# EFFECT OF POULTRY MANURE RATES ON THE PERFORMANCE OF CASSAVA/MAIZE/TELFAIRIA INTERCROP IN OWERRI, SOUTHEASTERN NIGERIA

**BY**

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## CERTIFICATION

We certify that this project work entitled "Effect of Poultry manure rates on the performance of Cassava/Maize/Telfairia in Owerri Southeastern Nigeria" was carried out by Nwaigwe, Maureen Ogechi (Reg. No: 20124760558) in partial fulfillment of the requirements for the award of Master of Science (M.Sc.) degree in Agronomy in the Department of Crop Science and Technology of the Federal University of Technology, Owerri.

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## DEDICATION

This Project work is dedicated to my God and to the memory of my late Dad, Engr. Augustine Adielenwa Nwaigwe, my Mum, Mrs. Helen Ifeyinwa Nwaigwe and my mentor Prof. J. A. Alachie.

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## ABSTRACT

With the population growth in Nigeria especially in Southeastern region of Nigeria, the need to produce more sustainable food for this group became a concern. Experiments on intercropping with cassava as the base crop were conducted on the effect of poultry manure rates on the performance of Cassava/Maize/Telfairia in Owerri Southeastern Nigeria. Field experiments were carried out in 2013 and repeated in 2014 cropping seasons at the teaching and research farm of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Imo State. Results indicate that intercropping Cassava/Maize, Cassava/Telfairia and Cassava/Maize/Telfairia with the application of 20t $ha^{-1}$ and 10t $ha^{-1}$ respectively were statistically significant ($P < 0.05$) from the sole with or without poultry manure application.Investigation however, showed that weed population was increased with increasing poultry manure rates application. On monetary returns and benefits, the application of 20t $ha^{-1}$ and 10t $ha^{-1}$ poultry manure produced high yield in the intercropping systems. They also gave higher monetary returns and benefits than the sole cropping systems as Cassava/Maize/Telfairia with 20t $ha^{-1}$ produced ₦1, 659,250 as benefit, while the same crop combination with 10t $ha^{-1}$ gave ₦1, 245,100 as benefit, whereas, the highest yield of the sole cropping cassava with the application of 20t/ha poultry manure was ₦938, 300 and 10t/ha gave ₦739,800 benefits respectively. The sole maize cropping systems produced negative returns and did not benefit the farmer while sole Telfairia had some benefits but was not as low or negative as that of sole maize.

Key words: Poultry manure rates, cassava based intercropping system in Owerri.

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# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Currently there is population explosion in sub Saharan Africa including Nigeria. In South eastern Nigeria the situation is acute coupled with the returnees from the Northern part of Nigeria as a result of 'Boko Haram' insurgency thus adding pressure to the existing fragmented farmlands. This situation is worrisome and calls for research into the ways and means to ensure sustained food production for the ever increasing population in the southeastern agro-ecology of Nigeria. In our agro-ecology, intercropping is almost synonymous with peasant agriculture to the extent that attempts made to introduce sole cropping systems which are alien to the environment and traditions have failed (Okigbo and Greenland, 1976). The advantages of intercropping systems are numerous and well documented (Ibeawuchi, 2007). It is a known fact that intercropping is a common feature of agriculture in tropical Africa and American tropics, (Ibeawuchi, 2007; Ibeawuchi and Ofoh, 2000). Over the centuries, specific intercropping systems have developed in different countries (Ibeawuchi, 2007), and intercropping systems differ frequently from one area to another with changes in soil and local climate while social and cultural conditions may superimpose on the ecological zones (Kurt, 1984).

Cassava (*Manihot esculenta*) is a dicotyledonous plant, belonging to the family Euphorbiaceae and is an important root crop often found in mixtures with other food crops providing food, feed and income to many people within the southeast agro-ecology.

In Nigeria, the cultivation of cassava by resource poor farmers has tremendously increased in recent years due to its adaptation to shorter fallow periods, relatively drought tolerance, ability to thrive well in soils of low fertility and its storage potentials in the soil (Olojede, 2004), coupled with the presidential interactiveaz on cassava. Cassava impoverishes the soil rapidly, unless the absorbed or lost nutrients are replaced (Eke, 1999). However, low soil fertility occurs in many cassavas growing areas because of the soil type (ultisols) and shortened fellow period as the pressure on arable land is increasing. This has made the use of poultry manure necessary as poultry keeping is the trade in stock of many resource poor farmers in Owerri southeastern, Nigeria. Maize is often found severally intercropped with assorted crops In Nigeria,thereby forming an integral component of various cropping systems. Maize is the third most important cereals after wheat and rice all over the world. It can also be called corn and belongs to family Poaceae. Maize is increasingly gaining importance in crop husbandry because of its high yield potentials and short growth duration. Maize is the major cereal crop cultivated in Southeastern Nigeria and always a component of the major cropping systems (Ibeawuchi and Ofoh, 2000). It is intercropped with vegetables and other crops in traditional agriculture mainly to satisfy dietary requirements. It is a crop of world repute and has a remarkable adaptability to a wide range of climates and it is more distributed all over the world than most other local crops (Onwueme and Sinha, 1991).

The production of Telfairia is a common place in Owerri Southeastern Nigeria. It is known scientifically as *Telfairiaoccidentalis*Hook F and locally our people call it Ugu. It is a popular vegetable grown and eaten by many. It is commonly known as fluted pumpkin belonging to the family cucurbitaceae and it is` a native of tropical West Africa (Akoroda, 1990). Nwonuala*et al*., 2008 emphasized that *Telfairiaoccidentalis* (Ugu) is indigenous to Nigeria, specifically the rainforest agroecology of Southeastern Nigeria.

The fluted pumpkin is found in many cropping systems of the South east agro ecology and its influence on the crops especially cassava have not been widely researched on to understand its influence on the intercrops and production within the system. Hence, its inclusion in this research works on Cassava/Maize to study this all important crop which has a lot of benefits. According to Asiepbu (1987), the fluted pumpkin has beneficial effects on the lipid profile with antilipidaenui effects including blood cholesterol and protection from a range of associated complications like cardiac problems, hypertension and diabetes. In our traditional homes, the seeds are processed and ground for use in soups or boiled and eaten as nuts, while the leaves, shoots or vines are used as cooked vegetables (Asiegbu, 1987).

Under intensive agriculture, inorganic fertilization in often associated with reduced crop yield, soil acidity and nutrient imbalance (Ojeniyi, 2000). As a result of its importance in food production and soil improvement, the use of organic manure to meet soil nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture in low input agriculture, since organic manure generally improve soil, physical, chemical and biological properties along with conserving the water holding capacity of the soil thus resulting in enhanced crop productivity along the maintaining the quality of crops produced (Eghball, 2002).

Organic fertilizers which are manure from natural sources improve the soil by lowering bulk density, reducing soil erosion and improving soil fertility (Awodun, 2007). The dark colours that form with increasing organic matter content improve soil temperature relations which improve essential microbial activity and root development (Ahaiwe, 2008).

When organic manure is applied, apart from supplying plants nutrients, it also plays important buffering role because of its beneficial effects in enhancing Cation Exchange Capacity (CEC), improvement of soil aggregation, increasing water holding capacity of the soil, stabilizing its humus content and preventing the leaching of nutrients (Swift and Woolmer,1993). From the foregoing therefore, there is need for research to improve the production of root/tuber, cereals and vegetable mixture and evaluate their productivity using different rates of organic fertilizer. Hence the broad objective of this research was to determine the effect of organic fertilizer rates on the performance of cassava, maize, telfairia mixture. The understanding of performance using locally sourced organic manure will go a long way in helping us sustain food production on a long period on the infertile ultisols of southeast agro-ecology.

## 1.2 Objectives of the Study

The specific objectives of this study were to:-

i. determine the impact of poultry manure on the growth and yield of cassava, maize and Telfairia,

ii. Assess the yield in sole cropping systems with those of intercropping system,

iii. Evaluate the effect of intercropping and sole cropping systems on weed suppression anddetermine the economic returns of the enterprises.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Intercropping

Intercropping is considered as the practical application of ecological principles such as diversity, crop interaction and other natural regulation mechanisms. It can be defined as the growing of two or more crops in proximity to promote interaction between them (Willey, 1979).Wahua(1983), explained that intercropping as the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include their vegetative stage. The crops must not necessarily be sown or harvested the same time but the main definition is that they are both on the field at the same time for a significant part of their growing period (Ibeawuchi, 2007). Available growth resources, such as light, water and nutrients are more completely absorbed and converted to crop biomass by the intercrop as a result of differences in competitive ability for growth factors between intercrop components. The more efficient utilization of growth resources the more the yield and results in increased stability compared to sole cropping (Mazaheri*et al.*, 2006).

Furthermore, the multifunctional profile of intercropping allows it to play many other roles in the agroecosystem, such as protection of plants of individual crop species from their host-specific predators and disease organisms, greater competition towards weeds and improved product quality and quantity (Wahua, 1983). Also nitrogen fixing legumes can be included to a greater extent in arable cropping system via intercrops. Legumes contribute to maintaining the soil fertility via nitrogen fixation, which is increased in intercrops due to the more competitive character of the cereal for soil inorganic nitrogen. This leads to a complementary and more efficient use of nitrogen sources. Intercropping of grain legumes and cereals therefore offers an opportunity to increase the input of fixed nitrogen into agroecosystems without compromising cereal nitrogen use, yield level and stability (Singh *et al.,* 2002).

### 2.1.1 Types of Intercropping

According to (Grossman and Quarles, 1993) intercropping can be divided into four basic spatial arrangements, which include:

(i) **Mixed-Intercropping**: Growing of two or more crops simultaneously with no distinct row arrangement. This type can be suitable for grass-legume intercropping in pastures.

(ii) **Strip-Intercropping**: This is also growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically.

(iii) **Relay-Intercropping**: Defined as the growing of two or more crops simultaneously during part of the life cycle of each. In this case, the second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest.

Resource poor farmers mostly practice intercropping because of limited land but also for the beneficial interaction regarding chemical application.

(iv) **Row- Intercropping**: Growing of two or more crops simultaneously where one or more crops are planted in regular rows; or other crops maybe grown simultaneously in row or randomly with the first crop.

### 2.1.2 **Benefits of Intercropping**

Some of the important advantages of intercropping are as follows;

(1) **Increasing Production**

The increase in the use efficiency is important, in intercrop system especially for small-scale farmers and also in areas where growing season is short (Altieri, 1995). Higher production in intercropping can be attributed to the higher growth rate, reduction of weeds, reduced the pests and diseases incidence and more effective use of resources due to differences in resource consumption (Eskandari, 2012). Furthermore, as a result of "complementary effects" between the components of intercropping, production increases by reducing the competition between them (Mahapatra, 2011).

(2) **Greater use of Environmental Resources**

Intercropping has advantages over sole cropping due to the interaction between components in intercrops and the difference in competition for the use of environmental resources (Mahapatra, 2011). The intercrops components have differences in the use of environmental resources, thus use of resources is more effective than a sole cropping, and the result in increased yield. In terms of competition, it means that intercrop components are not competing for same niche (ecological nest) due to their morphological and physiological differences as the competition between species is less than competition within species (Vandermeer, 1989). Francis and Decoteau, (1993) reported that sweet corn yield increase when planted with pea as intercrops due to better use of environmental resources. It also noted that competition between species in maize and peas' intercrop was less than the competition within species.

The crops complement one another in their use of field and time. Their period of demand for light, water and nutrient may differ, for instance, during the two or three months that yam takes to sprout and establish adequately on the field, a quick intercrop of maize or melon would efficiently utilize the field resource during the said time (Eskandari, 2012).

The component of intercrop also complement each other in the use of space for example an intercrop of deep rooted and shallow rooted crop can exploit various horizons of the soil. They utilize resources which the main crop may not be able to utilize or may be disadvantaged especially on hydromorphic soils, yams can be sown on mounds or ridges and rice will adequately exploit the waterlogged lower areas. Similarly, a shade tolerant specie such as the tannia cocoyam growing under full canopy of oil palm would be able to utilize some light transmitted which would have been wasted, thereby utilizing the light. When grown separately as sole crop, each component crop would only be able to exploit its own specific rooting horizon (Mahapatra, 2011). Plantains intercropped with young cocoa seedlings are used to provide shade for the young seedling.

