single application	Derived savanna

on several ecological zones based on the above researches.

Source: Author's investigation from literature review.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

Based on the reviewed trials on Tomato, Pepper, Cucumber, Garden egg, Onion, Carrot, Okra, Cabbage, Water leaf, Lettuce, Bitter leaf, Amaranth, Scent leaf, Celosia, Fluted pumpkin and Ewedu, evidence has shown that Poultry manure positively influences the yield and growth parameters of vegetable.

A combination of 10-25 t/ha of PM and 50kg NPK 15:15:15 will be sufficient for the production of tomatoes to be applied in splits, and 20- 25t/ha of sole PM will equally suffice. For Peppers, PM at the rate 10- 20t/ha is recommended for optimal growth and yield. The combination of organic and inorganic fertilizer at the rate of 10 t/ha of poultry manure and 400kg NPK 20:10:10 applied in a split manner, and the rates of 15-40 t/ha of poultry manure alone is recommended for Cucumbers. The combination of 15 t/ha PM + 350kg/ha and 15-20 t/ha is suitable for the production of Garden eggs. For Onions, 10-15t/ha of poultry manures alone or 120-400kg/ha of NPK 15:15:15 in addition with 0.5-15t/ha PM is recommended. A combination of 5-10t/ha PM with 80-200kg/ha of NPK 15:15:15 and 10-20t/ha of PM is recommended for the production of Carrots. For Okra, the recommendations are 6.6- 10t/ha of poultry manure alone and a combination of 60-400kg/ha of NPK 15:15:15 with 2.5- 4t/ha PM. For Cabbage, the recommendation is 6-20t/ha of poultry manure. The recommended rate of poultry manure for the production of water leaf is 5-10 t/ha. A combination of 10t/ha PM with 150kg/ha NPK 20:10:10 and poultry manure alone at the rate 5-30t/ha is recommended for the production of Lettuce. The recommended rate for the production of Bitter leaf is 5-10 t/ha. For Amaranth, the application of poultry manure at the rate 4-15 t/ha of poultry manure. For Scent leaf, the application of 3-6t/ha

is recommended. For Celosia, poultry manure at the rate 10-25 t/ha and combinations of 3-4 t/ha with 20kg N/ha and 140kg N/ha Urea. A rate of 6-10 t/ha of poultry manure is recommended for the production of Fluted pumpkin. A combination of 0.4t/ha NPK 15:15:15 + 60t/ha of PM and poultry manure alone at the rate 20-25t/ha is recommended for the production of Ewedu.

Poultry manure as a soil amendments and source of nutrients for plants should be recommended, with the current advocacy for organic farming.

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