Economic analysis of poultry manure and NPK fertilizer on the performance of pepper relay cropped with cassava

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ABSTRACT

A split-plot layout was adopted in conducting the the trial on the effects of NPK fertilizer and poultry manure on the performance of pepper relay cropped with *Oko Iyawo* (a local variety of cassava) in Ogbomoso during 2001/2002 and 2002/2003 cropping seasons using Poultry Manure (PM) and NPK fertilizer : no fertilizer, 120N + 80P + 50K kg/ha, poultry manure (PM alone) 6,250 kg/ha and 50 % to 50 % mixture of NPK and PM. The cropping pattern, which was a local variety of cassava (*Oko Iyawo*) relayed into pepper at 1 month after transplanting (MAT) was the main plot while the fertilizer treatments formed the subplots. The experiments were replicated three times. Descriptive statistics and ANOVA were used to analyze the data of growth and yield parameters. Partial budget analysis was used to determine the economic benefits of the treatments. All the fertilizers significantly ($P < 0.05$) affected the yields of both pepper and cassava. The highest (13.6t/ha)fruit yield of pepper was obtained from the plots treated with 120N + 80P + 50K kg/ha. The highest (25.6t/ha) cassava tuber yield was obtained from the plots treated with 6,250 kg PM/ha. in both years. The yield of pepper under different fertilizer application was in the order NPK > (NPK + PM) > PM. All the fertilizer treatments yielded more than the control by 36 %, 37 % and 35.6 % in the following order: NPK alone, ½ NPK + ½ PM and PM alone respectively. The treatment with NPK fertilizer gave the highest net benefit of N402, 319/ha followed by treatment with ½ NPK + ½ PM that gave a net benefit of N375, 680. The use of PM alone as organic fertilizer gave an appreciable increase (68.7 %) in the net benefit compared to zero application of fertilizer. The cost involvement in
the treatment of ½ NPK + ½ PM was not tangibly higher than that of poultry manure alone (3.7%) but lower than NPK-treated plants. Its adoption could be considered for economic reasons. Besides, the use of NPK + PM would alleviate the problem of bulkiness that is usually associated with organic fertilizer use and also reduce the cost of production compared to the use of inorganic fertilizer alone.

Keywords:*Capsicum annuum*, cropping pattern, fertilizer, *Manihot esculenta*, relay,

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INTRODUCTION

Pepper (*Capsicum annuum*) is a crop of tremendous economic and nutritional importance in Nigeria as it forms an important part of the diet, supplying some of the nutrients such as Ca, P, Fe and Na. It is an excellent source of vitamins. Pepper produces high amounts of vitamin C, provitamin A, E, P (citrin), B1 (thiamine), B2 (riboflavin), and B3 (niacin) (Bosland and Votava, 2000).

Within traditional agriculture, intercropping is very common and extremely sophisticated. The suitable land for food production is fixed or diminishing, yet farmers and agronomists are faced with the task of increasing productivity (Midmore 1993). In the light of this, a system integrating different practice of soil fertility maintenance, which will include the use of both mineral fertilizer, organic manure and intercropping which provides fast and good ground cover should be developed (Steiner, 1991).

Management of soil fertility in an intercropping system has a major influence on crop production. Several studies have revealed that intercropped mixtures extracted more nutrients from the soil than did single stands per unit area (Kassam and Stockinger, 1973; Oelsligle *et al.,* 1976). High cost of nitrogen fertilizer has led to several research studies on the benefit of intercropping with legumes. Cassava (*Manihot esculenta*) requires adequate fertilizer especially (K and N) for optimum growth and root yield (Obigbesan and Fayemi, 1976; Sitti-busaya and Kurmarohita, 1978). The cultivation of cassava in traditional agriculture is without the use of any form of fertilizer (Onwueme, 1994). The use of adequate levels of nutrients by any crop is essential in order to increase its productivity and yield. Bosland and Votava (2000) reported that pepper required adequate amounts of major and minor nutrients to produce well. May (1982) recorded the highest yield of 12.3t/ha from N and P application rates of 150 kg/ha and 100 kg/ha respectively. Alabi (2006) found that P significantly increased pepper plant height, number of leaves and branches per plant and leaf area up to 125 kg P/ 1ha but concluded that poultry droppings increased the yield components of pepper more significantly than the phosphorous.

Poultry manure is a form of farmyard manure (FYM) which may be deep litter, broiler litter or in-house air-dried droppings (MAFF/ADAS, 1991). Heathman *et al*. (1995) reported that poultry manure is considered one of the best sources of organic fertilizers. Poultry manure is a valuable organic source of essential plant nutrients and soil amendment to improve soil quality. Application of poultry manure to agricultural lands has been found to be environmentally sound method of recycling essential nutrients.