(3) **Reduction of Pests, Diseases and Weeds Damage**

One important advantage of intercropping is its ability to reduce past and disease damage. In general, strategies involved in reducing pest infestation and damage in intercropping can be divided into three groups: Firstly, the second species breaks down the ability of a pest in attack to its host. Secondly, trap crop hypothesis means that second species, attracted towards their pest or pathogen that normally does damage to the main species, and is used more in general pests and pathogenic agents. Thirdly, natural enemies' hypothesis means that the predators and parasites are more attracted in intercropping, than the mono-cropping, thereby reduces the effects of the parasites on the crops (Danso, 1987). Although intercropping does not always reduce pest or pathogen, but most reports have pointed to reduced populations of pests and diseases in the intercropping (Fujita, 1992). Sole crops require more chemicals to control insect pests and diseases and these chemicals (pesticides, herbicides and insecticides) may not be available even if financial resources are available (Singh and Adjeigbe, 2002). Intercropping systems increases biodiversity like the natural ecosystems. This increase in diversity reduces pest damage and diseases (Anil *et al.*, 1998).

(4) **Weed Control**

It is well known that weeds interfere with crops causing serious impacts through either competition (for light, water, nutrients and space). Intercropping patterns are more effective than monocropping in suppression of weeds, but their effectiveness varies greatly (Girjesh and Patil, 1991). Intercrops may demonstrate weed control advantages over sole cropping for example, in monocropping systems, rarely does the sole crop use all available natural source such as moisture, nutrients and light, consequently the released niche are captured by the weeds. But in the intercropping, the complementary crops use the entire resources including the niche, thus in this system there is more and effective use of ecological resources and filling the empty niche, which leads to better weed control as compared to the monocropping system (Saudy and El-Metwally, 2009).

(5) **Stability and Uniformity of Yield**

For farmers who have limited resources, stable yield of agricultural systems is very important. When several crops can be grown together, if one crop fails the farmer could be compensated by other crop, and thereby reducing the risk. Risk or agronomy failure in multi cropping systems (Altieri, 1995).

(6) **Improve Soil Fertility and Increase in Nitrogen**

There are several reports indicating that increasing the nitrogen content in non-legume plants, due to the intercrops with plants of leguminosae family (Eskandari, 2012). Rhizobium bacteria are able to have a symbiotic relationship with plants of leguminosae family, and thereby can fix atmospheric nitrogen into available nitrogen for plants uptake.

(7) **Protects the Soil and Ecosystem**

As a result of the multiple crops grown in and their resultant large leave cover; radiant energy reaching the soil surface and maximum diurnal soil temperature is lowered, according to (Anil *et al*., 1998). This leads to increase in soil moisture content and improves the activities of earthworm and other microbes which decomposes the organic matter and encourage the formation of stable soil crumb structure, thus improving soil internal drainage, infiltration and aeration.

### 2.1.3 Disadvantages

The main disadvantages of intercropping systems may comprise of planning, managing fertilization, weed control, pest control and harvesting for both crops as it is normally done manually by small-scale formers (Sullivan, 2003).

## 2.2 Assessment of Intercropping Productivity

### 2.2.1 Land Equivalent Ratio (LER)

One of the most important reasons for growing two or more crops simultaneously is to ensure that an increased and diverse productivity per unit area is obtained compared to sole cropping. An assessment of land return is made from the yield of pure stands and from each separate crop within the mixture. The calculated figure is called the Land Equivalent Ratio (LER), where intercrop yields are divided by the pure stand yields for each crop in the intercropping system and the two figures added together (Mead and Willey, 1980).

$$LER = \frac{intercrop\ maize}{sole\ maize} + \frac{intercrop\ legume}{sole\ legume}$$

Yield advantages from intercropping as compared to sole cropping, are often attributed to mutual complementary effects of component crops, such as better total use of available resources. Generally, monoculture legumes have higher yields compared to yields in an intercropping system. However, in most cases, land productivity measured by LER clearly shows the advantage of mixed cropping of cereals and legumes (Mandal, 1990). LER gives an indication of intercropped land and research results indicate that response of N to intercropping generally results in reduced LER values. However, when two intercrops are using the same growth resource, a decrease in yield of one crop could be expected especially when one crop is more competitive than the other.

## 2.3 Cassava

Cassava (*ManihotEsculentaCrantz*) belongs to the family *Euphorbiaceae*and is a perennial woody shrub producing enlarged tuberous roots. The roots are the main storage organs and in some area it is cultivated as a perennial plant with the storage roots being harvested during the first or second year (Eneji*et al.*, 1997). Cassava appears to have originated in Brazil and Paraguay, but has spread throughout tropical areas of South and Central America long before the arrival of Columbus. It is now one of the most important food crops in tropical countries throughout the world. It ranks as the $6^{th}$ most important food crop worldwide, even though in western countries it is little known or used (FAOSTAT, 2010). The five largest producers of cassava in the world are: Nigeria, Thailand, Brazil, Indonesia and Congo Democratic Republic. However, Nigerian cassava production with 45.7, 43.4 and 44.6 million tons in 2006, 2007 and 2008 respectively is by far the largest in the world; a third more than production in Brazil and almost double the production of Indonesia and Thailand (FAOSTAT, 2010).

Cassava is an important source of dietary carbohydrate, and provides food for over 60 million people in Nigeria (Abdulahi, 2003). It contributes significantly to the nutrition and livelihood of 800 million people and thousands of processors and traders around the world, and forms a base for a wide variety of fermented foods in Africa, Asia and Latin America. In addition, it serves as raw material in the manufacture of processed foods, animal feed and industrial products (Dada, 2007). Its highly resilience and adaptability to a wide range of agro-ecological conditions and its ability to produce reasonable, dependable yields where most crops like maize cannot thrive has sustained its production through many generations in sub-saharan Africa, a region susceptible to the damaging effects of drought and heavy rainfall (Adebayo, 2009). Famine rarely occurs in areas where cassava is widely grown, since it provides a stable food base to the food production system. Apart from its use as a staple food to human beings other uses include animal feed formulation, agro-industrial uses (e.g. starch, ethanol, adhesive, and fructose/glucose syrup), the peels in organic-mineral fertilizers formulation (Ojeniyi, 2001). Cassava has become the magic crop in Nigeria as a result of the

Presidential Initiative on cassava some years ago with good export potential. This shows that cassava possesses the potential of eliminating food crisis and famine.

### 2.3.1 Prospects of Cassava Production in Nigeria

According to (FAO, 2002) strengths of Nigeria in cassava production include;

1. available cultivable land area,
2. available market, locally and internationally,
3. adaptability of cassava to different soil conditions,
4. available water bodies,
5. conducive weather conditions for increased production,
6. human resources – over 70% of the Nigerian populations is involved in one form of agriculture or another, largely in the rural areas.
7. available improved cultivars and
8. available local resources for appropriate technology.

**Weaknesses**

Relatively low productivity: subsistence farming is still widely practiced, mainly because of the low level of mechanized farming with little or no encouragement/motivation for farmers. The supply of agricultural production inputs is inadequate. Poor or low infrastructural facilities, especially on energy. Yahaya and Olayide, (2006) reported that despite the ongoing cassava revolution in Nigeria and the high level of awareness of associated technologies, lower levels of cassava technologies use still predominates.

The crop is however prone to attack by a number of insects and diseases. Poor agronomic practices combined with the insects and diseases have contributed to yield losses. FAO, (2002) names the cassava mosaic disease as the biggest biological constraint to cassava production in Africa. The other disease affecting cassava are cassava bacterial blight, cassava anthracnose, and root rot. The main insects are white flies, cassava green mite, and cassava mealy bugs. About 91% of the farmers in the Ohaji-Egbema Local Government Area of Imo State, Nigeria indicated that pests were the major constraint affecting production, while 95% mentioned high demand for hired labor (Asinobi, *et al* 2005). The cassava mosaic disease alone can cause up to 60% percent yield loss (Horna, 2007). Cassava is also a highly perishable root crop. Fresh tubers contain up to 62 to 65 percent of moisture and can dry out in less than 48 hours (Dada, 2007). Losses due to poor agronomic practices combined with insects and diseases cause harvest losses equal to 48 million tons yearly or 30% of total world production valued at US$1.4billion (FAO, 2002).

## 2.4 Maize

Maize is the most important cereal crop of the world after wheat and rice. Botanically, it is known as *Zea Mays* L. While its vernacular name is corn and belongs to family Poaceae. It is an annual cross pollinated crop with thick and strong stem, bears leaf at each mode. The leaf consists of a sheath and a broad, large blade. The sheath covers the stem, the male or terminal inflorescence is called tassel while female inflorescence known as ear is in the middle. The intermodes are straight and nearly cylindrical in the upper part of the plant but alternatively grooved on the lower part (Khalil and Jan, 2004). Maize is high yielding cereal crop for total dry matter production. Maize use moisture efficiently. Water requirement of any crop is very much depended on that prevailing environment (Temperature and Humidity) in which it is grown. It requires 500 – 800 mm of water during life cycle of 80 to 110 days (Critchleyand Klaus, 1991). According to Jamieson *et al,. (1995*) water requirement of maize at the time of tesseling is 135 mm/month (4.5 mm/day) and this requirement may increase up to 195 mm/month (6.5 mm/day) during hot windy conditions. Cropping patterns are being changed due to water scarcity.

Under such circumstances evolution of high yielding, drought tolerant maize varieties are reliable option to cope with the menace of water shortage. Physiological parameters may be used as selection criteria but must be simple and rapidly measurable, heritable, responsive to selection and most of the crops production is often reduced by drought. Water being integral part of plants plays a pivotal role in the initiation of growth, subsequentmaintenance of developmental process throughout the plant's life and ultimately economy of a country. The maize crops may experience reductions of grain yields when subjected to water deficit during the critical period of crop cycle from tasseling stage to initiation of grain filling. During 1998/99 a long drought period, 48.8 mm rain only allowed grain yield of 4.8 t/ha. While during the year 2002/03 a short duration drought at critical period reduced grain yield less than 2 t/ha, affecting the ear per plant and kernel per ear (Bergamaschi*et al.* 2004).

### 2.4.1 Maize Production

Maize crop production requires heavy fertilizer for an optimum yield in terms of nitrogen derived from chemical or organic manure (Awotundun*et al.,* 1994). It has been noted that, it is impossible to grow healthy and vigorous crops without humus, which is derived from both vegetable and animal materials.

Until recent years, the bulk of maize grain produced in Nigeria was from her South-Western Zone. Olakojo*et al,* (1998) reported that Western Nigeria generally produced about 50 percent of nigerias green maize, the remaining 50 percent being split between the North and the East. Although large proportion of the green maize still produced in the South Western part, there has been a dramatic shift of dry grain production to the savannah especially the Northern Guinea Savannah belt which encompasses Kwara, Kogi and Niger States. In Kwara state Fadama maize is a common cropping system in almost all the state in lowland areas. The production of fadama maize crops is an important component of fadama farming system in Kwara state where irrigation is being practiced (FAO, 2002).

### 2.4.2 Importance of Maize in Nigeria

Maize (*Zea mays L.*) is the most productive grain corps in the middle and northern belts of Nigeria where sunshine is adequate and rainfall is moderate. In these areas, storage of grains can be accomplished without much damage from the insect pests. The recent achievement by the breeders in the development and release of superior maize varieties with higher yield potentials and better resistance to insect and diseases has also played a central role in maize production increase in Nigeria (FAO, 2000).

Maize is increasingly gaining an important position in crop husbandry in Nigeria because of its higher yield potential and short growth duration. It contributes a lot to the economy of the country, as it is a rich source of food, fodder, feed and also provide raw materials for the industry. In recent years corn oil is becoming popular among the people due to its non cholesterol character. In addition, its products like corn starch, corn flakes, gluten germ cake, lactic acid, alcohol and acetone are either directly consumed as a food or used by various industries like paper, textile, foundry and fermentation etc. About two-third of the total world production of maize is used for livestock feed or for commercial starch and oil production (Khalil and Jan, 2004). It is estimated that 75% of the total production of maize is used as food by the farming community and the remaining finds its way in starch manufacturing industry, poultry feed and urban food grain sales (Muhammed, 1979).

### 2.4.3 Problems Associated with Maize Production in Nigeria

Maize has a great promise of higher yield and easy cultivation than any other cereal crop and if managed properly can go a long way in increasing food production in our country. Unfortunately, in spite of its great yield potentials, the average yield in Nigeria is still very low as compared to other important maize growing countries of the world (Awotundun, 1994). To obtain better grain yields, it is essential to maintain the optimum number of plants per hectare. Maize crop production requires heavy fertilizer for an optimum yield in terms of nitrogen derived from chemical or organic manure (Awotundun*et al.*, 1994).

