THE PRODUCTIVITY OF SOLE AND INTERCROPPED MAIZE WITH GROUNDNUT USING THREE RATES OF POULTRY MANURE IN OWERRI IMO STATE

BY

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CERTIFICATION

This is to certify that this work titled "The Productivity and sole and intercropped maize with Groundnut using three rates of poultry manure in Owerri, Imo State" was carried out by Uzoigwe, Chinenye Priscillia (20154940318) in partial fulfillment of requirements for the award of Master of Science (M.Sc) in Agronomy of the Department of Crop Science and Technology, Federal University of Technology, Owerri.

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DEDICATION

I dedicate this research work to Almighty God and to my beloved husband Dr. Onyebuchi Uzoigwe.

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ABSTRACT

The experiment was carried out in the farm of School of Agriculture and Agricultural Technology, of Federal University of Technology Teaching and Research Farm Owerri, during the 2017 cropping season to determine the productivity of sole and intercropped maize with groundnut using 3x 3factorial fitted into a Randomized Complete Block Designed replicated three times. The treatments consisted of three rates of poultry manure at 0, 5 and 10 tons/Ha and three cropping systems namely; sole maize, sole groundnut, and maize/groundnut intercrop. The biological efficiency of the intercropping system was evaluated using the land equivalent ratio and the relative yield totals respectively. Data on various crop growth and yield parameters for maize and groundnut were measured and subjected to analysis of variance while mean separation was done using the least significant differences at 5 level of probability. Results indicated that the 10 tons/ha poultry manure rate gave the highest maize fresh cob yield of 4.68tons/ha compared with 1.83tons/ha when no manure was added. Also groundnut grain yield of 2.83tons/ha was highest when 10 ton/ha of poultry manure was applied compared with 1.02 tons/ha when no manure was applied. The result from the post-harvest soil analysis showed that substantial amount of magnesium increased which indicates that in the pre-planting chemical and physical analysis 0.16 of Magnesium was available, then in the post soil chemical and physical analysis is observed to have increased to 0.67. Then calcium in the preplanting soil physical and chemical analysis was 0.40 later increased to 1.5 in the post-harvest soil chemical and physical analysis. Then nitrogen in the preplanting soil physical and chemical analysis was 0.15 and in the post-harvest soil chemical and physical analysis it was 0.14 which means not all the nitrogen was used up. Based on the results of this experiment I strongly recommend the application of 10 tons/ha of poultry manure to boost the productivity of maize/groundnut yields in mixture.

Keywords: Intercropping, productivity, poultry manure, Maize, Groundnut, land Equivalent Ratio and Relative yield.

CHAPTER ONE

1.2 INTRODUCTION

Maize (Zea mays/Zeasacharrata) commonly called OBA SUPER II and Groundnut (Arachishypoea/virpinia)

Intercropping is an advanced agro technique of cultivating two or more crops in the same space at the same time. It has been practiced in past decades and achieved the goal of agriculture. It increases in productivity per unit of land via better utilization of resources. Reduces weed completion and stabilizes the yield. Several factors influence intercropping such as maturity of crop, selection of compatible crops, planting density, time of planting as well as socio economic status of farmers, (John and Mini, 2005). In intercropping, land is effectively utilized and land equipment ration (LER) is used to measure the productivity of land. Several findings show the advantages of intercropping by using LER (Land Equipment Ratio). Cereal-legume intercropping is commonly practiced world wide. Maize is reorganized as a component crop in most intercropping. The forms of agriculture and cropping system found throughout the world are the results of variation in local climate, soil, economics and social structure. Water balance, radiation, temperature and soil conditions are the main determinants of the physical ability of crops to grow and cropping system to exist (Seran and Jeyakumaran, 2009; Brintha and Seran, 2009).

Therefore, the cropping system varies from place to place in the world. Farmers generally take decisions on the technologies to be adopted on the basis of cost, risk and return calculation. In small farms, the farmers raise crops as a risk minimizing measures against total crop failures and to get different products to take care of their family's food, income etc. World population is growing exponentially and it has to fulfil their food requirements. An attractive strategy for increasing productivity and labor utilization per unit area of available land is to intensify land use. This can be increased by growing several crops simultaneously or in succession with each other in farms devoted to short maturing annual crops. (Seran and Jeyakumaran, 2009; Brintha and Seran, 2009).

1.2. STATEMENT OF PROBLEM

The continuous use of inorganic fertilizer causes environmental degradation, loss in biodiversity, damage to soil structure, acidification of the soil, causes nitrogen eutrophication by excessive use of nitrogenous fertilizer and because of these problems organic manure is a better alternative.

1.3. JUSTIFICATION

Growing maize and food legumes in mixtures offers a good crop relation because the food legume may enrich the soil with nitrogen, provide live mulch, suppress weed. Also their respective growth habits complement one another

Vast areas of land in the humid tropics comprise of strongly leached soils-ultisols and oxisols. These soils are characterized by the low inherent nutrient status and a high degree of exchangeable aluminum saturation which often reaches toxic.

levels on the growth of many crops. The introduction of late season maize/legume intercrop in the high rainforest zone deserves special attention.

Moreover, in the high rainfall regions where cassava and yams are the major food crops, the inclusion of maize and food legumes in rotation system could substantially improve the present low protein diet of many families in the rural areas, (John and Mini, 2005).

1.4 OBJECTIVES OF RESEARCH

The objectives of this research are:

i. To assess the performance of sole groundnut and sole maize using different rates of poultry manure.

ii. To determine the optimum poultry manure rate that will boost the yield of groundnut and maize.

iii. To compare the productivity of the sole groundnut and intercropped, sole maize and intercropped, using Land Equivalent Ratio and Relative Yield Total (RYT).

iv. To evaluate the current residual effects of poultry manure on soil nutrient value.

CHAPTER TWO

2.0. LITERATURE REVIEW INTERCROPPING

Intercropping is a type of mixed cropping and defined as the agricultural practice of cultivating two or more crops in the same space at the same time (Seran and Jeyakumaran, 2009; Brintha and Seran, 2009).

The important reason to grow two or more crops together is the increase in productivity per unit of land. In intercropping systems, all the environmental resources are utilized to maximize crop production per unit area and time. Risk may be minimized in intercropping. There are some socio economic biological and ecological advantages in intercropping over monocropping. Several scientists has been working with intercropping (Mandal *et al*., 1990; Natarajan, 1992; Kalarani, 1995; Aravazhi *et al*., 1997; Balan, 1998; Sadashiv, 2004; John and Mini, 2005; Suresha *et al*., 2007; Seran and Jeyakumaran, 2009;

2.1 MAIN ASPECTS TO BE CONSIDERED IN INTERCROPPING SYSTEM

Successful intercropping needs several considerations before and during cultivation. Silwana and Lucas (2002) reported that intercropping affects

vegetative growth of component crops, therefore the need to consider the spatial, temporal and physical resources. Economically viable intercropping largely depends on adaptation of planting pattern and selection of compatible crops (Seran and Brintha, 2009a). Cereal-legume intercropping, potential to provide nitrogen depends in densities of crop, light interception, crop species and nutrients (Francis, 1989). Compatible crop selection is vital in intercropping. The choice of compatible crops for an intercropping system depends on plant growth habit, land, light, water, (Brintha and Seran, 2009a). Hardarson and Atkins (2003) found legume-cereal intercropping increases the fixation of nitrogen by legumes. Silwana and Lucas (2002) reported different crop species in mixtures increased capture of growth limiting resources.

