Cassava Production Systems Improved With Groundnut And Poultry Manure.

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Abstract: Cassava is predominantly grown as an intercrop with maize with little or no fertilizer resulting in rapid decline in soil fertility and crop yields. High yields to feed the growing cassava processing industry could be sustained through the introduction of groundnut and poultry manure. The study was conducted at Ohaji, Imo State, Nigeria, to develop a stable and high productive cassava/maize/groundnut system with an optimum rate of poultry manure for high cassava for high cassava root yields. A split-plot treatment arrangement fitted in a randomized complete block design with 3 replications was used. Time of planting groundnut (same time maize planting and after maize harvest) formed the main plot, rates of poultry manure (0,5,10 t ha^{-1}) formed the sub plots and number of rows of groundnut (1,2,3 rows) constitute the sub-sub-plot. Productivity of all the intercrops was high (land equivalent ration of 1.11 – 1.88) with high maximum cassava yield (56.4 – 69 t ha^{-1}). Productivity of all the intercrops was high (land equivalent ration of 1.11 -1.88) with high maximum cassava yield (56.4 – 69 t ha^{-1}) and stability in a system when groundnut is planted in 2 or 3 rows between 2 rows of cassava (1 x 1m) after maize harvest with 10 t ha^{-1} of poultry manure application. Thus a cassava/maize/groundnut being planted at 62,500 and 111,111 stands t ha^{-1}, after maize harvest is recommended for high cassava component yield. [Report and Opinion. 2009;1(4):26-31]. (ISSN: 1553-9873).

Key words: Cassava, Production, System, Groundnut, Poult, Manure

1. INTRODUCTION

Cassava (*manihot esculentus)* is among the major staple food crops in developing countries. It is an excellent source of carbohydrate (Willey, 1979). It is processed in households mainly into “garri” (fermented and roasted flour), “fufu” (fermented cassava root) and cassava flour for human consumption. A recent major government policy is the production of cassava by small scale farmers for processing into industrial starch. This calls for development of cassava production system that gives high yield, high productivity, sustainable and profitable production of the raw roots of cassava to feed the processing industry.

In Nigerian farming system, cassava is predominantly grown as intercrops with maize (*Zea mays)* usually with little or no fertilizers (Ikereogu *et al* 1989). This, coupled with annual slash and burn results in rapid decline in crop yield and a fast rate of shifting cultivation. Originally fields are cropped for 2-5 years and left under natural fallow to regain fertility. With increasing population pressure, fallow periods are shorter than needed to regain fertility as more continuous cropping is norm in Nigeria.

The development of productive cassava-based cropping system that ensure high cassava yield is of paramount importance. One approach is to exploit the biological nitrogen fixing (BNF) capacity of leguminous crops by using maize and groundnut (*Arachis hypogeae)* rotation and poultry manure in a maize/cassava intercropping system. Estimate of the amount of nitrogen fixed by cowpea (73-354 kgn/la), pigeon pea (168-208 kg N la-1), Bambara (40-65 kg N ha-1) etc had been reported by Norman (1976).

It has been observed that most of the cassava farmers spread house hold refuse or poultry manure in their farms as an alternative fertilizer since chemical fertilizer is no more available to them as a result of its exorbitant price. Unfortunately, some of them obtain low yield from cassava because little information is available as the best combination of minor crops, manures and planting pattern of these crops which vary in their combination involving roots cereals, legumes and vegetables, (Willey, 1979).

The objective of this study was to develop agronomic practices that will ensure stable and highly productive cassava/maize/groundnut intercropping system with high cassava yields.

2. MATERIALS AND METHOD

The study was carried out at the Imo State Polytechnic, Imo State, Nigeria, during the 2007 and 2008 cropping seasons respectively. The climate of the area is a humid

tropical type characterized by wet and dry seasons. The mean annual rainfall is about 2500mm and is bimodal with peaks in July and September (Nwosu, 1981).

The minimum and maximum temperatures are 20^0c and 32^0c respectively. The area has rainforest vegetation and the soil is characterized by deep porous red soils derived from sandy deposits in the coastal plane which are highly weathered, low in mineral and natural fertility, hence farmers in the area practice bush fallowing as a means of improving soil fertility (Ononiwu, 1990). Data on the soil before planting commenced is shown in table 1.

The cassava (*Manihot esculentus)* variety (TMS419) used for the trial is an improved IITA cultivar. The variety is very high yielding early maturing sweet cassava, low in HCN content (3.3 mg/100g), branching pattern is sparse and has about 44.4% dry matter content and is resistant to Cassava Mosaic Virus (CMV), Cassava Bacterial Blight (CBB) and Cassava Mealybug.