Maize is known to use moisture efficiently. Water requirement of any crop is very much depended on that prevailing environment (temperature and humidity) in which it is grown. Maize requires 500-800 mm of water during life cycle of 80 to 110 days (Olakojo*et al*, 1998). Other factors affecting the productivity of maize in the region include the acidic nature of the soil to Southern Nigeria that lead to low fertility of the soil. Another important factor in maize production is weed infestation. Weeds compete with maize for nutrients, soil moisture, space and light and considerably reduce the yield and the quantities of plant nutrient, including micro nutrients which have high benefits for plant growth (Ibeawuchi*et al.*,2007).

## 2.5 Telfairia

*Telfairiaocidentalis* popularly known as Ugu in Igbo, Iroko in Yoruba and Ubong in Efik. Other common name for the plant includes fluted pumpkin. *Telfairiaoccidentalis* is a tropical vine grown in West Africa as a leaf vegetable for its edible seeds.

Lately the popularity has spanned across other ethnic groups, thereby taking the medicinal and commercial value of the vegetable to a higher level (Akoroda, 1990b). Telfairia is drought tolerant, dio-economic perennial vegetable that is usually grown trellised. The seeds are used as propagating materials, eaten roasted, boiled or grounded to paste as soup thickener.

In some cases Telfairia provides an appreciable income to small farm families (Akoroda, 1990). Despite the high nutritional value of Telfairia and its importance, there is dearth of information on its method of production and associated constraints.

### 2.5.1 Problems of Telfairia Production

Telfairia is recalcitrant in nature and seed storage is poor. The female plants are much desired by consumers and producers because of its succulent large leaves and the fact that it produces the pods (Onwueme*et al.,* 1986; NIHORT, 1986; Arnyim and Akoroda, 1985). It does well in the heavy rainfall area and late planting does not favourTelfairia production because of dry season, which will not allow extension of the period of crop production (Asiabaka, 1982, Asiegbu, 1985). Telfairia is now being cultivated not only as backyard crop but also as commercial crop during the wet and dry seasons.

## 2.6 Organic Manures

Organic manures are natural fertilizer made up of combination of plant and animal waste. Organic fertilizers are not immediately available to plants. Before the plants can use them, they must be broken down by soil microorganisms into simpler, inorganic molecules and ions. In contrast, the nutrients in chemical fertilizers are already in inorganic form and so can be immediately used by the plants (Le, Ha Chau, 1998). He discovered that brodigester effluent produced significantly high cassava biomass and protein content than no manure. Okigbo (1989) observed that organic mulching materials have potential for increasing cassava yield.

### 2.6.1 Gains in the use of Organic Manure

1) **Plant Growth**

Organic fertilizers provide nutrients necessary for plant growth, with the benefit of being slower-acting and gentler than chemical fertilizers, so that you are less likely to overfeed and chemically burn your plants. Organic fertilizers are not in a form that is immediately absorbed by plants, but rather must be first broken down by soil bacteria and fungi into forms that plants can absorb. This means that, unlike chemical fertilizers, organic fertilizers are not easily washed away in a heavy rainstorm or irrigation session, and that the plants get the benefit of nutrients for growth more evenly over a longer period of time rather than all at one (Eneji*et al.,* 1997).

2) **Soil Improvement**

Organic fertilizers help improve soil structure and nutrient content over time. While chemical fertilizers simply add water-soluble chemicals which are either absorbed by the plant roots or leach away, potentially polluting water resources, organic fertilizers add organic matter that helps the soil to retain moisture and nutrients.

Organic manure alters the structure of the soil which usually leads to increased root growth. During decomposition of organic material, soil microorganisms secrete a sticky substance that plays an important role in soil granulation. This results in increased aeration of silt or clay loam soil and improves the texture and the water holding capacity of sandy loam soils Awodun (2007)

3) **Food for Soil Microorganisms**

Organic manure serves as food for many microoganisms in the soil. These organisms are necessary for maintaining and promoting soil granulation. Organic manure also helps keep the soil temperature constant so that the activity of the microorganisms can continue at an even rate.

4) **Slow Release of Nutrients**

When fertilizers are incorporated into the soil, the nutrients are absorbed from the soil by the roots of the plant. In synthetic fertilizers, these nutrients are in ready to use form and when in the soil, can be immediately absorbed by the roots and hence, the plant. There is however a real danger that the roots absorb more nutrients that necessary, causing the roots and plant to burn up. On the other hand, organic fertilizers do not contain nutrients in an easily usable form. When they are mixed with the soil, the microorganisms like bacteria that are in the soil, have to work on the fertilizer, break it up and release the nutrients. This is a slow process and so there is no danger that too many nutrients are ever available to the plant. As such there is low chance for a ‘plant burn’ when organic fertilizers are used (Eneji*et al.,* 1997).

5) **Long-term Benefits to the Soil**

Chemical fertilizers are manufactured with the sole purpose of helping the growth of a plant. As a result while they may contain a better balance of all the major nutrients that a plant needs, they also contain certain harmful elements that can cause acidity in the soil. This can kill the helpful microbes that live in the soil and studies indicate that long-term use of chemical fertilizers can cause great damage to the soil on the other hand, since organic fertilizers need these microbes to work on them to release the nutrients, they end up stimulate the growth of these microorganisms, ensuring long-term fertility of the soil.

6) **Long-Term Benefits of the Environment**

Synthetic fertilizers also tend to release many chemicals into the soil that contain nutrients helpful to soil but may also contain elements that are not easily biodegradable. These may go on to contaminate our lands and our water. On the other hand be definition, organic fertilizers almost always have only biodegradable contents Ayenigbara (2000)

7) **Cheap and Cost-Effective**

Organic Fertilizers can be produced at home or on farms by using a mix of cow, sheep, chicken, and horse manure along with wastes like leaves and dead plants. This is a great way of getting rid of waste from your garden or farm and certainly a cheaper alternative to purchasing chemical fertilizer.

## 2.7 Poultry Manure

Poultry Manure refers to a combination of faeces and urine, it includes production residues such as bedding, soil, spilled feed, and water that is spilled or used for sanitary purposes. Small amounts of spilled feed, water, dust, hair and feathers are unavoidably added to manure and are detectable in the production facility. These small additions must be considered to be a part of manure (United States Department of Agriculture (USDA), 1992). Livestock manure is an important resource for agriculture; it contains a high level of nutrients and organic matter.

### 2.7.1 History of Poultry Manure

Poultry farming have existed many years ago, but chickens were kept in small flocks and reared mainly for home consumption and eggs, with any surplus sold or exchanged for other farm produce. This practice continued until the 20$^{th}$ century when poultry faring became commercialized (Cast, 1996). It started from the production of eggs (by layers), then the production of meat (broilers), and then the production of manure from their litter (Eneji*et al,* 2001). In agriculture poultry litter is a material used as bedding in poultry operations to render the floor more manageable common litter materials are wood shavings saw dust, groundnut hulls, shredded sugar cane, straw, and other dry absorbent, low-cost organic materials. Sand is also occasionally used as bedding. After use, the litter consists primarily of poultry manure, but also contains the original litter material, feathers and spilled feed. Poultry litter (combination of accumulated manure and bedding material) is a valuable source of minerals including Nitrogen, Phosphorus, Sulphur and Potassium etc, for soil fertilization (Waterman *et al*, 1995). The application of poultry litter to growing crops provides a means of disposing litter and also provides nutrients to the crops and enriches soil organic matter content.

Poultry litter is an organic amendment that has successfully been used as an alternative source to inorganic, commercial fertilizers. Poultry litter also has the potential to improve other aspects of soil quality (Devandra and Rooghavan, 1978). Poultry litter for an increasing number of farmers is becoming a natural choice as a low-cost fertilizer. When properly applied, it can be a valuable resource for cereal crops and row crop production. It is however important to carryout litter analysis before using poultry litter as fertilizer, as the nutrients contained in the litter are highly variable (Bock, 1999).

### 2.7.2 Uses of Poultry Manure

Poultry manure, an efficient organic fertilizer is an important source of plant nutrients; its average nutrient content is 3.03 N, 2.63 P205 and 1.4% K2O (Reddy and Reddi, 1995) and in addition to releasing nutrients, it is rich in organic matter improves the physical properties of soil (Ayeni, 2011).

Poultry manure has frequently been found to increase the yields of pastures and crops including vegetable. The positive yield response from chicken manure treatment is attributed to increased nitrogen nutrition (Hochmuth, 1993; Opara and Asiegbu, 1996). In addition to its value as an organic N source, poultry manure has also been shown to increase soil organic matter content and to effectively reduce root knot nematode populations and root galling in vegetables (Cheung and Wong, 1983).

The superiority and richness of poultry manure over other manures has been confirmed in many experiments, (Asiegbu, 1987) reported that the yield of each of the nine crops (except lettuce) fertilized with 5 t ha-1 poultry manure was equal to or greater than those obtained with inorganic fertilizer. Asiegbu, (1987) also showed the superiority in the application of 10 t ha-1 poultry manure over 50 kg N, 22 kg P and 60 kg K ha-1. Application of 10 tonnes per hectare of poultry manure gave a significantly greater number of fresh pods and fresh pod weight in okra when compared with 50 kg N+22 kg P+60 kg K $ha^{-1}$.

The fact that mineral fertilizers are expensive and not easily affordable (FTTC, 1997) and its attendant hazards to the soil and crop injuries (Stopes, 1988) make the use of organic manure a good option. The use of poultry manure promotes organic farming and enhances soil fertility management for the resource-poor farmers in the rural communities of most parts of the developing world. Ayenigbara, (2000) reported on the need to consider application of organic matter to ensure soil management for improved crop yield. Asiegbu, (1987) attributed the superiority of organic matter to the slow release of balanced nutrient resources during decomposition. This makes organic waste of greater residual beneficial effect distributed over a longer period than inorganic fertilizers (Obi, 2005). However, the slow release of nutrient ay make them not available to crop in the year of application and thus short season crops may not fully benefit from organic manure if applied shortly before planting (Muoneke and Asiegbu, 1997). As organic manure, poultry manure (PM) has come to serve as one of the most important manure as it consists of higher nitrogen value. Poultry manure had been found to be an important resource in sustainable practices like intercropping.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Location of the Study Area

The field experiment was carried out in 2013 and repeated in 2014 cropping seasons at the Teaching /Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State. Owerri is located on Latitude $5^0$ 27\` 44.49\`\` North and Longitude $7^0$ 02\` East at a height of 55m above sea level (Handheld Global Positioning System).

## 3.2 Climate, Soil and Vegetation

Owerri is in the tropical rainforest zone of Southeastern Nigeria and characterized by wet and dry seasons. The two seasons are influenced by the air mass with its winds. The wet or rainy season usually starts in Mid-March and ends in October with little dry spell in August known as August break. The dry season begins in Mid-November and ends in Mid-March being climate change interventions which may alter this natural sequence. The area is characterized by minimum and maximum temperatures of $20^0$C and $32^0$C respectively. The annual rainfall is about 2500mm and is bimodal with peaks in July and September (Nwosu and Adeniyi, 1980) and relative humidity of 84-89%. The soils of Owerri are formed from acid sands and are classified as ultisols (Eshett and Anyahucha, 1992) and they belong to the soil mapping unit number 431, that is, Amakama-Orji-Oguta soil Association Federal Department of Agriculture and Land Resources (1985) and derived by classification from the coastal plain sands (Lekwa and Whiteside, 1986). The site was a three year fallow bush after planting sweet potato, cassava and maize, of which poultry manure was applied.

## 3.3 Land Preparation

Land preparation was carried out manually. The experimental site was cleared, packed and stumped using spades, rakes, matchetes and diggers respectively.

### 3.4.0 Field Layout and Experimental Design/Treatments

The total experimental field measured $540m^2$. The field was marked out using measuring tape, ranging poles and pegs. Thereafter, the 3 main plots with 6 sub-plots in each block were marked out. Each block measured 4x23m that is $92m^2$ with 1.0m path between plots and 2m between block with a 2m guard area round the experimental site. Each sub plot measured 4x3m = $12m^2$. There were 18 treatment combinations. The treatments consisted of poultry manure at 0.00t $ha^{-1}$, 10.00t $ha^{-1}$ and 20.00t $ha^{-1}$ giving an application rate of $0.00kg/0m^2$, $12kg/12m^2$ and $24kg/12m^2$ respectively. The cropping systems include sole cassava, maize and telfairia and intercropping of cassava based include Cassava/Maize, Cassava/Telfairia and Cassava/Maize/Telfairia. These treatments were laid out in a split plot arrangement fitted in a randomized complete block design (RCBD) replicated 3 times.