2.1.1 MATURITY OF CROP:

When two or more crops are grown together the peak period of growth of components do not coincide. The biggest complementary effects and thus biggest yield advantages seen to occur when the component crops have different growing periods to make their major demands on resources at different times. Crops of varying maturity duration should be chosen. Therefore a rapidly maturing crop completes its life cycle before the major growth period of other crop commence. Selecting crops or varieties with different maturity time can also assist staggered harvesting and separation of grain commodities. By this, the time of peak nutrient demands of component crops should be differed. Crops which mature at different times thereby separating their periods of maximum demand to nutrient and moisture aerial space and light could be suitably intercropped (Enyi, 1977). In maize-green gram, peak light demand for maize is around 60 days after planting, while greengram is ready to harvest (Reddy and Reddi, 2007).

2.1.2 COMPATIBLE CROPS

Choice of the crop combination plays vital role in intercropping. Plant density, shading and nutrition competition between plants reduce the yield of monocrop. Plant competition could be minimized not only by spatial arrangement, but also by choosing those crops best able to exploit soil nutrients. Baker and Norman (1975) stated that increased yield from better use of space in mixture are complimentary to utilizing time with crops in sequences. Therefore, maximum cropping should be obtained with sequences of high yielding crops in compatible mixtures. Cereal-legume intercropping is commonly practiced in Asia, Africa and South America (Vandermeer, 1992; Maluleke *et al*., 2005). In the tropics, maize-cowpea intercropping is often practiced Mpangane *et al*., 2004). Krantz (1981) found that maize is easy to manage in maize-pegionpea intercropping. Singh *et al*. (1998) stated that Central and South America and parts of East Africa, maize is intercropped with beans.

2.1.3 PLANT DENSITY

Low plant population per unit area leads to low yield (leyakumaran and Seran, 2007). The seedling rate of each crop in the mixture is adjusted below its full rate to optimize plant density. If full rates of each crop were planted, neither would yield well because of intense overcrowding. By reducing the seedling rates of each, the crops have a chance to yield well within the mixture. The challenge comes in knowing how much to reduce the seedling rates. Modification of planting pattern of *Capsicum* in intercropping system is feasible for vegetable cowpea cultivation (Jeyakumaran and Seran, 2007). Planting of pearl millet in paired row may provide additional space for an intercropping (Sivaraman and Palaniappan, 1996). Keeping the plant population per unit area of the base crop constant, no deviation of its yield has been noted by altering the orientation of the rows (Sivaraman and Palaniappan, 1996). Brintha and Seran (2009) stated" that in radish- vegetable *amaranthus* intercropping, yield of radish was not significantly affected due to constant plant density of radish in monocropping and intercropping. The planting pattern of the maize and legumes (intercropping or growing maize after the legume harvest) did not affect the yield of maize.

A reasonable Leaf Area Index (LAI) IS critical to maintain high photosynthetic rates and yield (Xiaolei and Zhifeng, 2002). In radish-vegetable *amaranthus* intercropping, higher density of vegetable *amaranthu*s produced more LAI in radish (Brintha and Seran, 2009). Prasad and Brook (2005) reported that increasing maize plant density had significant effect on LAI in maize soybean intercropping.

2.1.4 TIME OF PLANTING

Mongi *et al*. (1976) found planting cowpea simultaneously with maize gives better yield. Amede and Nigatu (2001) stated that simultaneously planting maize and sweet potato did not influenced maize grain y

.ields, whereas late planting of sweet potato negatively affected maize yield. Several researches have been focused on bush bean and maize planted simultaneously in alternate rows (Pilbeam, 1996; Santalla *et al*., 1999).

Maize has diverse uses and the diversity of environment under which it is grown (Doswell *et al*., 1996). It has high potential for carbohydrate accumulation per unit area per day (Aldrich *et al*., 1975). Also maize has been recognized as a common component in most intercropping systems. It seems to dominate as the cereal component of intercrop and it is often combined with different legumes (Anil *et al*., 1998; Maluleke *et al*., 2005). It is the third most important cereal crop of the world and used as food, feed and forage. Intercropping with maize is a way to grow a staple crop while obtaining several benefits from the additional crop.

2.2 BENEFITS OF INTERCROPPING

2.2.1 Resource utilization

The main reasons for higher yields in intercropping is that the component crops are able to use natural resources differently and make better overall use of natural resources than grown separately (Willey, 1979). The efficient use of basic resources in the cropping system depends partly on the inherent efficiency of the individual crops that make up the system and partly on complimentary effects between the crops. Biological basis for intercropping involves complementarily of resources used by the two crops (Barhom, 2001). One of the main yield advantages in intercropping those crops sown as intercrop combination may be able to make better overall use of resources than when growing separately. The partitioning of limiting resources among crop plants occurs whenever plants are grown in association (Blade *et al*., 1997).

Soil fertility problems are not only an agronomic issue, but also strongly related to economical and social issues. Number of pods per *Capsicum* plant were lower in capsicum-vegetable cowpea intercropping compared to monocropping due to

Nutrition and light competition (Seran and Jeyakumaran, 2009). Integrated nutrient management adopts a holistic approach to plant nutrient management by considering the totality of the farm resources that can be used as plant nutrients. Vesterager *et al*. (2008) found maize and cowpea intercropping is beneficial on nitrogen poor soils. Maize-cowpea intercropping increases the amount of nitrogen, phosphorous and potassium contents compared to mono crop of maize (Dahmardeh *et al*., 2010). Suryanta and Harwood (1976) reported that nutrient uptake and utilization was more efficient in corn-rice and corn-soybean intercrops than in those crops as monocrop.

Different root and leaf systems are able to harness more light and make use of more water and nutrients than when the roots and leaves of only one species are present. When only one species is grown, all the roots tend to compete with each other since they are all similar in their orientation and below surface depth. Similarly, the leaves of plants of the same species are directly opposite and growing at the same rate as each other, whereas the leaves of a plant of another species do not compete therefore directly for sunlight in space and time. In the tropics, multi storey plants harvested in sequence can utilize the sun's energy on a year round basis. A combined leaf canopy might make better special use of light (Waddington and Edward, 1989). Intercropping between high and low canopy crops is a common practice 111 tropical agriculture and to improve light interception and hence yields of the shorter crops requires that they be planted between sufficiently wider rows of the taller ones. Intercropping create micro climate that favour the lower plant growth t Azam-Ali *et al*., 1990). Jiao *et al*. (2008) found maize-groundnut intercropping enhanced the efficient utilization of strong light by maize and weak light by groundnut led to provide yield advantages. Soybean and maize intercropping has been attributed to better use of solar radiation (Keating and Carberry, 1993), nutrients (Willey, 1990) and water (Morris and Garrity, 1993) over the mono crop. When two morphologically dissimilar crops with different periods of maturity are intercropped light is the vital factor that determines the yield (Willey, 1979). Competition of light affected the plant height in capsicum-bushitao intercropping (Jeyakumaran and Seran, 2007).

