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

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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 consists 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 with a corresponding low yield of fresh cob of 1.50 and 0.99 ton/ha as recorded in the zero manure treatment. 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 physical and chemical analysis showed that substantial amount of magnesium increased which indicate that in the pre-planting chemical and physical analysis 0.16 of Magnesium was available, then in the post soil chemical and physical analysis it was 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 pre-planting soil physical and chemical analysis was 0.15 and in the post harvest soil chemical and physical analysis it was 0.144 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.

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, minimizes the risk, 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 and the region. (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 word wide. Maize is reorganized as a component crop in most intercropping. In this study, the work carried out by various researches in maize based intercropping are discussed. 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 his 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).
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 because of these problems organic manure is a better alternative.

MATERIALS AND METHOD
LOCATION
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 $7^{0}2^{1}E^{0}$.

EXPERIMENTAL DESIGN AND TREATMENT.

The experimental design used is 3 by 3 factorial in Randomized Complete Block Design (RCBD) the treatment include three levels of poultry manure namely: 0, 5, and 10tons/ha as well as three cropping system viz: sole groundnut and groundnut/maize intercrop respectively.

LAND PREPARATION

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

PLANTING MATERIALS

The maize variety (Oba Super II) used in this study is hybrid maize and good specie 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 grain yield was 'also weighed and recorded per treatment.

DISCUSSION

POULTRYMANURE

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.

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. In 1986, a master's thesis study in the Philippines compared the effects of using various fertilizers to enhance milkfish production in brackish water ponds. 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. The study concluded that the use of cow manure only as a fertilizer fared best, and the use of chicken manure only as a fertilizer fared second best.

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

DISCUSSION

Maize fresh cob yield (tha^{-1})

The pre-planting soil physical soil physical and chemical analysis shows 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. Such competition for height causes maize to grow taller which is consistent with work done by Akande (2007) who reported that maize in mixture tend to grow taller to compete for sunlight needed for its photosynthetic activities. 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.

In the maize intercrop the cob yield was 1.83 tons/ha in the first month, 3.37 tons/ha in the second month, 4.55 tons/ha in the third which is better than the monocrop of maize which gave 1.50 tons/ha in the first month, 2.78 in the second month, 4.68 tons/ha in the third month when zero manure was added, As shown in Table 2.

Table 2: 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		

Groundnut Grain Yield (Tons/ha)

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 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 superity of poultry manure over other organic manures has been confirmed (Hugar and Palled (2008).

The increased yield response of both maize and groundnut especially to the Poultry manure rate of 10tons/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 very rich animal manure. Poultry manure, well cured, is known to have the highest nitrogen content of about 4.5 as well as faster release of resources Ahmads (1982).

Based on the post-harvest soil physical analysis there was an increase in the soil pH indicating that acidity is decreasing with increasing rate of poultry manure application.

Table 3 showed that maize/groundnut gave a higher yield with mean of 2.34 compared with the sole groundnut which is 2.15. This shows that intercropping gives a greater yield over monoculture. (Table 3)

Table 3: 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 Maize	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		

Assessment of Yield Advantages

The biological efficiency of intercropping is determined by comparing 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 CRYT) , competition ratio (CR) competition index (Cl) and aggressively CA). 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. The LER is usually applied to combine intercrop yields but can be applied also to the intercrop yield of each crop component.

Table 4: Assessment of profitability 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

Relative yield

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 (Dew it and Vanden Bengh 1963). 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

Qa = yield of crop A in mixture

rb = relative yield of crop B

Ma = yield of crop A in monoculture

Qb = Yield of crop B in mixture

Mb = Yield of crop B in monoculture

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.

Table 5 shows that in maize/groundnut intercrop, when no manure was added the relative yield of maize was 1.35), the relative yield of groundnut monocrop was 1.3 1 and the relative yield total was 2.66 but when 10 tons of manure added, the relative yield of maize was 0.920/0, the relative yield of groundnut was 0.79 and relative yield total was 1.71%.

Table 5: 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

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

Table 6 : Effects of cropping system and poultry manure on soil physic-chemical properties

Treatments	pH (H_20)	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	1.5	0.67	0.192	0.21	92.72	5.56	1.72	S
A1B2	5.82	1.177	2.029	0.126	9.8	1.2	1.4	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	1.137	1.96	0.116	10.3	0.75	1.3	0.84	0.125	0.141	93.72	3.52	2.76	S
A2B2	5.65	0.998	1.72	0.108	15	0.5	1.2	0.53	0.26	0.315	93.72	3.56	2.72	S
A2B3	5.42	0.938	1.617	0.092	13.4	1.44	2	1.5	0.157	0.228	93.72	3.56	2.72	S
A3B1	5.74	1.297	2.236	0.129	15.2	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	14.6	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	2.8	1.7	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.

The result from the post-harvest soil physical and chemical analysis showed that substantial amount of magnesium increased which indicate that in the pre-planting chemical and physical analysis 0.16 of Magnesium was available, then in the post soil chemical and physical analysis it was observed to have increased to 0.67 then calcium in the pre-planting 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 pre-planting soil physical and chemical analysis was 0.15 and in the post harvest soil chemical and physical analysis it was 0.144 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.

Based on the post harvest soil physical analysis there was an increase in the soil pH indicating that acidity is decreasing with 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.

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 various-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.

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