The treatment combinations were:-

| 0.00kg $ha^{-1}$ | 10.00t $ha^{-1}$ | 20.00t $ha^{-1}$ |
|---|---|---|
| Cassava Sole | Cassava Sole | Cassava Sole |
| Maize Sole | Maize Sole | Maize Sole |
| Telfairia Sole | Telfairia Sole | Telfairia Sole |
| Cassava/Maize | Cassava/Maize | Cassava/Maize |
| Cassava/Telfairia | Cassava/Telfairia | Cassava/Telfairia |
| Cassava/Maize/Telfairia | Cassava/Maize/Telfairia | Cassava/Maize/Telfairia |

## 3.5 Inputs for the Experiment

### 3.5.1 Cassava Cuttings

Twelve (12) bundles of cassava TMS 98/0505 variety were used for the trial. The cassava cuttings were obtained from Imo State Agricultural Development Programme (Imo ADP) Owerri zonal office.The TMS 98/0505 is an early, good maturing variety with heavy vegetative growth and heavy yield.

### 3.5.2 Poultry Manure

Poultry manure (deep litter system) was procured from a commercial farmer at Umuagwo.

### 3.5.3 Maize

The Oba supper 2 maize variety was procured from Imo State Agricultural Development Programme.

### 3.5.4 Telfairia Seeds

Telfairia pods were procured from Eziobodo in Owerri West. A total of 108 seeds were planted.

## 3.6 Application of Treatment

The poultry manure rates were weighed out based on the rates i.e. $12kg/12m^2$ and $24kg/12m^2$ for $10t\ ha^{-1}$ and $20t\ ha^{-1}$ poultry manure respectively. The poultry manure rates were applied on the plots 2 weeks before planting and uniformly incorporated into the soil while mounds were made after which planting was done.

## 3.7 Planting

The crop combinations were worked out on a piece of paper and each planted on the plots as randomized. The planting materials were planted on raised mounds spaced 1mx1m apart. Maize was planted 2 seeds per hill and Cassava one cutting of 20cm per mound while telfairia was planted one seed per hill. This gave a plant population of 10,000 plants/ha for cassava, 20,000 stands/ha for maize and 10,000 stands/ha for telfairia.

## 3.8 Weeding

The plots were manually weeded at interval of 4, 8 and 12 weeks after planting using hand, hoes and matchetes.

### 3.9.0 Poultry Manure Characterization

Samples of the poultry manure were collected randomly from the bulk, air dried in the laboratory under room temperature for 15days. Nitrogen, Ca, K, P, Mg. Organic matter and pH were determined by using the micro kjeldahl method for Nitrogen determination, Potassium and Calcium were obtained by flame photometry, Phosphorus was determined by Bray II method, and Magnesium was determined by Atomic Absorption Spectrometry. Organic matter was obtained by the Walkley Black Method while pH in water measured by the pH meter.

### 3.10 Soil Sampling and Analysis

Soil samples were randomly collected from all parts of the experimental plots, bulked and dried in the laboratory and later sieved and analysed for Nitrogen (% N), Calcium (Ca), Phosphorus (P), Potassium (K), Magnesium (Mg), Organic matter (% OM), pH, Sand, Silt and Clay. The method used in characterizing the chemical components of the soil while the particle size fractions were determined by the hydrometer method of Bouyoucos, (1951) using sodium hexametaphosphate as a dispersant.

### 3.11 Data Collection

#### 3.11.1 Plant Height and Vine Length

The cassava and maize plant heights were collected at 4, 8 and 12 weeks after planting while the vine length of telfairia was measured at 4, 8 and 12 weeks after planting. All these measurements were done using a meter rule taken from the ground level to the tip of the shoot apex.

#### 3.11.2 Leaf Area

Cassava leaf area was determined by measuring the length and width of the middle lobe multiplied with a leaf factor 0.44 used in the measurement of broad/medium lobed leaves. (Length/width ratio 2.5) (Ogoke, et al., 2003). Also, that of Telfairia was determined using the same method. Leaf area = L x W x Leaf factor (0.44) at 4, 8 and 12 WAP. The maize leaf area was got by measuring the length and width of 5 maize plant leaves and multiplying out and the average of this with a constant factor (0.75) at 4, 8 and 12 WAP.

### 3.11.3 Days to 50% Tasseling

From the time tasseling began, the field was visited on a daily basis to count the number of tasseled maize plants till 50% of the maize in each plot had tasseled. This was done by physically observing the plants and recorded.

### 3.11.4 Weeding and Fresh Weed Weight

The plots were carefully weeded three times with hoe and matchetes at 4, 8 and 12 WAP to ascertain the extent of weed control by the cropping systems under different rates of poultry manures application.

### 3.11.5 Telfairia Fresh Vegetable Yield

The telfairia plants were harvested at 4, 8 and 12 weeks after planting and were tied kg/head.

### 3.11.6 Telfairia Pod Yield

After the plants were harvested at 12 WAP, they were left to flower and produce pods. The pods were gathered treatment by treatment, weighed and recorded.

### 3.11.7 Harvesting of Cassava Root Tuber and Stem Cuttings

The Cassava roots and stem cuttings were harvested at 36 weeks after planting. The fresh root-tuber yield per plot per treatment was weighed and extrapolated per hectare and recorded. The stem cuttings were arranged in bundles of good quality stems, counted 50 per bundle, and recorded.

#### 3.11.8 Root-Tuber Length

The measuring tape was used to measure the length of the cassava root tuber at harvest and recorded.

#### 3.11.9 Root-Tuber Girth

The girth of the cassava root tuber was measured at harvest with a measuring tape and recorded.

#### 3.11.10 Maize Grain Yield

The maize cobs were harvested treatment by treatment at maturity. The cob's sheeths were removed and the cob dehusked, the maize grains were weighed and recorded.

#### 3.11.11 Cost Benefit Analysis

The cost of all inputs including field operations used in the experiment was recorded at the prevailing farm gate prices of the University. The yield returns from the harvest treatment by treatment among the cropping systems for cassava, maize and  were cost based on the prevailing farm gate prices. The benefit-cost ratio was computed per treatment and cropping system to understand the best cropping system using the poultry manure treatment for higher profits. In this experiment the cost of land did not count since it was given at no cost by the University.

#### 3.11.12 Analysis

Analysis of Variance (ANOVA) was used to compare variables using Genstat, (2000) a statistical analysis software. Data analysis and interpretations were based on Wahua, (1999). The least significant difference (LSD) at 5% level of probability was used to separate and test the means for difference.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Results

### 4.1.1 Cassava Plant Heights

The results in Table 1, showed that the application of poultry manure at all rates and the cropping systems did not affect the cassava plant heights at 4 WAP. However, at 8 and 12 WAP, there were significant ($P < 0.05$) differences among the cassava plant heights shown by the different manure rates at 8 and 12 WAP, and the cropping systems at 8 WAP. At 8 WAP, plots with 20t $ha^{-1}$ manure rates had taller cassava plants (80.95cm) than those treated with 10t $ha^{-1}$ (73.96cm) and 0.0t $ha^{-1}$ (50.24cm) respectively. At 12 WAP, the same trend followed and 20t $ha^{-1}$ produced a mean taller cassava plants (113.70cm), 10t $ha^{-1}$ (104.20cm) and 0.0t $ha^{-1}$ (69.70cm) respectively whereas the cropping systems showed statistically significant difference. Also, the interaction i.e. cropping system x manure showed statistically significant plant height, at 8 WAP, and at 12 WAP. This could be as a result of the high mineralized nutrient and possible uptake by the cassava plants within the systems at 8 WAP while at 12 WAP, every action within the system came to equilibrium and hence no significant interaction was observed (Ibeawuchi 2004)

**Table 1: Effects of Poultry Manure and Cropping System on Cassava Plant Height (cm)**

| | Poultry Manure Rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Cassava sole | 11.340 | 12.74 | 12.16 | 12.081 | 58.85 | 76.35 | 98.41 | 75.87 | 78.0 | 109.10 | 115.10 | 99.00 |
| Cassava/Maize | 11.48 | 11.50 | 17.0 | 11.66 | 49.65 | 75.46 | 74.08 | 66.40 | 61.3 | 100.10 | 111.60 | 91.00 |
| Cassava/Maize/Tel | 11.30 | 12.21 | 11.67 | 11.73 | 49.01 | 76.36 | 74.60 | 66.66 | 72.5 | 102.20 | 113.40 | 96.00 |
| Cassava/Telfairia | 11.31 | 11.53 | 11.55 | 11.46 | 49.43 | 67.66 | 76.71 | 64.60 | 12.0 | 105.10 | 114.90 | 97.40 |
| Mean | 11.36 | 12.00 | 11.85 | | 50.24 | 73.96 | 80.95 | | 69.7 | 104.20 | 113.70 | |
| $LSD_{0.05}$ (Manure) | | NS | | | | 3.71 | | | | 3.27 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | 5.81 | | | | NS | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | 2.92 | | | | NS | | |

WAP = Weeks after planting, NS = Non significant.

### 4.1.2 Maize Plant Heights

Results of plant heights at 4WAP, showed no significant differences ($P < 0.05$) for manure rates and cropping systems (table 2). At 8 and 12 WAP, there were significant differences ($P < 0.05$) for manure, cropping systems and the manure x cropping systems at 8 WAP, and for manure and cropping systems at 12 WAP (Table 2). The 20t $ha^{-1}$ poultry manure application gave significantly taller maize plants 190.86cm and 199.80cm at 8 and 12 WAP respectively. Tallest maize plants at 8 WAP, were produced in Cassava/Maize/Telfairia cropping system (190.86cm) whereas at 12 WAP, Cassava/Maize cropping system (199.80cm) for 20t $ha^{-1}$ in both 8 and 12 WAP respectively (Table 2).

**Table 2: Effect of Manure Rates and Cropping System on Maize Plant Height (cm) Weeks after Planting (WAP)**

| | Poultry Manure Rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Maize sole | 66.69 | 67.39 | 66.90 | 66.99 | 89.87 | 143.50 | 165.51 | 132.96 | 142.8 | 182.1 | 181.5 | 168.8 |
| Maize/Cassava | 67.35 | 67.07 | 67.44 | 67.29 | 87.90 | 145.50 | 182.17 | 138.55 | 150.3 | 186.0 | 199.8 | 178.7 |
| Maize/Cassava/Tel | 67.09 | 67.15 | 67.23 | 67.16 | 91.63 | 169.23 | 190.86 | 150.51 | 143.0 | 183.7 | 183.7 | 173.0 |
| Mean | 67.05 | 67.21 | 67.19 | | 89.80 | 152.77 | 179.50 | | 145.4 | 186.9 | 188.3 | |
| $LSD_{0.05}$ (Manure) | | NS | | | | 3.71 | | | | 27.08 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | 3.85 | | | | 3.50 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | 6.05 | | | | NS | | |

### 4.1.3 Vine Length of Telfairia (cm)

The results in Table 3, showed the effect of manure rates and cropping systems on Telfairia vine length. The results indicate that cropping system and cropping systems x manure interaction had no significant effect on the vines of telfairia. However, manure rates at 4, 8 and 12 WAP, gave significant differences among the cropping system. At 4 WAP, 10t $ha^{-1}$ and 20t $ha^{-1}$ manure were significantly different ($P < 0.05$) from the control (no manure) application. Also, it showed that 20t $ha^{-1}$ manure gave statistically significantly longer telfairia vines than 10t $ha^{-1}$ . In the same order, at 8 and 12 WAP, 20t $ha^{-1}$ had significantly longer vines of telfairia than the 10t $ha^{-1}$ and control respectively.