Availability of water in cropping system is vital to determine the growth of plant. Improvement of water use efficiency in intercropping leads to increases in the use of other resources (Hook and Gascho, 1988). Intercrops have been identified to conserve water largely because of early high leaf area index and higher leaf area (Ogindo and Walker, 2005). Under normal condition cereallegume intercropping uses water equally (Ofori and Stern, 1987). Various root systems in the soil reduces water loss, increases water uptake and increases transpiration, leads to create microclimate cooler than surroundings (Innis, 1997). Morris and Garrity (1993) mentioned that water capture by intercrops is higher by about 7 compared to mono crop. Willey (1979) stated cereallegume use water more efficiently than monocropping. Barhorn (2001) reported that water use efficiency was the highest under soybean-maize intercropping compared with monocropping maize and monocropping soybean. Soybean-maize intercropping was the best combination system during water scarcity periods (Tsubo *et al*., 2005). In area where there is water scarcity, intercropping is a suitable method (Lynam *et al*., 1986). Biological efficiency of intercropping is due to exploration of large soil mass compared to monocropping (Francis, 1989).

2.3 WEED CONTROL

Intercropping might better control weeds, pests and diseases. Evidence of better weed control is reasonably clear where intercropping provides a more competitive effect against weeds either in time or space than does monocroppmg. Weed population was reduced.

In brinjal-groundnut intercropping (Srikrishnah *et al*., 2008,). The nature and magnitude of crop-weed competition differs considerably between mono and inter crop combinations. The crop species, population density, sowing geometry, duration, growth rhythm of the component crop, the moisture and fertility status and tillage influence weed flora in cropping system. Crop-weed competition is determined by growth habit of crop. Increased leaf cover in intercropping systems helps to reduce weed populations once the crops are established (Beets, 1990). Shading showed considerable potential as a means of reducing the spread of *Cyperus rotundus* (Patters on, 1982). This reemphasizes the possible importance of growing more than two crops in same land at same time. Mixed cropping reduces weed incidence (Altieri and Liebman, 1986; Zuofa *et al*., 1992). Makindeaet at. (2009) found leafy greens can be intercropped with maize to control weeds in the tropics and increase productivity, Weed suppression in maize-groundnut intercropping was reported by Steiner (1984). Intercropping maize and legumes considerably reduced the weed density compared with the monocropping maize by decrease in available light for weeds compared to mono crops (Dimitrios *et al*., 2010). Maize-cowpea intercropping suppresses weeds and insures against total crop failure when one crop fails (Mongi *et al*., 1976). Maize-pumpkin and maize-bean intercropping reduced weed biomass by 50-66 when established at a density of 12,300 and 222,000 plants ha-I for beans (Mashingaidze, 2004). Mugabe *et al*. (1982) noted that intercropping controlled weed effectively and reduced the harvestable biomass. Advantages from intercropping in weed control under low input conditions and increases in components crop yields leads to improved weed control (Leihner, 1979). Maize-rye intercropping reduces weed biomass by 50 (Samson, 1991).

2.4 PESTS AND DISEASES

Maize is susceptible to many insects (Drinwater *et al*., 2002) and diseases (Flett *et al*., 1996). Intercropping appears to be a very promising cultural practice for this purpose. It is generally believed that one component crop of an intercropping system may act as a barrier or buffer against the spread of pests and pathogen. Intercropping maize-cowpea reduces the stem borer. (Henrik and Peeter, 1997), found that maize-groundnut and maize-soybean mixed, crop reduced the number of corn borer in maize. Insect problems are less on crops grown in mixture, especially with cowpea, pigeon pea, maize and some legumes. Trenbath (1993) noted that pest and diseases were high in mono cropping compared to intercropping. In chilli-maize intercropping, the incidence of *Anthonomuseugenii* was lower and yield was greater compared to chilli alone (Gutierrez, 1999). Pino *et al*. (1994) found pest and disease were less in tomato maize intercropping. Soybean and groundnut are more effective in suppressing termite attack than common beans (Sekamatte *et al*., 2003). Singh and Adjeigbe (2002) stated monocroppmg needs more chemical to control pests and diseases than intercropping.

2.5 EROSION CONTROL

Intercropping controls soil erosion by preventing rain drops from hitting the bare soil where they tend to seal surface pores, prevent water from entering the soil and increase surface erosion. Maize-cowpea intercropping, cowpea act as best cover crop and reduced soil erosion (Kariaga, 2004). Reddy and Reddi (2007) mentioned taller crops act as wind barrier for short crops. In brinjal-groundnut intercropping, pod weight of brinjal in mono cropping was low due to absence of intercrop which leads to high water evaporation in soil surface (Prashaanth *et al*., 2009).

2.6 YIELD ADVANTAGES

Yield is taken as primary consideration in the assessment of the potential of intercropping practices (Ani! *et al*., 1998). In legume and non legume intercropping, yield of non legume increased in intercropping as compared with monocropping. Mashingaidze (2004) found that by intercropping land was effectively utilized and yield was improved. The crops are grown together because of higher yields and greater biological and economic stability in the system (Francis, 1986). Land Equivalent Ratio (LER) is the most common index adopted in intercropping to measure the land productivity. It is often used as an indicator to determine the efficacy. of intercropping.(Fisher, 1977a). Land Equivalent Ratio.(LER) greater than one indicates greater efficiency of land utilization in intercropping system. It is due to greater efficiency of resource utilization in intercropping or by increased plant density (Fisher, 1977a). Mandal *et al*. (1990).Land Equivalent Ratio (LER) shows advantages of cereal-legume intercropping. Tsubo *et al*. (2005) stated legume-cereal intercropping is generally more productive than monocrop. When two crops are grown together yield advantages occurs because of differences in their use of resources.

Legume non legume intercropping increases total grain and nitrogen yield (Barker and Blarney, 1985; Singh *et al*., 1986). In intercropping higher yield, greater yield stability over mono cropping was reported by Oforiand Stern (1987). Mohta and De (1980) stated that Land Equivalent Ratio (LER) increased to a maximum of about 48 by intercropping maize with soya beans compared with the cereal sole crops.

2.7 ECONOMIC BENEFITS

Intercropping often provides higher cash return than growing one crop alone (Grimes *et al*., 1983; Kurata, 1986). Intercropping occupies greater land use and thereby provides higher net returns (Seran and Brintha, 2009a). Kalra and Gangwar (1980) reported that intercropping helps in increasing farm income on sustained basis. Intercropping commonly gave greater combined yields and monetary returns than obtained from either crop grown alone (Ahmad and Rao, 1982). Net return of radish and vegetable amaranths intercropping correlated with vegetable amaranths (intercrop) plant density. Intercropping capsicum and vegetable cowpea gave high net return compared to mono cropping.

