Journal of Agricultural Technology 2011 Vol. 7(3): 835-848
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Residual benefits of pigeonpea to cassava intercropped with maize at Otobi, Benue State, Nigeria

Egbe, O.M.[1*], Egbo,C.U.[2] and Odaba, B.O.[3]

[1]Department of Plant Breeding and Seed Science, University of Agriculture, P.M.B.2373, Makurdi, Nigeria.
[2]Benue State Agricultural and Rural Development Authority, P.M.B.102125, Makurdi, Nigeria.
[3]National Root Crop Research Institute Sub-Station,Otobi.P.O.Box 20,Otobi,Benue State, Nigeria.

Egbe, O.M., Egbo, C.U. and Odaba, B.O. (2011). Residual benefits of pigeonpea to cassava intercropped with maize at Otobi, Benue State, Nigeria. Journal of Agricultural Technology 7(3): 835-848.

A field experiment was carried out between 2007 and 2010 at the National Root Crops Research Institute Sub- Station, Otobi (07° 10′ N,08° 39′E, elevation 105.1 m) in Benue State, located in Southern Guinea Savanna agro-ecological zone of Nigeria to assess the residual benefits of pigeonpea to cassava intercropped with maize. The experiment was a 2 x2 x 3 split-split-plot comprising two planting mediums (previous pigeonpea and fallow plots), two cropping systems [sole cropping (cassava, maize) and intercropping (cassava+maize)] and three rates of NPK:15:15:15 fertilizer (0, 45, and 90 kg/ha). Fresh cassava tuber yields from previous pigeonpea plots {35.40 t/ha (sole cropping) and 31.10 t/ha (intercropping)} were higher than those obtained from the fallow plots {26.20 t/ha (sole cropping) and 23.80 t/ha (intercropping)}, irrespective of the fertilizer rates adopted. Similarly, previous pigeonpea plots gave significantly higher grain yield of maize (2.08 t/ha) than the fallow (1.50 t/ha). Previous pigeonpea plots produced LER, LEC and ATER figures above unity, but not so with the fallow plots where only LER figures were above 1.0. Dominance analysis indicated that the fallow treatments were dominated by the previous pigeonpea treatments. The previous pigeonpea plot gave the highest marginal rate of returns (87.54%). Previous pigeonpea plots, as planting medium, produced the largest net benefits (₦141, 333.00/ha) when no fertilizer was added, but such benefits decreased with increase in fertilizer levels from 45 kg/ha of NPK: 15:15:15 (₦ 132,667.00/ha) to 90 kg/ha NPK: 15:15:15 (₦ 124,667.00/ha).This implies that cassava and maize could be grown profitably under intercropping without additional inorganic fertilizer input when pigeonpea precedes these crops for two consecutive years in the rotation at Otobi.

Key words: residual benefits, pigeonpea, fallow, cassava

*Corresponding author: O.M.Egbe; e-mail: onyiloegbe @ yahoo.co.uk

Introduction

When legumes or other nitrogen-fixing plants affect the growth of plants grown after them in sequence, the changes in growth are termed residual effects (Giller, 2001).Nutrient depletion, as opposed to inherent fertility, affects large areas due to continuous cropping with few inputs. Nitrogen management requires a continual supply of N that can be achieved through fertilization, green manuring, legume rotations or leguminous tree-shrub fallows (Smithson and Giller, 2002).Legume rotations or intercrops are commonplace in small-holder agriculture. In Otobi, located in Benue state of Nigeria, such legumes as groundnuts, bambaranuts, cowpea, soybean and pigeonpea are often grown sole, mixed or intercropped with maize, cassava, yam and sorghum (Egbe and Kalu, 2006).The use of legumes in rotational systems is unpopular in this environment. Pigeonpea, one of the most drought-tolerant legumes (Valenzuela and Smith, 2002) has the ability to fix up to 235 kg N/ha (Peoples *et al*., 1995) and produces more N per unit area from plant biomass than many other legumes. Pigeonpea has been reported to fix between 36.10 and114.04 kg N/ha when intercropped with maize and 35.94-164.82 kg N/ha under intercropping with sorghum at Otobi (Egbe, 2005). Residual benefits of pigeonpea to maize crop at Otobi has been documented (Egbe *et al*., 2007), but maize is rarely grown sole by farmers at Otobi. Cassava/maize mixture occupies a prominent place in the cropping systems of Benue State (Ortese, 1986), because it plays the dual role of being a major staple and cash earner to the people.