**Table 3: Effect of Manure Rates and Crop Interaction on Telfairia Vine Length (cm)**

| | Poultry Manure Rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Cassava/Maize/Tel | 70.83 | 93.48 | 108.48 | 66.99 | 89.97 | 143.50 | 165.51 | 132.96 | 142.8 | 182.1 | 181.5 | 168.8 |
| Cassava/Telfairia | 77.50 | 92.38 | 106.89 | 67.29 | 87.90 | 145.50 | 182.17 | 138.55 | 150.3 | 186.0 | 199.8 | 178.7 |
| Telfairia | 71.31 | 92.83 | 67.23 | 67.16 | 19.63 | 169.23 | 190.86 | 150.51 | 143.0 | 183.7 | 183.7 | 173.0 |
| Mean | 73.21 | 92.90 | 67.19 | | 89.80 | 152.77 | 179.50 | | 145.4 | 186.9 | 188.3 | |
| $LSD_{0.05}$ (Manure) | | 41.98 | | | | 13.46 | | | | 20.45 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | NS | | | | NS | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | NS | | | | NS | | |

### 4.1.4 Cassava Leave Area ($cm^2$)

The results in Table 4 show the cassava leaf ($cm^2$) as affected by manure rates and cropping systems. The results show that cassava leaf area was significantly $P < 0.05$ affected by poultry manure rates and cropping systems. At 4 WAP, there were significant difference $P = 0.05$ between the application of 20t $ha^{-1}$ and 10t $ha^{-1}$ on cassava leaf area in cassava/telfairia cropping systems whereas others showed no significant difference. But all of them were significantly $P < 0.05$ different from the control. At 8 WAP, for 10t $ha^{-1}$ and 20t $ha^{-1}$, cassava sole and cassava/telfairia cropping systems had no significant differences ($P < 0.05$) in cassava leaf area whereas, cassava/maize and cassava/maize/telfairia showed significant differences in cassava leaf area (Table 4) At 12 WAP, the application of 10t $ha^{-1}$ and 20t $ha^{-1}$ manure rates and all the cropping systems were significantly $P = 0.05$ difference for the cassava leaf area ($cm^2$).

**Table 4: Effect of Manure Rate and Cropping System on Cassava Leaf Area (cm)**

| | Poultry Manure Rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Cassava sole | 57.67 | 67.00 | 68.33 | 64.33 | 87.67 | 92.70 | 92.13 | 90.83 | 96.77 | 110.60 | 104.60 | 103.9 |
| Cassava/Maize | 60.33 | 66.00 | 67.33 | 64.56 | 83.33 | 90.20 | 91.93 | 88.49 | 97.53 | 111.40 | 101.07 | 103.3 |
| Cassava/Maize/Tel | 59.00 | 66.00 | 63.00 | 62.67 | 88.00 | 88.60 | 92.00 | 89.53 | 91.00 | 108.40 | 102.30 | 100.5 |
| Cassava/Telfairia | 58.00 | 64.00 | 71.00 | 64.33 | 83.67 | 91.97 | 91.47 | 89.03 | 92.00 | 104.00 | 101.37 | 99.42 |
| Mean | 58.75 | 65.75 | 67.42 | | 85.67 | 90.87 | 91.88 | | 94.55 | 108.60 | 102.33 | |
| $LSD_{0.05}$ (Manure) | | 3.71 | | | | 1.64 | | | | 3.35 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | NS | | | | 2.87 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | NS | | | | NS | | |

### 4.1.5 Maize Leave Area ($cm^2$)

The results in Table 5, showed the effect of manure rates and cropping system on maize leaf area ($cm^2$). There were no significant differences($P < 0.05$) at 4 WAP for manure and for intercropping systems (Table 5). At 12 WAP and 8 WAP, application of 20t $ha^{-1}$ poultry manure produced the broadest leaf area for sole cropping system (233.93$cm^2$) and (233.40$cm^2$) respectively. Poultry Manure x Cropping System was not significant (Table 5).

**Table 5: Effect of manure rate and cropping system on leaf area ($cm^2$) of maize**

| | Poultry Manure Rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Maize Sole | 101.10 | 101.30 | 101.50 | 101.30 | 121.40 | 212.50 | 233.40 | 189.10 | 131.10 | 223.50 | 233.93 | 196.18 |
| Maize/Cassava | 101.90 | 101.80 | 101.50 | 101.73 | 121.80 | 202.97 | 213.40 | 179.05 | 131.90 | 213.96 | 213.96 | 186.27 |
| Maize/Cassava/Tel | 101.00 | 101.10 | 101.23 | 101.11 | 121.20 | 202.36 | 203.80 | 175.78 | 131.00 | 208.50 | 208.56 | 182.69 |
| Mean | 101.33 | 101.40 | 101.41 | | 121.47 | 202.61 | 218.86 | | 131.33 | 215.32 | 215.48 | |
| $LSD_{0.05}$ (Manure) | | NS | | | | 8.20 | | | | 5.72 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | 7.87 | | | | 4.51 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | NS | | | | NS | | |

### 4.1.6 Telfairia Leaf Area ($cm^2$)

Poultry manure applied at 10t $ha^{-1}$ and 20t $ha^{-1}$ significantly ($P < 0.05$) affected leaf area of telfairia ($cm^2$) at 4, 8 and 12 WAP. At 4 WAP, poultry manure application at 10t $ha^{-1}$ and 20t $ha^{-1}$ were significantly ($P < 0.05$) different with broader leaves produced than the control 0.0t $ha^{-1}$ (Table 6). At 8 WAP, sole telfairia, at 10t $ha^{-1}$ poultry manure had significantly ($P <0.05$) broader leaves than telfairia in cassava/telfairia and maize/cassava/telfairia cropping system. Also, at 20t $ha^{-1}$, Telfairia leaves in sole Telfairia cropping system had significantly ($P < 0.05$) broader leaves (384$cm^2$) than the one in Cassava/Telfairia (349.52$cm^2$) and Maize/Cassava/Telfairia (333.30$cm^2$) and all of them had broader leaves than the control (Table 6). At 12 WAP, Maize/Cassava/Telfairia at 10t $ha^{-1}$ and 20t $ha^{-1}$ poultry manure application had significantly broader leaves (396.0$cm^2$) than those in sole Telfairia and in Cassava/Telfairia cropping systems (Table 6) and they were significantly broader than the control (358.0$cm^2$).

**Table 6: Effect of Poultry Manure and Cropping System on leaf area of telfairia**

| | Poultry Manure rates tons/ha | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Maize/Cassava/Tel | 76.00 | 102.0 | 105.40 | 94.47 | 325.3 | 322.7 | 333.3 | 327.1 | 358.0 | 396.0 | 396.0 | 382.0 |
| Telfairia/Cassava | 74.33 | 103.87 | 103.63 | 93.94 | 334.0 | 347.3 | 349.5 | 343.6 | 342.0 | 374.0 | 370.0 | 362.0 |
| Telfairia | 74.67 | 103.13 | 105.40 | 94.40 | 325.0 | 384.0 | 384.0 | 364.4 | 347.3 | 384.0 | 363.0 | 364.8 |
| Mean | 75.0 | 103.0 | 104.81 | 104.81 | 328.2 | 351.3 | 355.6 | | 349.1 | 384.7 | 375.0 | |
| $LSD_{0.05}$ (Manure) | | 18.48 | | | | 16.17 | | | | 13.66 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | 12.54 | | | | 11.92 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | NS | | | | NS | | |

### 4.1.7 50% Tasseling of Maize

Results in Table 7, showed the effect of poultry manure rates and cropping systems on days to 50% tasselling of Maize. From the results Maize applied with 10t $ha^{-1}$ and 20t $ha^{-1}$ poultry manure tasseled earlier (68 days) and (67 days) respectively, for sole Maize than those without manure i.e. the control (70 days). Also, for Cassava/Maize cropping system, Maize applied with poultry manure 10t $ha^{-1}$ and 20t $ha^{-1}$tasselled earlier in 68 days than the control without manure that tasseled in 72 days (Table 7). In Cassava/Maize/Telfairia cropping system the Maize tasseled earlier for those applied with 20t $ha^{-1}$ poultry manure (66 days) whereas, 10t $ha^{-1}$tasselled in 68 days while the Maize that received no manure tasseled in 70 days Table 7.

**Table 7: Effect of Poultry Manure Rates and Cropping Systemson Daysto 50% Tasseling of Maize at 4 Week after planting.**

| | Poultry Manure Rate tons/ha 4WAP | | | |
|---|---|---|---|---|
| **Cropping System** | **0.00** | **10.00** | **20.00** | **Mean** |
| Maize | 70 | 68 | 67 | 68.33 |
| Maize/Cassava | 72 | 68 | 68 | 69.33 |
| Maize/Cassava/Tel | 70 | 68 | 66 | 68.00 |
| Mean | 70.67 | 68.00 | 67.00 | |
| $LSD_{0.05}$ (Manure) | | NS | | |
| $LSD_{0.05}$ (Cropping System) | | 2.04 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | |

### 4.1.8 Grain Yield and Yield Parameter of Maize (kg/ha)

Results in Table 8 showed the effect of poultry manure rates and cropping systems on the yield of Maize (kg/ha) and 1000 seed weight (g). The results indicate that poultry manure applied at 20t $ha^{-1}$ significantly ($P = 0.05$) affected the Maize yield kg/ha and 1000 seed weight (g). In sole Maize, the application of 20t $ha^{-1}$ (2.70$kgha^{-1}$) and 10t $ha^{-1}$ (1.7$kgha^{-1}$), had higher yields per hectare than the control (1.10$kgha^{-1}$) respectively Table 8. The cropping systems has some influence on maize yield and 1000 seed weight in that as the inclusion of crops increased from one to two in the cropping so also is the yield decline per system although this was not significantly. The poultry manure application significantly ($P < 0.05$) affected the grain fill and hence the weight (Table 8). The 20t $ha^{-1}$ had higher weight of grains than the 10t $ha^{-1}$ and the control (Table 8).

**Table 8: Effect of Poultry Manure Rates and Cropping System on Yield of Maize (kg/ha)**

| | Poultry Manure Rates tons/ha | | | | | |
|---|---|---|---|---|---|---|
| | Maize yield kg/ha | | | 1000 Seed weight (kg) | | |
| **Crop System** | **0.00** | **10.00** | **20.00** | **0.00** | **10.00** | **20.00** |
| Maize Sole | 1.10 | 1.72 | 2.70 | 11.83 | 12.40 | 13.40 |
| Cassava/Maize | 1.06 | 1.57 | 2.67 | 11.81 | 12.30 | 13.20 |
| Cassava/Maize /Tel | 1.06 | 1.52 | 2.67 | 12.10 | 12.30 | 13.30 |
| $LSD_{0.05}$ (Manure) | | 1.58 | | | 1.02 | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | NS | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | NS | |

### 4.1.9 Mean Weed Fresh Weight (t/ha)

Results in Table 9, show the effects of poultry manure rates and cropping systems on the mean weed fresh weight (t $ha^{-1}$). At 4 WAP, results show high weed incidence in all the plots irrespective of the manure application. Hence, the results were not significant. At 8 WAP, the results showed than the control had significantly lower mean weed, fresh weight that the plots treated with 10t and 20t organic manure. In cassava sole, the control produced 1.62 $tha^{-1}$ fresh weed while, 10t $ha^{-1}$ poultry manure application produced 1.82t $ha^{-1}$ fresh weed weight and 20t poultry manure produced 1.81t $ha^{-1}$. However, observations from the farm and results showed that intercropped plots had significantly lower weed weights than the sole. Cassava/Telfairia control without any manure application had 1.55t $ha^{-1}$ of weed weight, and plots applied with 10t $ha^{-1}$ poultry manure had 1.57t $ha^{-1}$ while the plots treated with 20t $ha^{-1}$poultry manure had 1.60t $ha^{-1}$ (Table 9).

Furthermore, the results of Cassava/Maize/Telfairia had significantly reduced weed weight at 8 WAP following the first round of weeding. The control had 1.07t $ha^{-1}$ weed weight plots treated with 10t poultry manure had 1.40t whereas plots treated with 20t poultry manure had 1.50t. At 12 WAP, results indicate reduced weed weight probably because of earlier weedings at 4 and 8 WAP. Results show that sole cassava plots without manure application had 1.45t of fresh weed weight, the same with plots treated with 10t poultry manure whereas plots treated with 20t poultry manure had 1.48t of fresh weed. The weed weights reduced s in insignificantly intercropped plot than the sole plots. Cassava/Telfairia plots had 1.15t, 0.62t and 0.56t for the control, 10t and 20t poultry manure application. Also, recorded for the Cassava/Maize/Telfairia are: control 1.05t weed weight, 10t poultry manure application 0.59t; and 20t poultry manure application 0.60t.