2.8 MAIZE BASED INTERCROPPING

2.8.1 MAIZE/LEGUME INTERCROPPING

Intercropping of legumes and cereals is an old practice in tropical agriculture that time back to ancient civilization. Snaydon and Harris (1979) found legume-cereal the most popular intercropping system in the tropics. Systems that intercrop maize with a legume are able to reduce the amount of nutrients taken from the soil as compared to a maize monocrop. During absence of nitrogen fertilizer, intercropped legumes will fix nitrogen from the atmosphere and 110t compete with maize for nitrogen resources (Adu-Gyamfi *et al*. 2007). The mixture of nitrogen fixing crop and 110n fixing crop give greater productivity than mono cropping. Maize-french bean gave high maize equivalent yield over sole maize yield and kernel yield of maize was unaffected in maize-french bean intercropping (Pandita, 2001). Akinnifesi *et al*. (2006) revealed that without nitrogen fertilizer application, gliricidia maize intercropping system gave high maize yield. It was also observed that maize yield was increased by 26 in maizc-soybean strip intercropping.

2.9 POULTRY MANURE

This is the faeces of chickens used as an organic fertilizer, especially for soil low in nitrogen. Of all animal manures, it has the highest amount of nitrogen, phosphorus, and potassium. Chicken manure is sometimes pelletized for use as a fertilizer, and this product may have additional phosphorus, potassium. or nitrogen added. Optimal storage conditions for chicken manure includes it being kept in a covered area and retaining its liquid, because a significant amount of nitrogen exists in the urine, Suryanta and Harwood (1976).

Fresh chicken manure contains approximately 1.5 nitrogen. One chicken produces approximately 8-11 pounds of manure monthly. Chicken manure can be used to create homemade plant fertilizer. The study compared the use of using chicken manure only, cow manure only, 16-20-0 fertilizer only, a mixture of cow manure and 16-20-0 fertilizer, a mixture of chicken manure and 16-20- o fertilizer, and a control group that used no fertilizer Suryanta and Harwood (1976).

2.10 ASSESSMENT OF CROP PERFORMANCE IN INTERCROPPING SYSTEM

Two main forms of neighborhood effects that influence mixture performance are competition and complernentarities. Competition refers to the struggle between individuals within a population for available resources when the level of resources is below the combined needs of members of the population (Vandermeer 1992). In population of plants of similar genotypes, the competition is intra specific but where different species of crops are grown in mixture, the competition in interspecific.

Competition can take place between parts of the same plant, between stems and leaves, leaves and grain yield (Xiaolei and Zhifeng 2002). Complex interspecific, inter varietal and inter plant interaction in forms of anmidation and allelopathy can occur in intercropping system depending on various combinations of the plant species, plant density, spacing planting patterns, canopy types, root systems of different species and differential demands on environmental factors at different growth stage.(Trenbath, 1993).

2.11 ASSESSMENT OF YIELD ADVANTAGES

The biological efficiency of intercropping is determined by companng the productivity of a given area of intercropping with the productivity of the same area if that same area were to be divided between sole crops to give the same ratio of the two species as in intercropping (Kariaga, 2004). If yield advantages are to be achieved, different intercropping conditions might have to satisfy rather different requirements. One of the more problematic areas of intercropping research is the quantitative evaluation of the advantages provided by any given intercropping system (Kariaga, 2004).

Competitive relationship between different crops and yield advantages of intercropping system over sole crop systems are assessed using different methods such as relative crowding coefficient (RCC), land equivalent ratio (LER), relative yield total (RYT), competition ratio (CR), competition index (Cl) and aggressiveness (A). Reddy and Reddi (2007).

More commonly, the LER had been the relative unit used by researchers and it is defined as the relative land area under sole crops that is required to produce the yield achieved by intercropping under the same level of management Reddy and Reddi (2007). The LER is usually applied to combine intercrop yields but can be applied also to the intercrop yield of each crop component.

The LER is calculated as LER = (Yield of component A in mixture I Yield of component B in sole) but it is expressed mathematically as:

LER= Land equivalent ratio =

$$\frac{\text{Yield of maize (sole Kg)}}{\text{Yield of maize + groundnut (Kg)}} + \frac{\text{Yield of groundnut (sole) Kg}}{\text{Yield of maize + groundnut (Kg)}}$$

LER = E (Yi/Yij)

Where Yi = the yield of that component from a unit area of intercrop

Yij = the yield of that component grown as sole crop over the same area.

The LER is indicative of competitive relationships between the species, when LER less than one (LER < 1) then there is yield disadvantage due to intercropping. LER is greater than one (LER > 1), there is yield advantage due to intercropping when LER is compared at uniform overall plant density of the sole and intercrops then it is known as relative yield total (RYT). Relative yield is the ratio of the yield of species in mixtures to its yield in pure stand Reddy and Reddi (2007).It is expressed as r = O/M

Where 0 = The yield of the species in mixture and

M = The yield of the species in monoculture.

The sum of the relative yields of both species is the relative yield total (RYT)

R YT = ra + rb = Oa + Ma + Ob/Mb

RYT = ra = Relative yield of crop A

rb = relative yield of crop B

Qa = yield of crop A in mixture

Ma = yield of crop A in monoculture

Qb = Yield of crop B in mixture

Mb = Yield of crop B in mono culture

A relative yield total less than one equal to one or greater than one indicate yield disadvantage, no difference or yield advantage of the intercropping respectively.

CHAPTER THREE

3.0. MATERIALS AND METHODS

Description of Experimental Area.

The experiment was conducted at the Teaching and Research Farm of the Federal University of Technology Owerri. Owerri lies in the tropical Region of South Eastern Nigeria latitude $5^{0}27^{1}E^{0}N$ and longitude $7^{0}2^{1}E^{0}$.

3.1 EXPERIMENTAL DESIGN AND TREATMENT.

The experimental design used is 3 by 3 factorial in Randomized Complete Block Design (RCBD)

Treatments

Factor A = Poultry Manure
Levels Al = 0 Manure

A2 = 5 tons/ha

A3= 10 tons/ha

Factor B = cropping Systems

Levels BI = Sole Maize

B2= Sole Groundnut
B3= Maize/Groundnut

Treatment combinations

Treatments Cropping Systems

Poultry Manure

Rate ton/ha			BI	B2	B3
	Al	=	AIBI	AIB2	AIB3
	A2	=	A2BI	A2B2	A2B3
	A3	=	A3BI	A3B2	A3B3

Total 9 treatment combinations replicated 3 times to give 27 plots

Treatment combinations are

AIBI	AIB2	AlB3
A2B1	A2B2	A2B3
AIB3	A3B3	A3B3

Interpretations

AIBI Zero Manure + Sole Maize

A1B2 Zero Manure + Sole Groundnut

A1B3 Zero Manure + Maize/Groundnut

A2Bl 5 tons + Sole Maize

A2B25 tons + Sole Groundnut

A2B35 tons + Maize/Groundnut

A3Bl 10 tons + Sole Maize

A3B2 10 tons + Sole Groundnut

A3B3 10 tons + Maize/Groundnut

3.2. LAND PREPARATION

The field area is 27m by 16m = 432m^2

The land cleared manually using matchet stumped and trash packed using rakes. Poultry manure was applied to each plot except the control (0 manure).

3.3 PLANTING MATERIALS

The maize variety (Oba Super II) used in this study is hybrid maize and good species of groundnut was bought from National Seed Council UmudikeUmuahia.

Planting of Maize and groundnut was done on ridges after land preparationMaize was sown four seeds per hole at a spacing of 1m X 1m while groundnut was sown 45cm X 45cm, 4 seeds per hole. The maize & groundnut were thinned down to 3 seedlings per hole.