The need to identify promising plant nutrient management practices to expand both cash and food crop production is becoming increasingly important for most developing countries, mainly because of the rapidly growing population and limited availability of productive land (Keerthisinghe *et al*., 2003). Inclusion of legumes in rotational cropping systems and recycling crop residues are widely recommended strategies, to improve soil fertility, enhance nutrient use efficiency and to save costs associated with productive activities. For example, studies conducted in moist savanna and humid forest zones of West Africa showed that by including cowpea in maize-based cropping systems and recycling cowpea residues, as much as 50% of urea application could be saved (Vanlauwe *et al*., 2002).

The work reported here was undertaken to evaluate the potential residual benefits of pigeonpea to the succeeding crop of cassava intercropped with maize at Otobi with the aim of minimizing inorganic fertilizer usage in this intercropping system, improve its productivity and subsequently ameliorate food security problems in the region.

Materials and methods

A field experiment was carried out between 2007 and 2010 at the National Root crops Research Institute Sub- Station, Otobi (07° 10′N, 08o 39′ E, elevation 105.1 m) in Benue State, located in Southern Guinea Savanna agro-ecological zone of Nigeria (Kowal and Knabe, 1972).The experiment was undertaken to assess the residual benefits of pigeonpea to cassava intercropped with maize at Otobi. The experimental site received a total rainfall of 1350.9 mm in 2007, 1453.3 mm in 2008 and 1543.6 mm in 2009.A total of 27 core samples were collected each year from different parts of the experimental field and bulked into a composite sample and used for the determination of the chemical and physical properties of the soil before planting pigeonpea in 2007 and before planting cassava and maize in 2009. The detailed physical and chemical properties of the experimental site are presented in Table 1.

Table 1. Physical and chemical properties of the surface soil (0-30 cm) of experimental site at Otobi in 2007 before planting and after land clearing in 2009.

Parameter	2007	2009	
		Previous pigeonpea plot	Fallow
Sand (%)	70.10	64.40	71.40
Silt (%)	11.68	12.56	12.20
Clay (%)	18.22	23.04	16.4
Textural class	Sandy loam	Sandy loam	Sandy loam
pH (H_2O)	5.98	6.26	6.25
Organic carbon	0.51	0.90	0.67
Organic matter	1.07	1.52	1.19
Total N (%)	0.09	0.16	0.11
Available P (cmol kg^{-1} soil)	7.62	5.22	4.70
Ca^{2+} (cmol kg^{-1} soil)	2.62	3.40	2.33
Mg^{2+} (cmol kg^{-1} soil)	2.34	2.60	1.89
K^{+} (cmol kg^{-1} soil)	0.64	0.45	0.17
Na^{+} (cmol kg^{-1} soil)	0.34	0.50	0.29
Exch.acidity (cmol kg^{-1} soil)	0.35	7.40	4.59
ECEC (cmol kg^{-1} soil)	6.29	14.35	9.18

On the 2nd day of August 2007, a piece of land measuring 36 m x 15 m was ploughed, harrowed and ridged. The ridges were spaced 1 m apart. An adjoining land of the same size was demarcated and left fallow. Pigeonpea var.*igbongbo* was planted on the ridged land at a spacing of 1 m x 0.30 m (33, 0000 plants /ha). Pigeonpea seeds were harvested in February of 2008 and the plants were left to perennate until 30th May, 2009 (having spent a total of 21 months in the field). From 1st to 3rd of June, 2009, both the pigeonpea and the fallow plots were manually cleared and ridges were constructed at the spacing of 1 m apart. A 2 x2 x 3 split-split-plot experiment comprising two planting mediums (previous pigeonpea and fallow plots), two cropping systems [sole cropping (cassava, maize) and intercropping (cassava+maize)] and three rates of NPK fertilizer (0, 45, and 90 kg/ha) was established on the 4th of June, 2009.The planting mediums constituted the main plot treatments, the cropping systems made up the sub-plot, while the fertilizer rates were assigned to the sub-sub-plots. The experiment was laid out in randomized complete block design with three replications. Gross plot measured 4 m x 3 m (12 m^2), while the net plot had the dimension of 2 m x 2 m (4 m^2). The fertilizer used was NPK: 15:15:15 .The cassava variety used was TMS 61/0061 obtained from IITA, Ibadan, and the maize variety used was QPM sourced from the National Seed Service, Abuja. Cassava was planted at the spacing of 1 m x 1 m (10,000 plants/ha), while maize was planted at 1 m x 0.25 m (40,000 plants/ha) in both sole and intercropping systems. The fertilizer was applied by side placement 4 WAP (weeks after planting) to the crops in plots requiring fertilizer. Two hoe-weedings were done at 4 and 8 WAP.Maize was harvested at maturity on 30th August, 2009, while the cassava component was harvested on 30th of May, 2010.Data collected included the following:cassava: fresh tuber yield, number of tubers per plant, plant height at maturity and canopy width at maize maturity. Maize: dry grain yield, dry cob weight, cob length, canopy width at 8 WAP, seed rows per cob and 100-seed weight.Intercrop advantage was calculated by the determination of land equivalent ratio (LER) (Ofori and Stern, 1987).The LER, an accurate assessment of the biological efficiency of the intercropping situation, was calculated as:

$$\mathbf{LER} = (Yab/Yaa) + (Yba/Ybb)$$

where *Yaa* and *Ybb* are yields as sole crops of *a* and *b* and *Yab* and *Yba* are yields as intercrops of *a* and *b*. Values of LER greater than 1 are considered advantageous.

Land equivalent coefficient (LEC), a measure of interaction concerned with the strength of relationship was calculated thus,

$$\mathbf{LEC} = \mathbf{L}a \times \mathbf{L}b$$

where, **L***a* = LER of main crop and **L***b* = LER of intercrop (Adetiloye *et al*., 1983). For a two-crop mixture the minimum expected productivity coefficient (PC) is 25, i.e. a yield advantage is obtained if LEC value exceeds 0.25.

Area-Time equivalency ratio (ATER), the ratio of number of hectare-days required in monoculture to the number of hectare-days used in the intercrop to produce identical quantities of each of the components, was computed as:

$$ATER=\frac{(RyaXta)+(RybXtb)}{T}$$

Where, Ry = Relative yield of species '*a*' or 'b' i.e., yield of intercrop/yield of main crop, t= duration (days) for species 'a' or 'b' and T = duration (days) of the intercropping system (Hiebisch and Mc Collum, 1987).

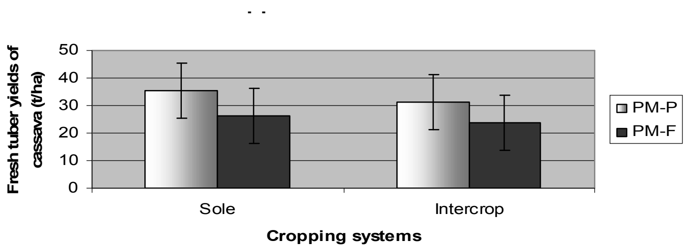
The economic analysis was carried out as described by CIMMYT (1998) to estimate the benefit-cost ratio. A dominance analysis was done and the non-dominated treatments were further subjected to marginal rate analysis.

Standard procedures were followed to collect data and analyzed using GENSTAT Release 7.23 (2007), following standard analysis of variance procedures. The least significant difference (LSD) test at 5% probability level was used to compare the treatment means.

Results

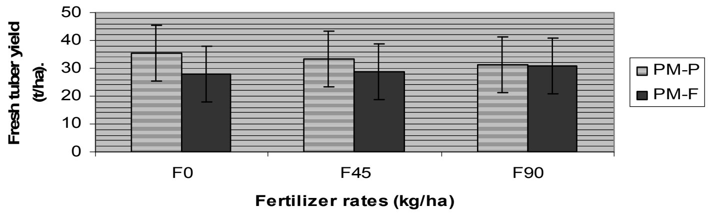
The soils in the experimental plot had the same texture (sandy loam) in 2007 (in both fallow and previous pigeonpea plots) and in 2009), but several of the physical and chemical properties were altered in 2009 (Table 1). The pH, organic carbon, organic matter and total nitrogen levels increased, while the available phosphorus and potassium levels decreased (Table 1).