**Table 9: Effects of Poultry Manure Rates and Cropping Systems on Mean Weed Fresh Weight (t/ha) at 4, 8 and 12 Weeks After planting.**

| | Poultry Manure Rates (tons/ha) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4WAP | | | | 8WAP | | | | 12WAP | | | |
| **Cropping System** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** | **0.00** | **10.00** | **20.00** | **Mean** |
| Cassava Sole | 1.61 | 1.62 | 1.62 | 1.62 | 1.62 | 1.82 | 1.81 | 1.75 | 1.45 | 1.45 | 1.48 | 1.46 |
| Telfairia Sole | 1.60 | 1.60 | 1.63 | 1.61 | 1.30 | 1.65 | 1.68 | 1.01 | 1.45 | 1.20 | 1.26 | 1.30 |
| Cassava/Telfairia | 1.65 | 1.65 | 1.65 | 1.65 | 1.45 | 1.57 | 1.60 | 1.60 | 1.15 | 0.62 | 0.50 | 0.77 |
| Maize Sole | 1.62 | 1.62 | 1.62 | 1.62 | 1.45 | 1.85 | 1.85 | 1.71 | 1.40 | 1.51 | 1.50 | 1.47 |
| Cassava/Maize | 1.63 | 1.63 | 1.60 | 1.62 | 1.52 | 1.50 | 1.52 | 1.51 | 1.25 | 0.90 | 0.95 | 1.03 |
| Cassava/Maize/Tel. | 1.63 | 1.62 | 1.63 | 1.62 | 1.07 | 1.40 | 1.50 | 1.32 | 1.05 | 0.59 | 0.60 | 0.81 |
| Mean | 1.63 | 1.62 | 1.62 | | 1.46 | 1.67 | 1.69 | | 1.29 | 1.05 | 1.09 | |
| $LSD_{0.05}$ (Manure) | | NS | | | | 0.07 | | | | 0.08 | | |
| $LSD_{0.05}$ (Cropping System) | | NS | | | | NS | | | | 0.10 | | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | | NS | | | | 0.17 | | |

### 4.1.10 Root Tuber Yields (t/ha) and Yield Parameters (cm) of Cassava

The results of the experiment showed that the cropping systems and the application of poultry manure significantly ($P < 0.05$) affected root tuber yield of cassava at harvest (Table 10). The application of 20t/ha poultry manure in sole cropping of cassava produced the highest root tuber yield of cassava (18.85 metric tones per hectare), whereas the application no manure i.e. the control at the Cassava/Maize/Telfairia cropping system produced the lowest yield of (10.39t $ha^{-1}$). The application of 0t $ha^{-1}$, 10t $ha^{-1}$ and 20t $ha^{-1}$ yielded 10.60, 15.29 and 18.16 in cassava/maize cropping systems.

The results show that the root tuber length of cassava was significantly affected by the application of poultry manure and cropping systems (Table 10). At the application of no poultry manure (i.e. control), the cassava/maize cropping system had the longest tubers (31.86cm) whereas cassava/maize/telfairia cropping sole and cassava/maize/telfairia cropping systems had 27.65, 30.37 and 28.25cm respectively. At the application of 10t $ha^{-1}$ poultry manure, the sole cassava cropping system, had the longest tubers (56.75cm) followed by cassava/maize (52.60cm), cassava/maize/telfairia (50.55cm) and cassava/telfairia (49.09cm).

At the application of 20t $ha^{-1}$ poultry manure, the sole cassava cropping system produced the longest tubers of cassava (58.96cm) followed by cassava/maize (54.90cm), cassava/maize/telfairia that produced (50.17cm). In general, the application of 20t/ha in sole cassava cropping produced the longest root tubers of cassava while cassava/telfairia produced the shortest.

The results in Table 10, showed the tuber diameter of root tuber yield of cassava. The results indicate that the application of 20t/ha poultry manure in cassava/maize produced the highest diameter (16.50cm) whereas the same application in sole cassava cropping system and cassava/telfairia produced 13.75. and they were significantly different ($P < 0.05$) from the application of 10t/ha and control in all the cropping systems evaluated.

**Table 10: Effects of Poultry Manure Rates (t/ha) and Cropping Systems on Root Tuber Yields (t/ha) and Yield Parameters (cm) of Cassava**

| Crop Systems | Root Tuber Weight at Harvest (t/ha) | | | Root Tuber Length (cm) | | | Root Tuber Diameter (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **0.00** | **10.00** | **20.00** | **0.00** | **10.00** | **20.00** | **0.00** | **10.00** | **20.00** |
| Cassava sole | 10.70 | 16.80 | 18.85 | 30.37 | 56.75 | 58.96 | 6.55 | 10.15 | 15.75 |
| Cassava/Telferia | 10.62 | 15.35 | 18.25 | 27.65 | 49.09 | 50.17 | 6.70 | 12.25 | 15.75 |
| Cassava/Maize | 10.60 | 15.29 | 18.16 | 31.86 | 52.60 | 54.90 | 6.45 | 13.50 | 16.56 |
| Cassava/Maize/Tel | 10.39 | 15.28 | 17.93 | 28.25 | 50.55 | 53.82 | 6.39 | 12.15 | 13.75 |
| $LSD_{0.05}$ (Manure) | | 2.05 | | | 0.57 | | | 0.29 | |
| $LSD_{0.05}$ (Cropping System) | | 1.51 | | | 1.12 | | | 0.33 | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | NS | | | NS | |

### 4.1.11 Telfairia Fresh Vegetable Yield (kg/head) t/ha

Table 11, contains the result, of the effects of poultry manure rates and intercropping systems on the Telfairia fresh vegetable yield (kg/head) t/ha harvested at 4, 8 and 12 WAP.At 4 WAP, the sole telfairia cropping system had higher fresh vegetable yields than the other cropping systems. Cassava/Telfairia and Cassava/Maize/telfairia in all the rates of poultry manure applied. The control treatment (0t $ha^{-1}$) 0.89, (10t/ha) had 0.94 while (20t/ha) 0.96t/ha vegetable yield respectively. These yields were statistically significantly ($P < 0.05$) different from that of cassava/telfairia (0.t/ha) 0.38, (10.t/ha) 0.64 and (20.t/ha) 0.88 tonnes of fresh vegetable per hectare respectively. Accordingly, cassava/maize/telfairia cropping system produced the lowest yield of fresh vegetables per hectare at various poultry manure rates: (0t/ha) = 0.36, (10t/ha)= 0.58 and (20t/ha)= 0.83 tonnes per hectare fresh vegetables. At 8 WAP, the sole telfairia increased in yield with 2.77t/ha for control treatment, 3.15 and 4.98 t/ha for 10t/ha and 20t/ha poultry manure, respectively. Also, the cassava/telfairia cropping system that had 2.35, 3.07 and 4.37 for 0, 10 and 20t/ha respectively poultry manure applied. The cassava/maize/telfairia cropping system produced 2.19, 3.05 and 4.15t/ha telfairia vegetable yield for control, 10t/ha and 20t/ha poultry manure respectively (Table 11).

At 12 WAP, the yield of telfairia vegetable for control was 3.09t/ha whereas 10t/ha and 20t/ha poultry manure application produced 4.01t/ha and 4.74 t/ha of vegetable respectively. Similar results were obtained in cassava/telfairia and cassava/maize/telfairia cropping systems (Table 11).

**Table 11: Effects of Poultry Manure Rates (t/ha) and Cropping Systems on the Telfairia Fresh Vegetable Yield (kg/head)t/ha harvested at 4, 8 and WAP**

| | Weeks After Planting (WAP) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Crop Systems** | | **4** | | | **8** | | | **12** | |
| | Poultry Manure Rates t/ha | | | | | | | | |
| | **0.00** | **10.00** | **20.00** | **0.00** | **10.00** | **20.00** | **0.00** | **10.00** | **20.00** |
| SoleTelferia | 0.89 | 0.94 | 0.96 | 2.77 | 3.15 | 4.98 | 3.09 | 4.01 | 4.75 |
| Cassava/Telferia | 0.38 | 0.64 | 0.88 | 2.35 | 3.07 | 4.37 | 2.91 | 3.95 | 4.09 |
| Cassava/Maize/Tel | 0.36 | 0.58 | 0.83 | 2.19 | 3.05 | 4.15 | 2.87 | 3.81 | 3.98 |
| $LSD_{0.05}$ (Manure) | | 0.52 | | | 1.29 | | | 1.27 | |
| $LSD_{0.05}$ (Cropping System) | | 0.36 | | | 1.71 | | | 1.22 | |
| $LSD_{0.05}$ (Manure x Cropping System) | | NS | | | 1.15 | | | NS | |

### 4.1.12 Pod Yield of Telfairia (kg/ha) and Number of Pods Produced

The results in Table 12 showed the effects of poultry manures rates (t/ha) and cropping systems on the pod yield of telfairia kg/ha. The results for sole cropping of telfairia showed that application of 20t/ha poultry manure had the highest number of pods per hectare (498) and weighed 1,198kg/ha and was significantly different ($P < 0.05$) from the control 0kg/ha and the application of 10t/ha respectively. Cassava/Telfairia (493 pods) and 1,186 kg/ha and Cassava/Maize/Telfairia (489 pods) 1,181kg/ha.

The results sequence for Cassava/Maize cropping system showed that 20t/ha poultry manure had the highest number of pods (1,193), whereas 10t/ha poultry manure and control had 429 and 189 pods and 1,032kg/ha and 402kg/ha respectively. Also, Cassava/Maize/Telfairia cropping system followed the result trend, 20t/ha poultry manure had 489 pods and 1,181kg/ha whereas 10t/ha poultry manure application and the control (0kg/ha) had 419 pods with 1,030kg/ha and 189 pods with 402kg/ha respectively (Table 12).

**Table 12: Effects of Poultry Manure Rates (t/ha) and Cropping Systems on the Pod Yield of Telfairia (kg/ha) and Number of Pods Produced**

| Cropping Systems | 0.00 | 10.00 | 20.00 | Mean |
|---|---|---|---|---|
| | Telfairia Pod Yield (kp/ha)/Number of Pods | | | |
| Sole Telfairia | 414.00(1920 | 1,064.67(433) | 1,198.00(498) | 892.22 |
| Cassava/Telfairia | 401.00(189) | 1,032.00(429) | 1,186.00(493) | 871.00 |
| Cassava/Maize/Telfairia | 402.00(189) | 1,030.00(419) | 1,181.00(489) | 871.00 |
| Mean | 465.67 | 1042.22 | 1186.33 | |
| $LSD_{0.05}$ (Manure) | 21.32 | | | |
| $LSD_{0.05}$ (Cropping Systems) | 14.60 | | | |
| $LSD_{0.05}$ (Manure x Cropping Systems) | 16.93 | | | |

### 4.1.13 Stem Yield of Cassava (bundles/ha)

The results in Table 13, showed that poultry manure and cropping systems significantly ($P <0.05$) affected stem yield of cassava at 50 stems of 1m high per bundle. In the sole cropping, the application of 20t/ha poultry manure produced the highest stem yield of 1,499 bundles/ha followed by the application of 10t/ha poultry manure which produced 1,419 bundle per hectare while the control without any application of manure produced 1028 bundle per hectare. The other cropping systems, cassava/telfairia, cassava/maize and cassava/maize/telfairia applied with 10t/ha poultry manure produce 1227, 1235 and 1098 cassava stem bundles per hectare respectively whereas the application of 20t/ha poultry manure to the other cropping systems produced 1360, 1386 and 1356 bundles/ha respectively. In the overall, the application of 20t/ha poultry manure produced the highest number of bundle per hectare (1499) and was significantly different ($P < 0.05$) from the application of 10t/ha poultry and the control. Amongst the cropping systems, sole cropping and cassava/maize produced higher number of cassava bundles per hectare than the others. The interaction of manure x cropping systems was not significant (Table 13).