WEED CONTROL: Weeding was carried out manually using hoe at 4, 8 and 12 weeks after planting.

HARVESTING: Maize was harvested when the leaves turned brown; fresh cobs were de-husked and weighed. Cobs were sundried to a moisture content of 12 then shelled. The grain yield was weighed. The groundnut seed yield was 'also weighed and recorded per treatment.

3.3.1 The procedure by which maize data was collected

The leaf area of maize at 4,8,12 WAP calculated by measuring the length and breath of selected maize plant in a plot. The product is the leaf area.

Leaf area = Lamina length X maximum with X K

Where K is the coefficient to be derived which is (0.75)

Number of leaves – this was determined by visual counting of leaves of selected plants per plot at 4,8,12 WAP

Maize stem girth – The measurement was taken 10cm from the ground. Maize stem girth was calculated by measuring the largest part of the stem of selected plants using tailor tape at 4,8,12 WAP

Plant Height – This was done by measuring the height of selected plants per plot at ground level to the top of the highest leaves or apical leaves at 4,8,12 WAP

Maize fresh cob – The maize fresh cob of selected plants were de-husked weighed and recorded per plot at harvest

Maize dry grain yield – The selected maize plant cobs were collected from each plot de-husked, sun dried to a moisture content of 12% weighed and recorded per treatment.

3.3.2 The procedure by which groundnut data was collected

Leaf area – The leaf area of selected groundnut plants per plot was calculated by measuring the length and Width of the selected groundnut plants then product is the leaf Area. Leaf Area = Lamina length X Maximum Width X K (where K is a coefficient to be derived)

Number of leaves – This was determined by visual counting of the leaves of the plants per plot at 4,8,12 WAP

Number of Branches – by visual counting of the branches of selected plants per plot at 4,8,12 WAP

Plant Height – This was done by measuring the selected plants height per plot from the ground level to the top of the highest leaves or apical leaves at 4,8,12 WAP

Groundnut Grain yield – The selected groundnut plants was harvested per plot, then weighed and recorded.

Data Analysis: All data collected were statistically analysed using analysis of variance (Anova). While means separation was carried out using the least significant difference at 5% level of significance

Table 1 below shows the pre planting soil physical and chemical analysis. The result shows tha

t soil pH (4.5) was low showing high acidity, while organic matter contents and carbon recorded 2.51 and 1.46 respectively. Nitrogen content was 0.15 while the exchangeable cat anions such as Magnesium, Calcium, Potassium and Sodium were all in very low concentrations.

TABLE 1: Pre Planting Soil Physical and Chemical Analysis

Item	**Soil Depth (0-15) cm**
pH in water	4.50
pH in Kcl	4.88
Carbon	1.461
Organic Matter	2.51
Total Nitrogen (%)	0.15
Available Phosphate (cmol/g)	2.40
Calcium l00g (cmol/g)	0.40
Magnesium/ 100 (cmol/g)	0.16
Sodium/ 100g (cmol/ g)	0.48
Potassium/l00g (Cl110l/ g)	0.65
AluminumllOOg (cmol/g)	0.50
Hydrogen/lOOg (cmol/g)	1.47
Exchangeable Bases (cmol/g)	5.65
% Base Saturation	27
% Clay	15
% Silt	5
% Sand	80
Textural Class	**Sandy Loam**

THE POSTHARVEST SOIL CHEMICAL AND PHYSICAL ANALYSIS WAS CARRIED OUT AFTER HARVEST

Table 2 Effects of cropping system and poultry manure on soil physic-chemical properties

Treatments	pH (H_2O)	OC (%)	OM (%)	TN (%)	AvP (ppm)	TEA	Ca	Mg ($Cmolkg^{-1}$)	K	Na	Sand (%)	Silt (%)	Clay (%)	TC
A1B1	5.62	1.536	2.648	0.144	11.24	0.82	1.50	0.67	0.192	0.210	92.72	5.56	1.72	S
A1B2	5.82	1.177	2.029	0.126	9.80	1.20	1.40	0.42	0.143	0.159	90.72	7.56	1.72	S
A1B3	5.69	1.097	1.892	0.113	12.8	0.88	1.15	0.42	0.224	0.276	92.72	3.56	3.72	S
A2B1	6.00	1.137	1.96	0.116	10.30	0.75	1.30	0.84	0.125	0.141	93.72	3.52	2.76	S
A2B2	5.65	0.998	1.72	0.108	15.00	0.50	1.20	0.53	0.26	0.315	93.72	3.56	2.72	S
A2B3	5.42	0.938	1.617	0.092	13.40	1.44	2.00	1.50	0.157	0.228	93.72	3.56	2.72	S
A3B1	5.74	1.297	2.236	0.129	15.20	1.41	1.55	0.62	0.155	0.186	91.72	6.56	1.72	S
A3B2	5.68	0.878	1.513	0.089	14.60	0.54	1.32	0.47	0.149	0.175	93.72	3.56	3.72	S
A3B3	5.56	1.436	2.476	0.137	16.72	0.35	2.80	1.70	0.288	0.272	91.72	6.56	1.72	S
LSD (0.05) X	**1.971**	**0.417**	**0.708**	**0.039**	**4.336**	**0.335**	**0.571**	**0.379**	**0.031**	**0.070**	**0.726**	**0.738**	**0.405**	
LSD (0.05) Y	**1.481**	**0.314**	**0.507**	**0.049**	**5.235**	**0.439**	**0.463**	**0.459**	**0.042**	**0.058**	**0.624**	**0.816**	**0.502**	
LSD (0.05) X*Y	**3.414**	**0.723**	**1.226**	**0.069**	**7.51**	**0.582**	**0.988**	**0.658**	**0.053**	**0.121**	**1.257**	**1.278**	**0.701**	

Key: OC=organic carbon, OM= organic matter, TN=total nitrogen, TEA= total exchangeable acidity, TC=textural class, A1B1=zero manure+sole maize, A1B2= zero manure+sole groundnut, A1B3= zero manure+maize/groundnut, A2B1=5tons+sole maize, A2B2=5tons+sole groundnut, A2B3=5tons+maize/groundnut, A3B1=10tons+ sole maize, A3B2=10tons+ sole groundnut, A3B3=10tons+ maize/groundnut, X=cropping system, Y= manure rates, X*Y= interaction between cropping system and manure rates.