Experimental Design

A 2x3x3 split-plot treatment arrangement fitted into Randomized Complete Block Design (RCBD) with 3 replications was used in the trial. Main-plot was times of planting groundnut; planted at the same time with maize (PST) and planting after maize harvest (AMH). Sub-plot treatments were the 3 rates of poultry manure, 0, 5 and 10tha-1 while the sub-sub plots were number of rows of groundnut within 2 rows of cassava (1,2,3 rows). Thus a total of 18 plots was used in the trial. Each plot containing six rows of cassava measured 4x4m. In both seasons, cassava was planted in April and maize intercropped 2 weeks later. In some plots maize was planted at the same time with groundnut but in some, groundnut was planted after maize harvest. Planting spacing for maize was 0.9m x 0.9m giving a population of 12,346 stands/ha. Some plots contained 1 row of groundnut planted at the spacing of 0.5x0.5m, while some contained 2 rows of groundnut at the spacing of 0.3x0.3m giving populations of 20,000, 65,500 and 111,111 stands per hectare, respectively.

For 5 tha1 of poultry manure, a plot received 8kg whilke for 10 t ha1, a plot received 16kg. Based on the treatment randoimization scheme, already established, the various manure rates were spread uniformly on appropriate plots and then manually incorporated into the soil. Planting was done 4 days after manure application thereby allowing manure to set properly. Sole crop of each crop was included as a check. Varieties used were the Downy Mildew Resistant, Early Streak Resistant Yellow (60 days) maize and react or bunchy type groundnut. Weeding was done 2 times, 3 times after planting and during the harvesting of maize.

Statistical Analysis System (SAS) was used for data analysis, each parameter was subjected to analysis of variance and treatment means were separated using LSD. Land Equivalent Ratio (LER) defined asa the total land area required under sole cropping to yields obtained in the intercropping was used as an index of intercrop productivity.

3. RESULTS

The effects of poultry manure and variation in the number of rows of groundnut on root yield of cassava was significant ($p>0.05$) (Table 2). Application of poultry manure increased root yield of cassava, (Table 2). The yield of cassava stands given poultry manure was 54% higher than those that were not treated with poultry manure in 2007 and 60% in 2008. this marked difference in root yield with application of poultry manure was an indication that the poor state of the soil as evidenced in the preliminary soil analysis (Table 1) has been improved as indicated in the post-harvest soil physico-chemical analysis (Table 6). Hussein (1997) reported that poultry manure application increased soil ph, organic matter, available phosphorus, microbial activity in nutrient metabolism.

Table 1: Pre-planting soil physico-chemical properties at the face 0-15cm at the experimental site, 2007

Properties	Value
Sand (%)	80.0
Silt (%)	3.0
Clay (%)	12.0
Ph (H_2O)	4.5
Organic matter (%)	1.20
Total N (%)	0.09
Available P (ppm)	5.08

Exch. Cations (Cmol/kg)	
Ca^{2+}	0.81
Mg^{2+}	0.64
K^{+}	0.09
CEC	3.08
Base Saturation (%)	33.8

Table 2: Root yield of cassava as affected by phased planting of groundnut and poultry manure.

Poultry Manure Rate t/ha	**No. of of rows groundnut**	**Root yield tha^{-1} 2007**					
		GPWM	**GPAMH**	**X**	**GPWM**	**GPAMH**	**X**
0	1	12.7	14.4	13.6	10.8	15.6	13.2
0	2	15.6	18.4	17	14.8	19.3	17.1
0	3	18.6	20.7	19.7	18.6	21.4	20.0
5	1	20.5	28.6	24.6	21.2	26.4	23.8
5	2	23.6	34.5	29.6	26.7	34.7	30.7
5	3	23.8	36.8	30.3	24.3	37.3	30.8
10	1	23.4	26.7	25.1	28.7	36.9	32.8
10	2	25.6	34.7	30.2	42.6	56.4	49.5
10	3	23.8	36.6	30.2	43.8	69.5	56.7
0	0	-	-	8.5	-	-	8.8
SOLE CASSAVA							
0	-	-	-	8.6	-	-	8.8
5	-	-	-	27.3	-	-	27.8
10	-	-	-	28.9	-	-	36.4
Mean		24.3	32.7	-	25.7	35.3	
LSDP>0.05			3.052			3.633	