Planting medium x cropping systems x fertilizer rates, planting medium x cropping systems, planting medium x fertilizer rates and cropping systems x fertilizer rates interaction effects on the fresh tuber yields of cassava intercropped with maize at Otobi were not significant ($P\geq 0.05$).Similarly, the main effects of planting medium, cropping systems and fertilizer rates were not significant. However the results of the interaction effects of planting medium with cropping systems and that of planting medium with fertilizer rates are presented in Figures 1&2. Fresh cassava tuber yields from previous pigeonpea plots {35.40 t/ha (sole cropping) and 31.10 t/ha (intercropping)} were higher than those obtained from the fallow plots {26.20 t/ha (sole cropping) and 23.80 t/ha (intercropping)} (Fig.1).Sole cropping gave higher fresh tuber yields (30.80 t/ha) than intercropped cassava with maize (27.45 t/ha). Cassava grown on previous pigeonpea plots gave higher fresh tuber yields at all fertilizer levels (with a mean of 33.25 t/ha) than those grown on fallow plots (25.00 t/ha) (Fig. 2. The fresh tuber yields of cassava decreased with increasing rates of fertilizer in the previous pigeonpea plots, but the opposite response was observed in the fallow plots (Fig.2).



PM-P: previous pigeonpea plot
PM-F: fallow

Fig. 1. Effects of planting medium with cropping systems on the fresh tuber yield of cassava intercropped with maize at Otobi.



PM-P: previous pigeonpea plot
PM-F: fallow

Fig. 2. Influence of planting medium with fertilizer rates on the fresh tuber yield of cassava intercropped with maize at Otobi.

Planting medium x cropping systems x fertilizer rates, planting medium x fertilizer rates and cropping systems x fertilizer rates interaction effects on the number of tubers produced per plant of cassava intercropped with maize at Otobi were not significant ($P \geq 0.05$). The main effects of planting medium and fertilizer rates on the number of tubers produced per plant of cassava were also not significant. However, planting medium x cropping systems and the main effect of cropping systems were significant ($P \leq 0.05$).

In both planting mediums, intercropping decreased the number of tubers produced by plant of cassava grown with maize at Otobi (Table 2). Sole cropping consistently gave higher number of tubers per plant of cassava (9.22 t/ha) than intercropping (7.14 t/ha).

Table 2. Planting medium x cropping systems interaction effects on the number of tubers produced per plant of cassava intercropped with maize at Otobi.

	Number of tubers per plant		
Planting medium (PM)	Cropping systems (CS)		
	Sole cropping	Intercropping	Mean
Previous pigeonpea	8.22	7.61	7.92
Fallow	10.22	6.67	8.45
Mean	9.22	7.14	8.18
FLSD (0.05)			
PM	3.65		
CS	0.26		
PM x CS	3.59		

PM: planting medium
CS: cropping systems

Interaction effects of planting medium x cropping systems x fertilizer rates, planting medium x cropping systems, planting medium x fertilizer rates and cropping systems x fertilizer rates, as well as the main effects of planting medium, cropping systems and fertilizer rates on the tuber length and canopy width of cassava intercropped with maize at Otobi were not significant ($P \geq 0.05$).Interaction effects of medium with fertilizer rates on the plant height of cassava component were significant. When fertilizer was not applied, cassava planted on the previous pigeonpea plots grew significantly taller (2.54 m) than those planted on the fallow (1.97 m), but not so when fertilizer was applied at both rates (Table 3)

Table 3. Influence of planting medium with fertilizer rates on the plant height (m) of cassava intercropped with maize at Otobi.

	Fresh tuber yield			
Planting medium (PM)	Fertilizer rates (FR)			
	0	45	90	Mean
Previous pigeonpea	2.54	2.07	2.17	2.26
Fallow	1.97	2.16	2.18	2.10
Mean	2.25	2.12	2.18	2.18
LSD (0.05)				
PM	0.39			
FR	0.20			
PM x FR	0.32			

PM: planting medium; FR: fertilizer rates

Table 4 presents the results of dry grain yield of maize intercropped with cassava as affected by planting medium, cropping systems, fertilizer rates and their interactions. In both planting mediums and in both cropping systems, grain yield of maize increased with increase in fertilizer levels. Previous pigeonpea plots (2.08 t/ha) gave significantly higher grain yield of maize than the fallow (1.50 t/ha).The sudden rise in maize grain yield in previous pigeonpea plot from 1.24 t/ha when no fertilizer was applied to 3.03 t/ha (at 45 kg NPK:15:15:15 /ha) and a decrease to 2.75 t/ha at the fertilizer rate of 90 kg NPK:15:15:15/ha is worth noting .Sole maize (1.97 t/ha) gave significantly higher dry grain yield than intercropped maize (1.61 t/ha) with cassava at Otobi.