CHAPTER FOUR

4.1 RESULTS

A. Maize Leaf Area (Cm2)

The maize leaf area was measured which is one of the parameters under study. It was observed that maize/groundnut intercrop showed significant improvement in the first month when 10/tons of manure was applied which is 54.30cm2 leaf area and when 0 manure was added to the plant, the maize leaf area had leaf area of 45.30cm2. The co-efficient of variation (CV) continued to increase from 10.4 in the first month and 50.4 in second month and then decrease in the third month to 34.0 (Table 3a-3c)

Table 3a: Effects of cropping system and poultry manure on maize leaf area (cm^2) per plant at 4WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	45.30	46.10	54.30	115.23
Sole Maize	69.50	40.80	35.30	81.87
Mean	57.40	43.45	44.80	
LSD (0.05) for cropping system		10.77		
LSD (0.05) for poultry manure		13.90		
LSD (0.05) for cropping system & poultry manure		18.65		
CV%		10.40		

Table 3b: Effects of cropping system and poultry manure on maize leaf area (cm^2) per plant at 8WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	38.70	53.00	68.00	53.20
Sole Maize	38.30	38.50	47.10	43.27
Mean	38.50	45.55	57.55	
LSD (0.05) for cropping system		255.30		
LSD (0.05) for poultry manure		312.70		
LSD (0.05) for cropping system & poultry manure		442.20		
CV%		50.40		

Table 3c: Effects of cropping system and poultry manure on maize leaf area (cm^2) per plant at 12WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	80.60	67.10	72.30	74.00
Sole Maize	60.30	60.10	83.07	67.47
Mean	70.45	63.60	77.05	
LSD (0.05) for cropping system		252.50		
LSD (0.05) for poultry manure		309.30		
LSD (0.05) for cropping system & poultry manure		437.40		
CV%		34.00		

B. Maize Number of Leaves

In the maize/groundnut, the maize number of leaves continued to increase, with increase in the poultry manure application. At the first month it was 8.00 in number, then in the second month 17.00 in number, then in the third month, it increased to 20.67 in number. While when no manure was added, the number was 6.33 in the first month, 11.33 in the second month then 16.00 in the third month. The was significant increase when 10tons of poultry manure was added (Table 4a-4c)

Table 4a: Effects of cropping system and poultry on number of leaves per plant of maize at 4WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	6.33	8.00	8.00	7.44
Sole Maize	6.00	6.00	7.33	6.44
Mean	6.17	7.00	7.67	
LSD (0.05) for cropping system		1.92		
LSD (0.05) for poultry manure		1.46		
LSD (0.05) for cropping system & poultry manure		2.07		
CV%		16.30		

Table 4b: Effects of cropping system and poultry on number of leaves per plant of maize at 8WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	11.33	13.00	17.00	13.78
Sole Maize	11.00	12.00	15.00	12.67
Mean	11.17	12.50	16.00	
LSD (0.05) for cropping system		1.01		
LSD (0.05) for poultry manure		1.24		
LSD (0.05) for cropping system & poultry manure		1.75		
CV%		7.30		

Table 4c: Effects of cropping system and poultry on number of leaves per plant of maize at 12WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	16.00	17.33	20.67	18.00
Sole Maize	15.00	16.33	15.00	16.44
Mean	15.50	16.83	19.00	
LSD (0.05) for cropping system		0.87		
LSD (0.05) for poultry manure		1.09		
LSD (0.05) for cropping system & poultry manure		1.55		
CV%		4.90		

C. Maize stem Girth (CM)

The maize/groundnut intercrop showed significant improvement in stem girth from the first month to the third month, when 10 ton,s of manure was applied. Thus in the first month it was 3.63cm, in the second month 7.55cm, and 8.33cm in the third month respectively compared with when no manure was added, the result was 3.03cm in the first month, 6.03cm in the second month and 7. 73cm in the third month. (Table 5a-5c)

Table 5a: Effects of cropping system and poultry manure on maize girth (mm) at WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	3.03	4.17	3.63	3.61
Sole Maize	3.60	3.60	3.69	3.63
Mean	3.32	3.80	3.66	
LSD (0.05) for cropping system		0.63		
LSD (0.05) for poultry manure		0.78		
LSD (0.05) for cropping system & poultry manure		1.10		
CV%		16.60		

Table 5b: Effects of cropping system and poultry manure on maize girth (mm) at 8WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	6.03	7.13	7.55	6.90
Sole Maize	5.3	6.90	7.73	6.72
Mean	5.78	7.02	7.64	
LSD (0.05) for cropping system		0.76		
LSD (0.05) for poultry manure		0.94		
LSD (0.05) for cropping system & poultry manure		1.32		
CV%		10.70		

Table 5c: Effects of cropping system and poultry manure on maize girth (mm) at 12WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	7.73	9.27	8.83	8.51
Sole Maize	7.87	9.07	9.37	8.77
Mean	7.65	9.17	9.10	
LSD (0.05) for cropping system		0.76		
LSD (0.05) for poultry manure		0.93		
LSD (0.05) for cropping system & poultry manure		1.32		
CV%		8.40		

D. Maize height (CM)

In the maize/groundnut intercrop significant increase, was observed in height which was highest when 10tons of poultry manure was used. Thus 43.53 cm, 53.50cm, 157.30 in the first, second and third month respectively compared with when no manure was added, the result was 37.7 cm in the first month, 51.1 Ocm in the second month, and 146.40cm in the third month (Table 6a-6c).

Table 6a. Effect of cropping system and poultry manure on maize plant height cm at 4WAP

Cropping system	0tons/ha-1	5tons/ha-1	10tons/ha-	**Mean**
Maize/groundnut	37.70	43.17	43.34	1.26
Sole Maize	39.17	45.40	36.47	40.35
Mean	38.17	44.26	40.00	
LSD (0.05) for cropping system		4.06		
LSD (0.05) for poultry manure		4.97		
LSD (0.05) for cropping system & Poultry manure		7.03		
CV%		9.50		

Table 6b. Effect of cropping system and poultry manure on maize plant height cm at 8WAP

Cropping system	0tons/ha-1	5tons/ha-1	10tons/ha-	**Means**
Maize/groundnut	51.10	58.30	53.50	54.30
Sole Maize	49.20	56.70	57.80	54.57
Mean	50.15	57.50	55.65	
LSD (0.05) for cropping system		5.80		
LSD (0.05) for poultry manure		7.11		
LSD (0.05) for cropping system & Poultry manure	10.05			
CV%		10.20		

Table 6C. Effect of cropping system and poultry manure on maize plant height cm at 12WAP

Cropping system	0tons/ha-1	5tons/ha-1	10tons/ha-	**Means**
Maize/groundnut	146.10	49.50	157.30	151.07
Sole Maize	142.20	147.10	148.80	145.77
Mean	144.15	148.50	52.75	
LSD (0.05) for cropping system		0.38		
LSD (0.05) for poultry manure1		2.72		
LSD (0.05) for cropping system & Poultry manure		17.98		
CV%		6.70		

E. Maize Fresh Cob Yield (tha^{-1})

In the maize intercrop the cob yield was 1.83 tons/ha when no manure was added, 3.37 tons/ha when 5tons of manure was added, 4.68 tons/ha when 10tons of manure was added which is better than the monocrop of maize which gave 1.50 tons/ha when no manure was added, 2.78 when 5tons of manure was added, 4.55 tons/ha when 10tons manure was added, As shown in (Table 7).

Table 7: Effect of cropping system and poultry manure on fresh maize cob yield

cropping system	Poultry Manure Level			
	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	**Mean**
Maize/Groundnut	1.83	3.37	4.68	3.25
Sole Maize	1.50	2.78	4.55	2.95
Mean	1.67	3.07	4.61	
LSD (0.05) for cropping system		0.38		
LSD (0.05) for poultry Manure		0.46		
LSD (0.05) for cropping system & Poultry manure		0.65		
CV%		11.5		

F. Maize Dry Grain Yield (Tons/ha)

In maize/ groundnut intercrop when no manure was added was 1.35 tons/ha when 5tons of manure was added, the yield was 2.19 tons/ha but when 10 tons of manure was added, there was a significant increase in the yield which is 3.39 tons/ha. This is better than the yield in maize monocrop which gave 0.99 tons/ha when no manure was added, 1.81 tons/ha when 5tons was added and 3.64 tons/ha when 10 tons was added (Table 8).