GPWM = Groundnut planted same time with maize

GPAMH = Groundnut planted after maize harvest

Significant Interaction PxRxT

P = Poultry manure

R = Rows of groundnut

T = Time of planting groundnut

Table 3: Grain yield of maize as affected by poultry manure and groundnut

Poultry Manure Rates t ha-1	Groundnut row arrangement	grain yield t ha-1 2007	2008
0	1	0.6	0.8
0	2	0.73	1.12
0	3	1.14	1.18
5	1	2.4	2.3
5	2	2.6	2.9

5	3	3.0	2.8
10	1	3.4	3.5
10	2	3.8	3.8
10	3	4.2	3.9
Sole Maize			
0	-	0.4	0.34
5	-	2.4	2.5
10	-	3.2	3.5
LSD P>0.05		1.083	

Table 4: Seed yield of groundnut in the Cassava/Maize/Groundnut mixture with poultry manure application poultry manure application poultry manure application.

Poultry Manure Rate t/ha	**No. of of rows groundnut**	**Root yield tha^{-1} MPWM**	**GPAMH**	**X**	**GPWM**	**GPAMH**	**X**
0	1	0.114	0.101	0.102	0.261	0.243	0.252
0	2	0.314	0.311	0.313	0.344	0.288	0.316
0	3	0.512	0.489	0.501	0.664	0.428	0.546
5	1	0.322	0.268	0.295	0.315	0.311	0.313
5	2	0.841	0.898	0.870	0.883	0.868	0.876
5	3	0.700	0.742	0.721	0.625	0.644	0.645
10	1	0.261	0.134	0.198	0.380	0.411	0.396
10	2	0.341	0.236	0.289	0.721	0.722	0.722
10	3	0.240	0.240	0.240	0.645	0.721	0.683
SOLE CASSAVA							
0	-	-	-	0.431	-	-	0.461
5	-	-	-	0.880	-	-	0.941
10	-	-	-	0.720	-	-	0.783
LSDP>0.05		0.101			0.148		

Table 5: Mixture productivity of the various crops as affected by poultry manure and cassava/maize/groundnut mixture.

Poultry Manure Rates t ha-1	Groundnut row arrangement	grain yield t ha-1 2007	2008
0	1	1.11	1.13
0	2	1.18	1.20
0	3	1.22	1.23
5	1	1.24	1.27
5	2	1.34	1.45
5	3	1.48	1.59
10	1	1.33	1.45
10	2	1.57	1.62
10	3	1.62	1.88
Sole cassava		1.00	1.00
Sole maize		1.00	1.00
Sole groundnut		1.00	1.00

Table 6: Post harvest soil physico-chemical properties as affected by poultry and row arrangement of groundnut in cassava/maize/mixture

Poultry Manure Rate t/ha	No. of of rows groundnut	Ph	% Total N	Avail P(ppm)	Exch K+	Exch Mg2+	Org M	CEC	Sand	Silt	Clay
0	1	4.4	0.07	4.34	0.07	0.63	1.21	3.21	82	3.0	12.47
0	2	4.5	0.07	4.52	0.09	0.64	1.23	3.68	82	3.0	12.17
0	3	4.5	0.07	4.56	0.09	0.64	1.23	4.74	82	3.1	11.28
5	1	5.0	0.26	5.01	0.11	0.71	1.59	4.82	82	3.2	12.17
5	2	5.0	0.28	5.60	0.13	0.74	1.61	4.21	82	3	12.20
5	3	5.3	0.31	5.68	0.14	0.76	1.871	4.68	82	3	12.21
10	1	5.4	0.61	5.21	0.16	0.75	1.69	4.77	82.	5.3	12.15
10	2	5.5	0.62	5.68	0.19	0.78	2.03	4.62	82	3.1	12.17
10	3	5.5	0.64	5.77	0.20	0.81	2.21	5.01	82	3.2	11.81
0	1	4.5	0.07	4.41	0.08	0.66	1.24	5.21	82	3.2	11.6
0	2	4.6	0.09	4.08	0.10	0.67	1.25	3.51	82	3	12.41
0	3	4.7	0.58	4.66	0.12	0.67	1.25	3.78	82	3	12.11
5	1	5.3	0.63	5.78	0.15	0.75	1.87	4.21	82	3	11.60
5	2	5.3	0.64	6.11	0.18	0.78	2.22	4.72	82	3.2	12.64
5	3	5.3	0.65	6.74	0.23	0.93	2.22	4.72	82	3.2	12.64
10	1	5.6	0.65	5.81	0.20	1.24	2.46	5.88	84	3.3	11.81
10	2	5.7	0.81	6.88	0.23	1.46	2.72	6.33	80	3.2	12.30
10	3	5.7	0.82	6.97	0.25	1.47	2.73	6.62	80	3.2	12.61