Planting medium, cropping systems, fertilizer rates and their interaction effects on plant height of maize intercropped with cassava at Otobi were not significant, but the interaction effects of planting medium with fertilizer were significant for maize canopy width. Also, the main effects of planting medium and cropping systems on the canopy width of maize intercropped with cassava at Otobi were significant. Table 5 presents the results of planting medium with fertilizer on the maize canopy width. Previous pigeonpea plots produced significantly larger canopy width (1.35 m) of maize than the fallow plots (1.16 m) at all fertilizer levels tested.

Table 4. Dry grain yield (t/ha) of maize intercropped with cassava at Otobi as influenced medium of planting, cropping systems, fertilizer rates and their interactions.

PM		Dry grain yield								
		CS								
		Sole crop				Intercrop				PM Mean
		FR			PM x CS	FR			PM x CS	
		0	45	90	mean	0	45	90	mean	
PM-P		1.24	3.03	2.75	2.34	1.41	1.78	2.24	1.81	2.08
PM-F		1.38	1.43	1.98	1.59	0.88	1.10	2.25	1.41	1.50
CS x FR mean		1.31	2.23	2.36	1.97	1.14	1.44	2.25	1.61	
FLSD (0.05)										
PM	0.04									
CS	0.18									
FR	0.27									
PM x CS	0.19									
PM x FR	0.31									
CS x FR	0.36									
PM x CS x FR	0.47									

Key: PM: planting medium
CS: cropping systems
FR: fertilizer rates
PM-P: previous pigeonpea plot
PM-F: previous fallow plot

Table 5. Effect of planting medium with fertilizer rates on the canopy width (m) of maize grown with cassava at Otobi.

PM	FR

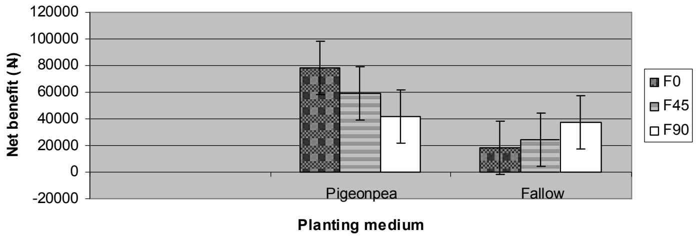
	0	45	90	Mean
Previous pigeonpea	1.31	1.34	1.41	1.35
Fallow	1.18	1.26	1.03	1.16
Mean	1.25	1.30	1.22	1.26
FLSD (0.05)				
PM	0.18			
FR	0.11			
PM x FR	0.16			

Planting medium, cropping systems, fertilizer rates and their interaction effects on the dry cob weight of maize were not significant, but the main effects were: Previous pigeonpea plots gave higher dry cob weight (3.47 t/ha) of maize than the fallow (2.50 t/ha) (Table 6).Also, sole cropping produced higher dry cob weight of maize (3.31 t/ha) than intercropped maize (2.65) with cassava at Otobi. Dry cob weight of maize increased with increase in fertilizer rates from 0 kg/ha to 90 kg/ha of NPK: 15:15:15.

Table 6. Main effects of planting medium (PM), cropping systems (CS) and fertilizer rates (FR) on the dry cob weight of maize intercropped with cassava at Otobi.

	PM			CS			FR			
	Previous Pigeonpea	**Fallow**	**Mean**	**Sole cropping**	**Inter-cropping**	**Mea n**	**0**	**45**	**90**	**90**
	3.47	2.50	2.99	3.31	2.65	2.98	1.96	3.07	3.91	2.98
FLSD (0.05)	0.35			0.52			0.88			

Fig.3 presents the effect of planting medium with fertilizer on the net benefits (₦) of cassava intercropped with maize at Otobi. Previous pigeonpea plots gave higher net benefits than the fallow, irrespective of the fertilizer rates applied. Previous pigeonpea with no fertilizer gave the highest net benefit (N141, 333.00), while fallow plots with no fertilizer produced the lowest net benefit (N81, 667.00).The net benefits decreased with increasing fertilizer levels when previous pigeonpea plots were used as a planting medium, while the opposite response was observed when cassava/maize was planted on fallow plots.