Table 8: Effect of cropping system on maize dry grain yield (Tons/ha^{-1})

cropping system	Poultry Manure Level (Tons/ha^{-1})			
	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	**Mean**
Maize/Groundnut	1.35	2.19	3.39	2.31
Sole Maize	0.99	1.81	3.64	2.15
Mean	1.17	2.00	3.52	
LSD (0.05) for cropping system		0.29		
LSD (0.05) for poultry Manure		0.35		
LSD (0.05) for cropping system & Poultry manure		6.50		
CV%		12.3		

RESULTS

A. Groundnut Leaf Area

The maize/groundnut intercropping and the sole groundnut performed very well with the mean of $2.88cm^2$, $3.53cm^2$ in the first month $14.27cm^2$, $16.27cm^2$ in the second month, Mean of $15.59cm^2$ and $18.53cm^2$ in the third month and the results were significant (Table 9a-9c).

Table 9a: Effects of cropping system and poultry manure on the leaf area of groundnut at WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	1.92	3.16	3.57	3.88
Sole Groundnut	2.69	4.16	3.75	3.53
Mean	2.31	3.66	3.66	
LSD (0.05) for cropping system		0.19		
LSD (0.05) for poultry manure		0.23		
LSD (0.05) for cropping system & poultry manure		0.32		
CV%		17.40		

Table 9b: Effects of cropping system and poultry manure on the leaf area of groundnut at WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	13.21	13.35	16.25	14.27
Sole Groundnut	10.41	18.41	20	16.27
Mean	11.81	15.88	18.13	
LSD (0.05) for cropping system		2.69		
LSD (0.05) for poultry manure		3.29		
LSD (0.05) for cropping system & poultry manure		3.29		
CV%		16.70		

Table 9c: Effects of cropping system and poultry manure on the leaf area of groundnut at WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	15.14	14.55	17.09	15.59
Sole Groundnut	14.00	19.58	22.02	18.53
Mean	14.57	17.07	19.56	
LSD (0.05) for cropping system		2.52		
LSD (0.05) for poultry manure		3.08		
LSD (0.05) for cropping system & poultry manure		4.36		
CV%		14.00		

B. Groundnut Number of Branches

The maize/groundnut produced more branches and more leaves. When 10tons of poultry manure was added it gave 7 number of branches in the first month 15 number of branches in the second month and 36 number of branches in the third month. This was significantly better than when zero manure was added in the first month which have 5.67 branches, in the second month 13.30 branches and in the third month 33.30 branches. (Table 10).

Table 10a: Effects of cropping system and poultry manure on the number of branches plant of groundnut at 4WAP poultry manure level (tha^{-1})

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	5.67	8.67	7.00	7.11
Sole Maize	6.33	7.33	7.33	7.00
Mean	6.00	8.00	7.17	
LSD (0.05) for cropping system		2.35		
LSD (0.05) for poultry manure		5.67		
LSD (0.05) for cropping system & poultry manure		4.06		
CV%		31.70		

Table 10b: Effects of cropping system and poultry manure on the number of branches plant of groundnut at 4WAP poultry manure level (tha^{-1})

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	13.30	17.70	15.00	15.33
Sole Maize	10.70	21.30	15.30	15.77
Mean	12.00	19.50	15.15	
LSD (0.05) for cropping system		5.00		
LSD (0.05) for poultry manure		6.12		
LSD (0.05) for cropping system & poultry manure		8.66		
CV%		30.60		

Table 10c: Effects of cropping system and poultry manure on the number of branches plant of groundnut at 4WAP poultry manure level (tha^{-1})

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	33.30	35.70	36.00	35.00
Sole Maize	33.30	38.30	36.00	35.87
Mean	33.30	37.00	36.00	
LSD (0.05) for cropping system		5.70		
LSD (0.05) for poultry manure		6.98		
LSD (0.05) for cropping system & poultry manure		9.87		
CV%		15.30		

C. Groundnut Number of Leaves

Maize/groundnut gave higher number of leaves compared with the monoculture thus it produced 247 number of leaves in the first month, 462 number of leaves second month and 1,061 in the third month, when 10 tons of manure was added. This was significantly better than when no manure was added the result was 94 number of leaf in the first month, 500 number in the second month and 640 number of leaves in the third month. (Table 11a-11c).

Table 11a: Effects of cropping system and poultry manure on the number of leaves per plant of groundnut at 4WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	94.00	252.00	247.00	197.67
Sole Maize	216.00	273.00	166.00	218.33
Mean	155.00	262.50	206.50	
LSD (0.05) for cropping system		85.40		
LSD (0.05) for poultry manure		104.50		
LSD (0.05) for cropping system & poultry manure		147.81		
CV%		39.00		

Table 11b: Effects of cropping system and poultry manure on the number of leaves per plant of groundnut at 4WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	500.00	759.00	492.00	583.67
Sole Maize	532.00	782.00	718.00	677.33
Mean	516.00	770.50	605.00	
LSD (0.05) for cropping system		199.50		
LSD (0.05) for poultry manure		244.31		
LSD (0.05) for cropping system & poultry manure		345.50		
CV%		30.10		

Table 11c: Effects of cropping system and poultry manure on the number of leaves per plant of groundnut at 4WAP

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	640.00	907.00	1061.00	869.33
Sole Maize	769.00	929.00	820.00	839.33
Mean	704.50	918.00	940.50	
LSD (0.05) for cropping system		243.72		
LSD (0.05) for poultry manure		298.72		
LSD (0.05) for cropping system & poultry manure		422.01		
CV%		27.10		

D. Groundnut plant Stand Height

The result obtained from the experiment showed that maize/groundnut intercrop showed significant increase in plant height. When 10 tons of poultry was used the plant height in the first month was 17cm, 31 in the second month, and 37.2 in the third month, but when no manure was added it showed significant difference in height which 10.73 I the first month 20cm in the second month 29.3cm in third month. (Table 12a-12c)

Table 12a: Effects of cropping system and poultry manure on plant stand height of groundnut (cm)

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	10.73	16.73	17.00	14.82
Sole Maize	10.33	17.20	15.10	14.21
Mean	10.53	16.97	16.05	
LSD (0.05) for cropping system		2.98		
LSD (0.05) for poultry manure		3.65		
LSD (0.05) for cropping system & poultry manure		5.16		
CV%		19.50		

Table 12b: Effects of cropping system and poultry manure on plant stand Height of groundnut (cm)

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	20.00	2960	31.70	27.10
Sole Maize	21.50	30.80	27.80	26.70
Mean	20.75	30.20	29.75	
LSD (0.05) for cropping system		5.09		
LSD (0.05) for poultry manure		6.24		
LSD (0.05) for cropping system & poultry manure		8.82		
CV%		18.00		

Table 12c: Effects of cropping system and poultry manure on plant stand height of groundnut (cm)

Cropping system	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	Mean
Maize/Groundnut	29.30	34.50	37.20	33.67
Sole Maize	29.50	38.10	33.80	33.80
Mean	29.40	36.30	35.00	
LSD (0.05) for cropping system		7.70		
LSD (0.05) for poultry manure		9.44		
LSD (0.05) for cropping system & poultry manure		13.34		
CV%		21.70		

E. Groundnut Grain Yield (Tons/ha)

The maize/groundnut gave higher yield with mean of 2.34 campared with sole groundnut which is 2.15. This suggests that intercropping gives a greater yield over monoculture thus there was a significant effect in the maize/groundnut yield. (Table 13).