**Table 13: Effects of Poultry Manure Rates (t/ha) and Cropping Systems on the Stem Yield of Cassava (bundles/ha)**

| | Poultry Manure Rates | | | |
|---|---|---|---|---|
| **Cropping Systems** | **0.00** | **10.00** | **20.00** | **Mean** |
| Cassava Sole | 1,028 | 1419 | 1499 | 1328.67 |
| Cassava/Telfairia | 969 | 1227 | 1360 | 1185.33 |
| Cassava/Maize | 981 | 1235 | 1386 | 1200.67 |
| Cassava/Maize/Telfairia | 954 | 1098 | 1356 | 1136.00 |
| Mean | 993 | 1244.75 | 1400.25 | |
| $LSD_{0.05}$ (Manure) | 59.63 | | | |
| $LSD_{0.05}$ (Cropping Systems) | 47.25 | | | |
| $LSD_{0.05}$ (Manure x Cropping Systems) | NS | | | |

#### 4.1.14 Summary of Cost-Benefit Analysis for a Cassava based Cropping System

Land was given free of charge but the clearing, ridge or mound making, cassava cuttings (bundles), maize seeds, telfairia seeds, poultry manure, transport, planting labour, weeding and harvesting were all quantified in terms of naira and kobo for the contemporary rates and the current farm gate price in the University farm was used to realize the returns. The benefits were gotten by subtracting the cost from the returns. Cost was according to the input variable. From the foregoing therefore, individual cropping system was assessed per hectare. For the six cropping systems apart from the sole crops of maize, telfairia and cassava, others were cassava based i.e. cassava/maize, cassava/telfairia and cassava/maize/telfairia were assessed. Amongst the sole cropping system, Maize sole with the application of 10t/ha poultry manure and the unmanured had negative benefits of -₦32,000 and –₦101,000 respectively. However, 20t/ha poultry manure rates on maize had ₦99,000 as benefits. On the other hands, cassava sole and telfairia sole had good/huge returns and benefits for no manure sole cassava was ₦476,600 as against ₦4,200 for telfairia whereas, the application of 10t/ha poultry manure increased the benefit from cassava sole to ₦739,800 while telfairia gave ₦82,733.50k (Table 14). The application of 20t/ha produced ₦938,300 as benefits while telfairia produced ₦199,900 as benefit for the intercrops, they produced huge returns and benefits that even simple intercropping of cassava/maize or cassava/telfairia can give high monetary returns and benefit especially when poultry manure is applied either 10 or 20t/ha (Table 14). the results show that intercropping cassava/maize/telfairia with the application of 20t/ha poultry manure produced the highest returns of ₦2,075,250 and benefit ₦1,659,250 indicating that intercropping is far more better and acceptable than sole cropping as the same piece of land is used for the production of the intercrops (Table 14).

**Table 14: Summary of Cost-Benefit Analysis for a Cassava Based Cropping System**

| Cropping System | Poultry Manure Rate(t/ha) | Returns (₦ : K) | Cost (₦ : K) | Benefit (₦ : K) |
|---|---|---|---|---|
| Cassava Sole | 0.0 | 740,600.00 | 264,000.00 | 476,600.00 |
| | 10.0 | 1,123,800.00 | 384,000.00 | 739,800.00 |
| | 20.0 | 1,242,300.00 | 304,000.00 | 938,300.00 |
| Maize Sole | 0.0 | 165,000.00 | 266,000.00 | -101,000.00 |
| | 10.0 | 258,000.00 | 286,000.00 | -32,000.00 |
| | 20.0 | 405,000.00 | 306,000.00 | 99,000.00 |
| Telfairia | 0.0 | 358,200.00 | 354,000.00 | 4,200.00 |
| | 10.0 | 465,733.50 | 374,000.00 | 82,733.50 |
| | 20.0 | 593,900.00 | 394,000.00 | 199,900.00 |
| Cassava/Maize | 0.0 | 887,260.00 | 276,000.00 | 611,260.00 |
| | 10.0 | 1,277,000.00 | 296,000.00 | 981,000.00 |
| | 20.0 | 1,590,200.00 | 316,000.00 | 1,274,200.00 |
| Cassava/Telfairia | 0.0 | 1,025,850.00 | 364,000.00 | 661,850.00 |
| | 10.0 | 1,434,500.00 | 384,000.00 | 1,050,500.00 |
| | 20.0 | 1,726,300.00 | 404,000.00 | 1,322,300.00 |
| Cassava/Maize/Telfairia | 0.0 | 1,161,460.00 | 376,000.00 | 785,460.00 |
| | 10.0 | 1,641,100.00 | 396,000.00 | 1,245,100.00 |
| | 20.0 | 2,075,250.00 | 416,000.00 | 1,659,250.00 |

## 4.2 Discussion

## 4.3 Plant Heights

### 4.3.1 Cassava

The non-significant difference recorded at 4WAP could be attributed to the delay in mineralization and subsequent uptake of the growth resources from poultry manure. However, the trend changed at 8 and 12 weeks after planting and the sole cassava plots with the application of 20t/ha poultry had taller cassava plants than the others. This can be attributed to the high quantity of poultry manure and lack of any competition for nutrients that enabled the plants to grow taller at 12 WAP. Furthermore, Nitrogen content of poultry manure must have also accounted for this fast growth of the cassava plants. This finding is in line with Okoh et al (2010), and Duruigbo*et al (*2007).

### 4.3.2 Maize

The non-significant effect of the maize plant heights in all the cropping systems at 4 weeks after planting could be as a result of little or no competition for growth resources such as light, water and nutrient (Ibeawuchi, 2004). Possibly the growth factors were in sufficient amount and were shared by the different crop combinations and in the sole cropping systems (Kurt, 1984). With the application of 10t/ha and 20t/ha at 8 and 12 WAP, the plant heights became taller in both 8 and 12WAP for the 10t/ha and 20t/ha indicating the presence of competition in the crop combinations and non in the sole crops. Also, the presence of high nutrient release in the systems particularly in the20t/ha poultry manure is visible in this report.

### 4.3.3 Telfairia Vine Length

The non-application of poultry manure showed no significant difference among the treatments. With respect to the vinelength the application of 10t/ha did not show any differences among the cropping system. For the application of 20t/ha, the telfaria had longer vine lengths when telfairia is combined with cassava or cassava/maize than in sole cropping.

## 4.4 Leaf Area

### 4.4.1 Cassava, Maize and Telfairia

As plant grow they produce leaves and the leaf area depends on the rate of the formation of new leaves, size of the leaves and longevity of individual leaves. The application of poultry manure which houses a lot of Nitrogen released in the soil and taken up by these cassava helped to boost and increase the vegetative growth and plant canopy. This finding agreed with Cooke, (1982).

Leaf area of the cassava plants increased with increasing quantities of poultry manure applied. The increase in leaf when 10t/ha was applied at 8 and 12 WAP was larger than the 0.0t/ha i.e. non application. Larger leaf area was obtained as 20t/ha poultry manure was applied. Maize and telfairia also increased in their leaf area except that maize leaf area was not significant at 4 WAP may be due to nutrient uptake, light and other growth resources which were not competed for. The application of poultry manure generally and significantly increased all vegetative growth at 8 and 12 WAP. The use of poultry manure as organic soil amendment and its capacity to improve growth has been reported for different crops in different ecological zones of Nigeria including sweet potato, (Ojeniyi and Adejobi, 2005, Okonkwo*et al.*, 2009). The results also agreed with Uduma and Eka, (2006) that poultry manure applied at the rate of 10t/ha significantly increased maize height, leaf number, leaf area, leaf dry matter, weight and stem dry matter. The cropping systems also significantly helped in increasing leaf area and other vegetative parameters for cassava, telfairia and maize in Maize role, cassava/maize and cassava/maize telfairia, sole telfairia, cassava sole and cassava/telfairia, at the application of 10 and 20t/ha at 8 and 12 WAP. This is attributed to the release or high nutrient contents in the poultry manure which mineralized, and taken up by those crops coupled with the competition in combination with other crops and weeds. The crops in the check plots where no poultry manure was applied were significantly different and had lesser leaf area and vegetative parameters.

### 4.5 Days to 50% Tasselling of Maize

The number of days to 50% tasseling of maize was significantly different ($P < 0.05$) at higher rates of poultry manure application (20t/ha) with reduced number of days. The cropping systems also affected the number of days to tasseling and this may be attributed to competition between and among the intercrops. However, the plots without poultry manure application did not show any significant differences among the cropping systems. Poultry manure at 10 and 20t/ha reduce the days to 50% tasseling as a result of nutrient uptake, growth and tasseling of the maize plants.

### 4.6 Maize Grain Yield (kg/ha)

The application of poultry manure and the cropping systems significantly affected maize grain yield and 1000 seed weight. This could be drawn from the fact that vegetative yield which was increased by poultry manure application reflected in the maize grain yield and the 1000 seed weight respectively. Maize in intercropping usually faces competition. Sole crops produced maize grains that are well filled and the yields were also high due to the release of nutrient elements from the poultry manure. As the application of 10t/ha and 20t/ha poultry manure in the sole maize crop produced the maize grain yield (kg/ha) it is believed that although sole maize crop gave high yield, cassava/maize and cassava/maize/telfairia were not significantly different from the sole crops.

### 4.7 Effect of Poultry Manure Rates and Intercropping on Weed

The application of 20t/ha and 10t/ha poultry manure produced high and large number of weeds in all the treated plots. Whereas, the treated plots produced large number and quantities of weeds, the untreated or check plots produced lesser weeds. However intercropping suppressed weeds in the plots with sole crop plots producing large and high quantities of weeds. This is in line with Ibeawuchi (2004) who reported intercropping suppressed weeds by reducing the weed weight with its many crop components per crop combination. In the intercropping system the weed number and quantities decreased from 4 – 8 WAP and 8 – 12 WAP. This agreed with Ibeawuchi and Ofor (2003) that weed weight decreased from 3 – 20 WAP with maize/cassava being the highest and maize/cassava/cowpea/groundnut/African yambean being the lowest. This report showed that cassava/maize/telfairia had the lowest weed quantity in all the crop combinations in the experiment. This was attributed to the high foliage and vegetative growth which helped in covering the ground faster and helped to reduce weeds in the plots especially in the 0t/ha and 10t/ha poultry manure treated plots.

### 4.8 Root Tuber Yield (t/ha)

Intercropping in cassava base crops showed that cassava roots in cassava sole cropping system with the application of 20t/h poultry manure (18.85t/ha) was significantly different from cassava sole with application of 10t/ha (16.80t/ha) and the two manure rates had better and higher cassava yield than the control without poultry manure. Intercropping cassava/telfairia had higher yields (18.25t/ha) than 15.35t/ha for 20t/ha and 10t/ha poultry manure application respectively. Cassava/maize and cassava/maize/telfairia followed the same trend for 20 and 10t/ha poultry manure application and they had higher cassava root tuber than the control. The application of poultry manure in intercropping helps to increase cassava root yield.

The yield differences in the intercropping systems could be attributed to the cropping system factors since simple intercropping systems help to increase crop yields (Kurt, 1984) and too, the poultry manure factors as a reservoir of, Om, N, P, K, Mg, Ca, other trace element necessary for increased cassava root yield in the system. This report agreed with

Okoli, (2015) who explained that higher tuber yields in cassava manured with poultry manure – palm bunch ash mixtures than in unmanured cassava could be attributed to adequate supply of nutrients such as N, P, K, Ca, Mg, etc. necessary for increased root yield in cassava.

### 4.9 Cassava Root Tuber Length (cm)

The cassava root length increased with increasing poultry manure rates application. The cassava sole tuber (58.96cm) were longer than the intercropped (54.90cm, 53.82cm and 50.17cm) for cassava/telfairia, cassava/maize and cassava/maize/telfairia at 20t/ha poultry manure respectively.

Application at the 10t/ha poultry manure rates, the same trend followed and they were longer than the unmanured control. However, this could be attributed to the summation of photosynthetic activities resulting in bulking and storage in the life cycle of the cassava plant.

### 4.10 Cassava Root Diameter (cm)

The root diameter of cassava increased with increasing poultry manure rates both in the sole cropping system and in the intercropped systems. With poultry manure, potassium is made available which is responsible for food translocation and deposit in tuberous roots such as cassava. This agreed with the findings of Ekenayake, (1993) that the higher the translocation of carbohydrate to the roots, the higher the cambial activity causing the roots to enlarge in size.

### 4.11 Cassava Stems (Bundles/ha)

Cassava stem is the regenerative part of the cassava, used for its multiplication in farms. The stem was gathered 50 per bundle and 10t/ha poultry manure application and 20t/h produced 1419 and 1499/ha bundles respectively in cassava sole cropping. Other intercropping systems cassava/telfairia 1227 bundle per hectare cassva/maize 1235 bundles and cassava/maize/telfairia produced 1098 for 10t/ha poultry manure while 20t/ha produced

1386, and 1356 bundles per hectare. This showed that poultry manure helped in increasing the vegetative parts of cassava so high that the higher the rate the higher the number of stems produced giving rise to higher number of bundles than the unmanured control.