Pigeonpea: previous pigeonpea plot, Fallow: previous fallow plot, F0: no fertilizer, F45: NPK:15:15:15 at 45 kg/ha, F90: NPK:15:15:15 at 90 kg/ha

Fig. 3. Effect of planting medium with fertilizer on the net benefit (N) of cassava intercropped with maize at Otobi.

Table 7 presents the main effects of planting medium on the LER, LEC and ATER of cassava intercropped with maize at Otobi. Previous pigeonpea plots produced LER, LEC and ATER figures above unity, but not so with the fallow plots where only LER figures were above 1.0.LER and LEC values in previous pigeonpea plots were significantly higher than those of fallow plots, but ATER values in both planting mediums were statistically at par.

Table 7. Main effects of planting medium on land equivalent ratio (LER), land equivalent coefficient (LEC) and area x time equivalency ratio (ATER) ofcassava intercropped with maize at Otobi

PM		LEC	ATER
Previous pigeonpea plot	2.00	1.18	1.30
Fallow	1.55	0.66	0.90

Table 8. Dominance analysis, effect of planting medium with fertilizer on the yield of cassava intercropped with maize at Otobi.

Treatment	TVC (₦'000/ha)	Net benefit (₦'000/ha)
Previous pigeonpea plot with no fertilizer	63.50	141.33
Fallow plot with no fertilizer	63.50	81.67 D
Previous pigeonpea with 45 kg/ha NPK	73.40	132.67
Fallow with 45 kg/ha NPK	73.40	97.67 D
Previous pigeonpea plot with 90 kg/ha NPK	83.30	124.67
Fallow plot with 90 kg/ha NPK	83.30	120.33 D

D: dominated treatment.

Table 8 shows the results of the dominance analysis of effect of planting medium with fertilizer on the yield of cassava intercropped with maize at Otobi. Fallow plot without fertilizer, fallow plot with 45 kg of NPK/ha and the previous pigeonpea plot with 90 kg/ha NPK were dominated. There was no significant difference in the net benefits that accrued to the non-dominated treatment plots. The marginal rate of return in going from previous pigeonpea plot with no fertilizer treatment to previous pigeonpea plot with 45 kg/ha NPK was 87.54% ,while that in going from previous pigeonpea plot with 45 kg/ha NPK to 90 kg/ha NPK was 80.80% (Table 9).

Table 9. Marginal analysis, effect of planting medium with fertilizer on the yield of cassava intercropped with maize at Otobi.

Treatment	Total variable cost(₦/ha)	Marginal costs(₦/ha)	Net benefits(₦/ha)	Marginal benefits(₦/ha)	Marginal rate of return
Previous pigeonpea with no fertilizer(F0)	63,500.00		141,333.00		
		`9900.00		8666.00	87.54%
Previous pigeonpea with 45 kg NPK/ha(F45)	73,400.00		132,667.00		
		9900.00		7999.00	80.80%
Previous pigeonpea with 90 kg NPK/ha(F90)	83,300.00		124,667.00		