4 DISCUSSION

Generally, introduction of groundnut into the system improved cassava root yield. Stands intercropped with groundnut irrespective of number of rows, produced higher yields, 48% higher than those with maize intercrop in 2007 and 42% in 2008. It is worthy to note that where cassava rows were more closely associated with groundnut (2 and 3 rows arrangements) intercropped cassava yielded more than sole cassava. Apparently, both fixed nitrogen and non-nitrogen benefits (such as increased moisture retention, improved soil structure, weed control) are often reported in legume/non-legume association and rotation, (Nguyen *et al.*, 2001, Tran and Nguyen, 2007, Wiley, 1979, Richard, 2005) and could account for this. In the two years of trial, the root yield of cassava was significantly higher ($p>0.05$) higher when groundnut was planted after maize harvest. Perhaps the removal of maize (regarded as aggressive in food competition) from the system has (not only reduced inter-specific competition among the crops) given cassava 100% assess to the nutritional contribution of the legume component and the applied poultry manure. Fagbamiye and Ikerogu (1984) reported that the growth cycles of the associated crops in cassava-based system are rather short, that when they are harvested, all the available nutrients including those added by the remains of the component crops, are left at the disposal of cassava.

The root yield of cassava was significantly ($p>0.05$) higher in 2008 (14%) than in 2007, especially in areas that received 10 t ha^1 of poultry manure application. Perhaps, this may be attributed to residual effects of the manure. In 2007, poultry manure at much higher rates (10-50 t ha^{-1}) have been reported to give optimum response of marketable yield of cabbage (Hochmuth, 1997), pepper, egg plant, tomatoes and okra (Maynard, 1991). Hussein (1997) indicated that application of poultry manure at higher rates ensures sustainability in the system. The highest root yield of cassava were obtained when groundnut was planted in 2 and 3 rows respectively between two rows of cassava after maize harvest at 10 t ha-1 of manure application (Table 2).

The grain yield of maize increased linearly with increase in the rate of poultry manure application in the two years of the trial (table 3). Increasing the number of rows of groundnut did not affect maize yield significantly ($p>0.05$). The yield of maize in the system was generally low. Inter specific competitions in the mixture may have contributed to it.

The seed yield of groundnut planted at the same time with maize was statistically ($p>0.05$) the same as those planted after maize harvest (Table 4). Highest seed yield of groundnut (0.870 in 2007 and 0.876 in 2008) irrespective of time of planting, were obtained when groundnut was planted at 2 rows between rows of cassava with 5 t ha^{-1} of poultry manure application. Perhaps, 5 t ha-1 was the optimum level of manure that groundnut could tolerate to boost its nitrogen fixing

ability. The yield of groundnut generally was lower in the intercrop plots than in solecrop plots. This may be attributed to the shading and competition arising from close association among intercrop in both systems. The low yield of cowpea/cassava mixture was attributed to shading competition (IITA, 1978).

The land equivalent ratios of cropping systems were all above 1 and on the average ranged from 1.11 to 1.88 across in both 2007/2008 (Table 5). This implies that the three crop systems involving maize, cassava and groundnut both in rotations and intercrops was found to be 11-88% more productive than the solecrops. This study showed that introducing groundnut and poultry manure into the cassavas/maize intercrop system, resulted in increased crop productivity evidenced by high LERs. Some reported gains in productivity involving legumes in intercrops are 13.8-40.6% cassava/flamingia (Richard, 2005), 50-80% cassava/cowpea (Tran and Ngumen, 2001). The yield or cassava root in 2008 was 14% higher than in 2007. Mixture productivity as expressed was also higher in 2008 than in 2007. Yield or productivity stability is the yield response to variations in environments due to years or locations. Post-harvest soil analysis showed that the nutrient status of the soil was maintained for the two years of trials. Thus in introducing poultry manure and groundnut in cassava/maize intercrop system ensures yield stability and sustainability. Targeting high and stable yields of cassava components to feed the cassava processing industries, a cassava/maize/groundnut mixture with 10 t ha^{-1} of poultry manure application, groundnut being planted at 20,000 or 62,500 stands ha^{-1}, after maize harvest is recommended.

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