Poultry manure contains a considerable amount of organic matter that has a positive effect on soil structure, tilth, water holding capacity, aeration, pH buffering, CEC and microbial activity (Mullins *et al*., 2002). Titiloye (1980) reported that 125 tonnes of poultry manure per hectare is equivalent to about 125 kg N, 55 kg P and 105 kg K.

In comparing the uptake of N, P, and K from un-composted poultry manure and green waste compost, Pearson *et al.* (1998) reported that N in un-composted poultry manure appeared to be more available for plant uptake than N in green waste compost. Research has also indicated that cassava responds well to application of FYM especially when fortified with some chemical fertilizer (Mandal *et al.*, 1973: and Kumar *et al.*, 1977).

The importance of integrated nutrient use in crop production in recent years cannot be over-emphasized in view of the high cost of chemical fertilizer to meet crop nutrient requirements. Complimentary use of organic manure and mineral fertilizers has proved to be a sound strategy to maintain soil fertility in many parts of the world (Lombin *et al.,* 1991*)*. However, farmers are likely to adopt alternative techniques for soil fertility improvement and increase productivity only if they become aware of the costs and benefits of such alternatives.

MATERIALS AND METHODS

Field trials on the effects of NPK fertilizer and poultry manure on the performance of pepper relay cropped with local variety of cassava were conducted in Ogbomoso during 2001/2002 and 2002/2003 cropping seasons. Ogbomoso is on Latitude 8 01 N, Longitude 4 06 E, about 310 m above sea level in the derived savannah belt of south-western Nigeria. The mean annual rainfall of the Experimental station was 1,062.18 with high intensity over a period of seven months (April to October). The land used for the experiment had been previously cropped to staple food crops such as cassava, maize, yam guinea corn and grain for two years. The soil is a ferric luvisol, locally classified as Iwo series. Composite samples of the topsoil (0 15 cm depth) were taken from the site and analyzed for their physical and chemical properties before the commencement of the experiment in each year.

The experimental design for the trial was a split-plot fitted into a randomized complete block design with three replicates. The main plot was cropping pattern where cassava was relayed into pepper at MAT. The sub-plot was fertilizer at four levels namely:

(I) No fertilizer,
(ii) Fertilizer (alone), which was supplied in the form of urea, single super-phosphate and muriate of potash at 120 N + 80 P + 50 K kg/ha
(iii) Poultry manure (PM) at the rate of 6.3 t/ha.
(iv) ½ NPK fertilizer (60 N + 40 P + 25 K kg/ha.) + ½ Poultry manure (3.15 t/ha.).

Each plot was 5 m x 4 m planted with cassava at 1 m x 1 m and pepper at 1 m x 0.5 m spacing. Plant population density was thus 10,000 per hectare for cassava and 20,000 plants per hectare for pepper. The local late-branching of cassava (cultivar *Oko iyawo)* and Pepper cultivar NHVI-B, released by the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria in the year 2002 were used for the experiment.

Partial budget analysis was used to determine the economic benefit of the treatments. A partial budget is a way of calculating the total costs that vary and the net benefits of each treatment in an on-farm experiment. The partial budget includes the average yields for each treatment, the adjusted yields and the gross field benefit (based on the field price of the crop). It also includes all the costs that vary for each treatment. (CIMMYT, 1988). All costs and benefits were calculated on hectare basis in Nigeria currency. The following concepts used in the partial budget analysis are defined as follows:

(i) Adjusted yield: This is the experimental yield scaled down by a given proportion to approximate the yields that farmers can obtain on their farms. The scaling down is necessary to prevent overestimation of the returns that farmers are likely to obtain from a treatment. In this experiment, 10 % was used in scaling down the cassava and pepper yield on the assumption that farmers can only achieve 90 % of the yield obtained in experimental fields (Alimi and Manyong, 2000).

(ii) Acceptable Minimum Rate of Return (AMRR): This is the minimum returns which farmers expect to earn from an enterprise or technology. It is the sum of the return to management and cost of capital. Returns below this, make an enterprise a failure.

(iii) Acceptable Minimum Return (AMR): This is the product of the AMRR and the total variable input cost of each treatment. The lowest AMR is required for the farmer to change to a new technology.

(iv) Gross farm gate benefit: This is the product of farm gate price of the output and adjusted yield.

(v) Net benefit: It is the difference between the farm gate benefit and total variable input cost.

(vi) Residuals: This is the difference between the net benefit and the

acceptable minimum return (AMR). Residual analysis is used as a decision criterion to recommend a treatment with the highest residual.

(vii) Marginal Rate of Return (MRR): The ratio of the change in net benefit to change in total variable input cost between treatments (Alimi and Manyong, 2000).