Table 13: Effect of cropping system and poultry manure on grain yield of groundnut (Tons/ha^{-1})

cropping system	Poultry Manure Level (Tons/ha^{-1})			
	0tons/ha^{-1}	5tons/ha^{-1}	10tons/ha^{-1}	**Mean**
Maize/Groundnut	1.33	2.87	2.83	2.34
Sole Groundnut	1.02	2.76	12.36	2.15
Mean	1.18	2.52	3.19	
LSD (0.05) for cropping system		0.19		
LSD (0.05) for poultry Manure		0.23		
LSD (0.05) for cropping system &				
Poultry manure		0.32		
CV%		7.8		

F. Productivity of intercropping system

The treatment with five tons poultry manure in maize and groundnut intercrop had the highest land equipment ratio of 2.03

(Table 14) this shows that the crop mixture has more than 100% yield advantage over its s0le crop yield. This is closely followed by the zero manure treatment with a land equipment ratio of 1.97. Table 14.

Table 14: Assessment of productivity of the intercropping system using land equipment ratio (LER)

Cropping system + poultry manure	sole maize	Maize + g/nu	sole g/nut	g/nut + maize	land equipment ratio LER
0 manure + sole maize					
0 manure + sole g/nut					
0 manure + maize + g/nut	2.01	1.34	1.01	1.33	1.97
5 manure + sole maize					
5 tons manure + sole g/nut					
5 tons manure + maize + g/nut	1.80	2.18	2.76	2.27	2.03
10 tons manure + sole maize					
10 tons manure + sole g/nut					
10 tons manure + maize + g/nut	3.64	3.39	3.55	2.82	1.72

G. Relative yield

In the maize/groundnut intercrop, when no manure was added the relative yield of maize was 1.35%, the relative yield of groundnut monocrop was 1.31% and relative yield total was 2.66%, when 10 tons of manure added, the relative of maize was 0.92%, the relative yield of groundnut was 0.79% and relative yield total was 1.71% (Table 15).

Table 15: Relative yield (RY) for evaluation of maize + groundnut intercropping effectiveness

Cropping system + poultry manure	maize relative Yield (RY)	groundnut relative yield (RY)	Relative yield total RYT
0 manure + sole maize			
0 manure + sole g/nut			
0 manure + maize + g/nut	1.35	1.31	2.66
5 manure + sole maize			
5 tons manure + sole g/nut			
5 tons manure + maize + g/nut	1.21	0.82	2.03
10 tons manure + sole maize			
10 tons manure + sole g/nut			
10 tons manure + maize + g/nut	0.92	0.79	1.71

4.2 DISCUSSION

The pre-planting soil physical and chemical analysis showed that soil is acidic (4.5), low in organic matter (2.51), low in nitrogen content (0.15)' and exchangeable cations. This means that the soil nutrient status is poor. This low nutritional status implies that for effective and good yield of arable crops external sources of nutrient supply need to be added to boast crop yields.

Based on the maize growth parameter there was an increased maize stand height in response to increasing rate of poultry manure application. The increase height stand of maize could be attributed to the high nutrient extraction capacity of maize in mixture as well as due to the interspecific competition between maize and groundnut. The reduced stand height in the zero manure treatment for both maize and groundnut is an evidence that poultry manure supplies nutrients needed for crop growth. Groundnut stand height was improved with increased rate of manure applications. The increased number of leaves observed in the groundnut at the various periods shows that groundnut as a legume has the ability of fixing nitrogen by its rhizobia which increases nitrate release and this was significantly affected by poultry manure rate of application.

This implies that poultry manure is rich in nitrogen which may have boosted leaf expansion or surface area in both maize and groundnut. The superiority of poultry manure over other organic manures has been confirmed (Rugar and Palled (2008a). The increased yield response of both maize and groundnut especially to the poultry manure rate of lOtons/ha is good evidence that poultry manure is highly nutritious and could boost crop yield. This agrees with earlier work of Fininsa (1996) and Fisher (1977) who reported that poultry manure is a very rich animal manure. Based on the post-harvest soil physical analysis there was an increase in the soil pH indicating that was increasing rate of poultry manure application. The mechanism responsible for the neutralization of acidity has been proposed by several workers who severally reported that the increase in soil pH is as a result of ion exchange reactions in which terminal hydroxyl ions of A13+, Fe++ are replaced by organic anion which are decomposition products of the manure such as malate, atrate and tartrate. Also suggested that the ability of organic manure to increase soil PH was due to the presence of basic cations contained in the organic manure.

Finally maize and groundnut yields were not adversely affected either by interspecific competition due to nature and manner of nutrient uptake, rooting systems or canopy architecture. These qualities makes them highly compatible for intercropping and ensures better utilization of environmental factors such as high interception, nutrient uptake and increased resources, use efficiency. This observation is in agreement with work by *Azam et al*., (1990) who reported that increased resources use efficiency can increase resources capture due to longer combined leaf area.

This experiment has provided a landmark for greater production of maize and groundnut interest using a locally available affordable and environmentally friendly nutrient sources such as poultry manure for use by our farmers.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

A field experiment was set up at the Federal University of Technology Teaching and Research Farm Owerri between June-August, 2017 to determine the productivity of sole and intercropped maize with groundnut using 3 rates of poultry manure in Owerri. The experiment was carried out using a 3x3 factorial in Randomized Complete Block Design. The experiment consisted of 3 rates of poultry manure namely 0, 5, 10 tons/ha respectively and three cropping systems namely; sole maize, sole groundnut, groundnut/maize.

Maize and groundnut was planted after land preparation. Maize was planted at 1m X 45cm while groundnut was planted 45cm X 45cm at inter row spacing arrangement with maize.

Data on various crop growth and yield parameters for maize and groundnut were measured and statistically analyzed using analysis of results indicated that poultry manure influenced the growth of maize and groundnut.

The poultry manure rate of 10tons/ha gave the highest maize grain yield of 4.68 tons/ha and groundnut 2.83 tons/ha and thus is hereby strongly recommended. The soil residual nutrient status was equally sustained and improved at the various rates of poultry manure rate of application. Maize and groundnut can be produced effectively using poultry manure which comfortably replaces inorganic fertilizer that is costly and causes soil acidity and results in soil microbiological degradation.

5.2 RECOMMENDATIONS

Based on the results of the experiment, I strongly recommend the application of 10tons/ha^{-1} of poultry manure to increase the yield of maize/groundnut intercrop, as well as boasting the post-harvest nutrient status of the soil.

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