### 4.12 Telfairia Fresh Vegetable Yield (kg/ha)t/ha

The telfairia crop was harvested at four weeks intervals. The sole cropping of telfairia gave higher yields than the others at the application of high rates of poultry manure. This was observed at 4, 8 and 12 WAP when we stopped the harvesting of vegetables to give room for pod production. The high yield of leaves was attributed to the nutrients N, P, K, Mg Ca, Om and trace elements stored in poultry manure which help in the vegetative growth of plants especially vegetables such as telfairia. Intercropping also affects vegetative production whereas no manure is applied.

### 4.13 Pod Yield of Telfairia (kg/ha)

Irrespective of cropping system, the telfairia after 12 WAP, expanded with several number of branches and thereafter the plants separated into males and females. The females produced the pods and had broad leaves whereas the males produced tiny leaves and several flowers. The pods in plots manured with poultry manure rates were higher in number and weight than the unmanured control plots.

### 4.14 Summary Results of Benefits of the Cassava based Cropping Systems with the Sole Crops

The differences in the input cost for unmanured plots is the poultry manure cost. For all the plots, weeding was done three times at 4, 8 and 12 WAP. For the sole crops, cassava sole was very productive and had high benefit for the enterprise with the application of 20t/ha poultry manure (₦938,300) while (₦99,000) and of negative benefit without the application of manure and the application of 10t/ha.

For the intercropping system, the cassava/maize/telfairia with 20t/ha poultry manure produced a huge benefit of (₦1,659,250) and against cassava/telfairia (₦1,322,300) and cassava/maize (₦1,274,200). In as much as there is a reduction or reduced yield when intercropping, the collective yields of the intercrop gave them the strength to do better than the sole crop. Infact, simple intercropping of cassava/maize and cassava/telfairia with the application of poultry manure performed better and yielded better and gave high returns and benefit than the sole cropping.

# CHAPTER FIVE

# SUMMARY, CONCLUSIONAND RECOMMENDATION

## 5.1 Summary

Increased productivity can be achieved through intercropping systems involving cassava with cereals and vegetables especially where poultry manures is applied at 20t/ha or 10t/ha. Although high poultry manure application generates high and fast weed growth. Intercropping with cassava as the base crop gave high aggregate output more than the sole cropping systems with only one crop utilizing the same growth resources and producing lesser product than the combined output of the intercrops. Maize plant heights grew taller in intercropping with poultry manure, producing a sizeable leaf area. Also, cassava root tuber, stem and leaf area are increased with increasing poultry manure application and so also were the vine length of telfairia which grew longer in plots treated with poultry manures producing broader leaves with high monetary value. The poultry manure helped in the production of telfairia pods while seeds sold at high prices at the farm gate.

## 5.2 Conclusion

The practice of intercropping should be encouraged especially among rural farmers to avoid crop failure, increased yield of the component crops and high returns for the farmers.

## 5.3 Recommendation

It is recommended that further work should be carried out with other root and tuber crops such as yam, cocoyam, and carrot with cereals such as wheat, sorghum, rice and vegetables of the tropical environment to assess their productivity and a good extension service established to help farmers master the technology so far developed.

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## APPENDIX 1

**Price List for the Operations, Labour and Materials**

| | | |
|---|---|---|
| Land = free | – gift from the university. | |
| Land clearing | – Manday 1500 x 10days x 3 | = ₦45,000/ha |
| Ridge making | = 12 mandays x 4 at ₦1,200 | = ₦57,600 |
| Cassava cuttings | = 50 bundles/ha at ₦200 | = ₦10,000 |
| Maize seeds | = 10kg/ha at ₦1,200/kg | = ₦12,000 |
| Telfairia seeds (10 seeds for 100) 10,000 seeds/ha | | = ₦100,000 |
| Poultry manure 50kg at ₦100/bag 20t | | = ₦40,000, 10t = ₦20,000 |
| Planting labour at days x ₦1,200 | | = ₦24,000 sole |
| Transportation | | = ₦5,000 |

Weeding – 3 x weeding = 10 mandays x 3100 mekt at 1200/day ₦108,000

Harvesting labour = at ₦1000/day for 3day for 5men = ₦15,000.

Total

## APPENDIX 2

**Cost benefit of Maize in the Cropping Systems as Affect by Poultry Manure Rates t/ha**

**Yield t/ha**

| **Cropping Systems** | **0.00** | **Cost/kg ₦ : k** | **Cost/ha ₦ : k** | **10.00** | **Cost/ha ₦ : k** | **20.00** | **Cost/ha ₦ : k** |
|---|---|---|---|---|---|---|---|
| Cassava Sole | - | - | - | - | - | - | - |
| Maize Sole | 1.10 | 150.00 | 165,000.00 | 1.72 | 258,000.00 | 2.70 | 405,000.00 |
| Telfairia Sole | - | - | - | - | - | - | - |
| Cassava/Maize | 1.06 | - | 160,060.00 | 1.57 | 235,500.00 | 2.67 | 400,500.00 |
| Cassava/Telfairia | - | - | - | - | - | - | - |
| Cassava/Maize/ Telfairia | 1.06 | - | 160,060.00 | 1.52 | 228,100.00 | 2.67 | 400,500.00 |

**t/ha Tuber Cassava Roots/bundles**

| | **R** | **₦** | **B** | **₦** | **R** | **₦** | **B** | **₦** | **R** | **₦** | **B** | **₦** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cassava Sole at ₦500/10kg ₦150/bundle | 10.70 | 535,000 | 1,028 | 154,200 | 16.08 | 840,000 | 1,419 | 212,850 | 18.85 | 942,500 | 1,499 | 224,850 |
| Cassava/Maize | 10.62 | 531,000 | 969 | 145,350 | 15.35 | 767,500 | 1,227 | 184,050 | 18.25 | 912,500 | 1,360 | 204,000 |
| Cassava/Telfairia | 10.60 | 530,000 | 981 | 147,150 | 15.29 | 764,500 | 1,235 | 185,250 | 18.16 | 908,000 | 1,386 | 207,900 |
| Cassava/Maize/ Telfairia | 10.39 | 519,500 | 954 | 143,100 | 15.28 | 764,000 | 1,098 | 164,700 | 17.93 | 896,500 | 1,356 | 203,400 |

## APPENDIX 3a

**Telfairia Leaves (kg/head) at ₦50**

| At ₦50/kg | 4 WAP t/ha Fresh Vegetable Yield | | | | | | 8 WAP t/ha Fresh Vegetable Yield | | | | | | 12 WAP t/ha Fresh Vegetable Yield | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 10 | | 20 | | 0 | | 10 | | 20 | | 0 | | 10 | | 20 | |
| Telfairia Sole | 0.89 | 44,500 | 0.94 | 47,000 | 0.96 | 48,000 | 2.77 | 138,500 | 3.15 | 157,500 | 4.98 | 249,100 | 3.09 | 154,500 | 4.01 | 200,500 | 4.74 | 237,000 |
| Cassava/Telfairia | 0.38 | 19,000 | 0.64 | 32,000 | 0.88 | 44,000 | 2.35 | 117,500 | 3.07 | 153,500 | 4.37 | 218,500 | 2.91 | 145,500 | 3.95 | 197,500 | 4.09 | 204,500 |
| Cassava/Maize/Telfairia | 0.36 | 18,000 | 0.58 | 29,000 | 0.83 | 41,500 | 2.19 | 109,500 | 3.05 | 152,500 | 4.15 | 207,500 | 2.87 | 143,500 | 3.81 | 190,500 | 3.98 | 199,000 |

**3b** **Telfairia Pods kg/ha at ₦500/10kg**

| | 0 | | 10 | | 20 | |
|---|---|---|---|---|---|---|
| Telfairia Sole | 414 | 20,700 | 1064.67 | 51,733.50 | 1198 | 59,900 |
| Cassava/Telfairia | 401 | 20,050 | 1032.00 | 51,600.00 | 1186 | 59,300 |
| Cassava/Maize/Telfairia | 402 | 20,100 | 1030.00 | 51,500.00 | 1181 | 59,050 |

## APPENDIX 4a

**Returns from the Sales of the Products of the Cropping Systems**

| Cropping System | Poultry Manure t/ha | Maize Grain | Cassava Root Tuber | Cassava Bundles | Telfairia Leaves kg/head | Telfairia Pods |
|---|---|---|---|---|---|---|
| | | **₦ : k** | **₦ : k** | **₦ : k** | **₦ : k** | **₦ : k** |
| Cassava Sole | 0.00 | - | 535,000 | 205,600 | - | - |
| | 10.00 | - | 840,000 | 283,800 | - | - |
| | 20.00 | - | 942,500 | 299,800 | - | - |
| Maize Sole | 0.00 | 165,500 | - | - | - | - |
| | 10.00 | 258,00 | - | - | - | - |
| | 20.00 | 405,000 | - | - | - | - |
| Telfairia | 0.00 | - | - | - | 337,500 | 20,900.00 |
| | 10.00 | - | - | - | 405,000 | 51,733.50 |
| | 20.00 | - | - | - | 534,000 | 59,900.00 |
| Cassava/Maize | 0.00 | 160,060 | 531,000 | 196,200 | - | - |
| | 10.00 | 235,500 | 767,500 | 274,000 | - | - |
| | 20.00 | 400,500 | 912,500 | 277.200 | - | - |
| Cassava/Telfairia | 0.00 | - | 530,000 | 193,800 | 282,000 | 20,050.00 |
| | 10.00 | - | 754,500 | 245,400 | 383,000 | 51,600.00 |
| | 20.00 | - | 908,000 | 292,000 | 467,000 | 59,300.00 |
| Cassava/Maize/Telfairia | 0.00 | 160,060 | 519,500 | 190,800 | 271,000 | 20,100.00 |
| | 10.00 | 228,000 | 764,000 | 219,600 | 378,000 | 51,500.00 |
| | 20.00 | 400,500 | 400,500 | 271,200 | 448,000 | 59,050.00 |

<u>Note:</u>Maize grain = ₦150 = 1kg; Telfairia Leaf Yield = ₦50/kg

Cassava Root Tuber = ₦500/10kg; Telfairia Pods = ₦500/10kg

Cassava = ₦200/bundle of 50 Cuttings.

## APPENDIX 5

### Cost for Intercropping Enterprises

| Operations | Cassava/Telfairia | Cassava/Maize | Cassava/Maize/Telfairia |
|---|---|---|---|
| Land Clearing | 45,000 | 45,000 | 45,000 |
| Ridge Making/Mounds | 57,000 | 57,000 | 57,000 |
| Cassava Cuttings | 10,000 | 10,000 | 10,000 |
| Maize Seeds | - | 12,000 | 12,000 |
| Telfairia Seeds | 100,000 | - | 100,000 |
| Poultry Manure (10t/ha) | 20,000 | 20,000 | 20,000 |
| Poultry Manure (20t/ha) | 40,000 | 40,000 | 40,000 |
| Transportation | 5,000 | 5,000 | 5,000 |
| Planting Labour | 24,000 | 24,000 | 24,000 |
| Weeding | 108,000 | 108,000 | 180,000 |
| Harvesting | 15,000 | 15,000 | 15,000 |

10t/ha = 384,000

296,0`00 396,000

20t/ha = 404,000

316,000 416,000

0t/ha = 364,000

276,000 376,000

## APPENDIX 6

### Cost for Sole Cropping Enterprises

| Sole Cropping Operations | Cassava/Telfairia | Cassava/Maize | Cassava/Maize/Telfairia |
|---|---|---|---|
| Land Clearing | 45,000 | 45,000 | 45,000 |
| Ridge Making | 57,000 | 57,000 | 57,000 |
| Cassava Cuttings | 10,000 | - | - |
| Maize Seeds | - | 12,000 | - |
| Telfairia Seeds | - | - | 100,000 |
| Poultry Manure (10t/ha) | 20,000 | 20,000 | 20,000 |
| Poultry Manure (20t/ha) | 40,000 | 40,000 | 40,000 |
| Transportation | 5,000 | 5,000 | 5,000 |
| Planting Labour | 24,000 | 24,000 | 24,000 |
| Weeding | 108,000 | 108,000 | 180,000 |
| Harvesting | 15,000 | 15,000 | 15,000 |

| | | |
|---|---|---|
| 10t/ha | = | 284,000 |
| 286,000 | | 374,000 |
| 20t/ha | = | 304,000 |
| 306,000 | | 394,000 |
| 0t/ha | = | 264,000 |
| 266,000 | | 354,000 |