RESULTS AND DISCUSSION

All the fertilizer treatments yielded more than the control by 36 %, 37 % and 35.6 % (pooled data for the two seasons) in the following order: NPK alone (NPK + PM) and PM alone respectively. Significant differences were observed in the yield of pepper obtained across the fertilizer treatments in the following season (Table 1).

Table 2 shows the partial budget analysis of different treatments of fertilizers on cassava/pepper intercrop. Partial budget analysis combines the information on physical input-output relationship with those of prices of input and output to determine the economic implications of the different treatments for the farmers. The input and output prices used in the economic analysis were the prevailing market prices during the period of the experiment.

The treatment with NPK fertilizer gave the highest net benefit of N 402, 319/ha followed by treatment with NPK + poultry manure that gave a net benefit of N375, 680 and no fertilizer treatment had the least net benefit of N 141,702 in 2001/2002 cropping season (Table 2). Among the fertilizer treatments, the cost of treatment with inorganic fertilizer was the highest (N59, 400) which also gave the highest corresponding net benefit with a residual of N 307, 279/ha. The highest cost involvement with the application of NPK alone could be attributed to the high cost of inorganic fertilizer. The use of poultry manure alone as organic fertilizer gave an appreciable increase (68.7 %) in the net benefit compared to zero application of fertilizers. Similar trend was observed in 2002/2003 cropping season.

The marginal rate of return (MRR) values in both years indicated that, changing from the no fertilizer control to NPK fertilizer were 2555 and 2680 % respectively while changing from the control to NPK + poultry manure were 2526 and 2830% in 2002 and 2003 respectively. In changing from no fertilizer to the use of poultry manure alone, MRR values of 2889% and 2825% in 2001/2002 and 2002/2003 cropping seasons respectively were recorded. These values imply that farmers must make extra investments of N10/ha, N 200/ha.; N 9,260/ha. and N 7,200/ha. in changing from no fertilizer to NPK fertilizer; NPK + PM and PM alone respectively; in return, they will obtain extra benefits of N 273,443/ha; N 262,509/ha.

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Table 1 Pepper and cassava yields under different fertilizer treatments in 2001/2002 and 2002/2003

Treatments	Pepper yield (kg/ha)		Cassava yield (t/ha)	
	2001/2002	2002/2003	2001/2002	2002/2003
No fertilizer	4,338d	4,064d	18,120d	18,100d
NPK Fertilizer	13,422a	13,612a	21,700c	21,600c
NPK + Poultry manure	12,290b	12,994b	22,900b	23,100b
Poultry manure	11,019c	10,503c	25,030a	25,600a

Means in the same column followed by the same letters are not significantly different at P<0.05 according to Duncan's multiple range test

Table:2 Partial budget for effects of fertilizer on cassava + Pepper intercrop 2001/2002

Treatments	Mean cassava root Yield kg/ha	Mean pepper fruit yield kg/ha	Mean cassava root adjusted yield kg/ha	Mean pepper fruit adjusted yield kg/ha	Gross farm gate benefit #/ha	Total veriable cost #/ha	Net benefit #/ha	Acceptable Minimum Return*AMR	**Residual	Marginal Rate of Return MRE (%)
No Fertilizer	18,120	4,338	16,308	3,904	190,902	49,200	141,702	78,720	62,982	
NPK Fertilizer	21,700	13,422	19,530	12,080	461,719	59,400	402,319	95,040	307,279	2,555
NPK + Poultry Manure	22,900	12,290	20,160	11,061	434,144	58,460	375,680	93,536	282,144	2,526
Poultry manure	25,030	11,019	22,527	9,917	406,124	56,400	349,724	90,240	259,484	2,889

NPK=Mineral fertilizer,Cassava= #4.17/kg., Pepper= #31.40/kg.*AMR= This was calculated using AMRR of 160% to multiply total variable cost ** Residual = Net Benefit -AMR

Table 3 partial budget for effects of fertilizer on cassava + pepper intercrop (2002/2003)

Treatments	Cassava average yield Kg/ha	Pepper average yield kg/ha	Casava adjusted. yield kg/ha	Pepper adjusted yield kg/ha	Gross farm gate benefit #/ha	Total variable cost #/ha	Net benefit #/ha	Acceptable Minimum Return *AMR	**Residual	Marginal Rate of Return MRR
No fertilizer	18,100	4,064	16,290	3,657	183,05	249,200	133,852	78,720	55,132	
NPK Fertilizer	21,600	13,612	19,440	12,250	466,695	59,400	407,295	95,040	312,255	2,680
Npk + Poultry Manure	23,100	12,994	20,790	11,694	454,821	58,460	396,361	93,536	302,825	2,830
Poultry manure	25,600	10,503	23,040	9,542	393,626	56,400	337,226	90,240	246,986	2,825

*NPK= Mineral fertilizer, Cassava =#4.17/kg., Pepper = #31.48kg. * AMR = This was calculated using AMRR of 160 % to multiply Total variable cost. ** Residual = Net Benefit - AMR*

and N 203,374/ha in that order. These results indicated that farmers stand to gain in return for every N1.0/ha on average invested in changing from no fertilizer option to NPK fertilizer they recover their N1.0 plus an extra of N 25.55 and N 26.80/ha in net benefits in 2001/2002 and 2002/2003 respectively while changing from no fertilizer option to NPK + PM will attract an extra of N 25.26/ha and N28.30/ha for every N 1.0/ha invested in both years. Interestingly, changing to the use of poultry manure alone attracted highest return of N 28.89/ha in 2001/2002 and N 28.25/ha in 2002/2002 for every N 1.0/ha invested.

CONCLUSION

The net returns from cassava + pepper intercrop were controlled by the yield and the prevailing market prices. Pepper contributed more to the net income with an average farm gate price of N31.48 per kilogram of fresh fruit of pepper compared to that of cassava at N4.17/kg. Therefore, if emphasis is on increasing profit from the intercrop, the management of cassava + pepper intercrop should aim at increasing the yield of pepper.

Adoption of NPK + PM could be considered as a more economically profitable fertility maintenance strategy since its use would alleviate the problem of bulkiness that is usually associated with organic fertilizer use. It also reduces the cost of production compared to the treatment with NPK fertilizer alone.

REFERENCES

Alabi, D. A. (2006). Effects of fertilizer phosphorous and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L.). *African Journal of Biotechnology* 5. 8: 671 - 677.

Alimi, T. and V.M. Manyong, (2000). *Partial Budgeting Analysis for On Farm Research*. IITA *Research Guide* 65:.1 - 51.

Bosland, P. W., and Votava, E. J. (2000). *Peppers: Vegetables and Spice Capsicums*. Wallingford Oxon 0X10 8DE UK: CABI International. 12- 204.

CIMMYT (1988). From Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely revised edition. Mexico, DF.

Heathman, A. N., Shapley, S. J. S. and Robinson, J. S. (1995). Land application of poultry litter and water quality in Oklahoma, U.S.A.

Fertilizer Research 40:165 - 173.

Kassam, A. H. and K. R. Stokinger, (1973). Growth and N-uptake of sorghum and millet in mixed cropping. *Samaru Agricultural Newsletter* 15: 8 32.

Kumar, B. M. Mandal, R.C. and Magoon, M. L. (1977). Effect of farm yard manure and NPK on cassava. *Symposium of the 4th International Society for Root Crops.* Ottawa, Canada: International Development Research Centre. 122 124.

Lombin, L. G. Adepetu, J. A. and Ayotade, A.K. (1991). *Organic fertilizer in the Nigerian agria nationculture: present and future.* Abuja: Fertilizer Procurement and Distribution Division(F.P.D.D). 16 162.

MAFF/ADAS, (1991). *Profitable utilization of livestock manures.* New edition, London: Ministry of Agriculture, Fisheries and Food, HMSO. 2081.

Mandal, R. C., Singh, K. D. and Maini, S. B. (1973). Effect of plant density, fertility level and shoot number on tuber yield and quality of tapioca hybrids. *Indian Journal of Agronomy* 18. 4: 449 452.

May, K. W. (1982). Effects of planting schedule and intercropping on green gram (*Phaseolus aureus*) and bulrush millet (*Penisetum americanum*) in Tanzania. *Experimental Agriculture* 18: 149 156.

Midmore, D. S. (1993). Agronomic modification of resource use and intercrop productivity. *Field Crops Research* 34: 239 245.

Mullins, G. I., Bendfeldt, E. S. and Clark, R. A. (2002). Poultry litter as a fertilizer and amendment. Virginia cooperative extension Bulletin 424 -434.

Obigbesan, G. O. and Fayemi, A. A. (1976). Investigations on Nigerian root and tuber crops. Influence of nitrogen fertilization on the yield and chemical composition of two cassava cultivars (*Manihot esculenta*). *Journal of Agricultural Science*. 89: 23 27.

Oelsligle, D. D., McCollum, E. E. and Kang, B. T. (1976). Soil fertility management in tropical multiple cropping.In: Papendick, R. I., Sanchez, P. A. and Triplet, G. B. Eds. *Multiple Cropping Symposium, American Society of Agronomy* Madison: Wisconsin. 1- 378.

Onwueme, I. E. and W.B. Charles (1994). Tropical Root Tuber Crops production perspectives and future prospects in F.A.O. *Plant Production and Protection Paper* 1 -126.

Pearson, A. J., Spiers, T. M. and Cant, G. (1998). Crop uptake of nitrogen, phosphorus and potassium from soil amended with chicken