Discussion

The alteration of the physical and chemical properties of the soil at the experimental site observed in 2009 might have resulted from the decomposition of the pigeonpea leaves (litter) and other plant parts (aborted floral parts, roots and root nodules, unharvested pods and seeds), thereby increasing organic matter content of the soil which might subsequently have improved the soil structure. It is common knowledge that addition of easily decomposable organic residues leads to the synthesis of complex organic compounds that bind soil particles into structural units called aggregates. The increased organic matter content of the soil might also have resulted in the enhanced CEC and the increased level of total N and available P in the soil. Similar observations had been recorded by Egbe and Ali (2010) in their studies on influence of soil incorporation of common food legume stover on the sandy soils of Odoba-Otukpa. Though not significant, the higher fresh tuber yield of cassava planted on previous pigeonpea plots as compared to fallow plots, irrespective of the fertilizer rates adopted , was an indication of the superiority of the former as a planting medium. This fact was further buttressed by the significantly taller plants of cassava in previous pigeonpea plots than those in the fallow at zero fertilizer level. Furthermore, the grain yields of maize planted on previous pigeonpea plots were higher than the fallow plots in both cropping systems and at the different fertilizer rates. These results might be ascribed to the increased organic matter content, total N and P levels in the previous pigeonpea plots as compared to the fallow. Egbe *et al.* (2007) had reported better performance of maize planted on previous pigeonpea plots than those on fallow plots at Otobi and attributed such increases to higher levels of N fixed in the pigeonpea plots as compared to the fallow. Adjei-Nsiah *et al.* (2007) ascribed the high grain yields of maize and associated cassava in previous pigeonpea plots to the faster decomposition and N release of the biomass compared with the slower release of N by the poorer quality materials (e.g.speargrass) found in the fallow. The residual benefit of pigeonpea to the cassava/maize intercropping was most noticeable when no fertilizer was applied. The difference between previous pigeonpea plot and fallow was nearly 15 t/ha of fresh tuber yield of cassava at zero fertilizer application. This might have accounted for the large difference in profit (N59, 666.00) when no fertilizer was applied. The difference decreased with increasing fertilizer level. The dominance analysis also indicated that the fallow treatments were dominated by the previous pigeonpea treatments. The previous pigeonpea plot gave the highest marginal rate of returns (87.54%).This might be consequent upon the high yield of cassava and the attendant net benefit (N59, 666.00) when this treatment was employed. Several workers (Adjei-Nsiah *et al.*, 2007; Egbe *et al.*, 2007; Kumar Rao *et al.*, 1983) had observed residual effects of pigeonpea on succeeding crops in rotation with varying degrees of net benefits. These results implied that as much as 6 bags of NPK:15:15:15/ha (equivalent to ₦12,000.00) can be saved in two years if sole pigeonpea is included in a rotation for two consecutive years, even if the seeds were harvested from the pigeonpea. Also, cassava and maize could be grown without input of inorganic fertilizer if this technological option is adopted-a window for organic agriculture. The reduction of fresh tuber yield and number of cassava tubers per plant by intercropping as well as the decreased grain yield, dry cob weight and the canopy of intercropped maize might have been due to both inter- and intra-specific competition for growth resources (e.g.water,light and nutrients) by both intercrop components. Egbe (2010) had reported similar competitive interactions among intercrop species between soybean and sorghum at Otobi. The higher significant values of LER and LEC in previous pigeonpea plots than those obtained from the fallow indicated higher biological efficiencies in the previous pigeonpea plots as compared to the fallow. This result further implied the superior performance of cassava +maize intercropping systems on preceding pigeonpea plots as compared to the fallow.

The use of pigeonpea in rotation resulted in increased fresh tuber yield of cassava and dry grain yield of maize in sole and intercropped systems. LER and LEC figures indicated better performance of cassava intercropped with maize in previous pigeonpea plots than in fallow. Previous pigeonpea plots, as planting medium, produced the largest net benefits (₦141, 333.00) when no fertilizer was added, but such benefits decreased with increase in fertilizer levels from 45 kg/ha of NPK: 15:15:15 (₦ 132,667.00) to 90 kg/ha NPK: 15:15:15 (₦ 124,667.00).This suggests that cassava and maize could be grown profitably under intercropping without additional inorganic fertilizer input when pigeonpea precedes these crops for two consecutive years in the rotation at Otobi.

References

Adetiloye, P.O, Ezedinma, F.O.C. Okigbo, B.N. (1983). A land coefficient concept for evaluation of competitive and productive interactions on simple complex mixtures.Ecology Modelling, 19: 27-39.

Adjei-Nsiah, S., T.W. Kuyper, C. Lewis, M.K. Abekoe and K.E. Giller. (2007). Evaluating sustainable and profitable cropping sequences with cassava and four legume crops: Effects on soil fertility and maize yields in the forest/savannah transitional agro-ecological zone of Ghana Field Crops Research, 103 (2): 87-97.

CIMMYT. (1998). From Agronomic Data to Farmer Recommendations: An Economic Training. Manual.Completely revised edition.Mexico.D.F.

Egbe, O.M. (2005). Evaluation of some agronomic potential of pigeonpea genotypes for intercropping with maize and sorghum in Southern Guinea Savanna.Ph.D. Thesis, University of Agriculture, Makurdi, Nigeria.

Egbe, O.M. (2010). Effects of plant density of intercropped soybean with tall sorghum on competitive ability of soybean and economic yield at Otobi, Benue State, Nigreia.J.of Oilseeds and Cereals 1(1): 1-10.

Egbe, O.M. and Kalu, B.A (2006). Farming Systems Study: Participatory Rural Appraisal of pigeonpea cropping systems in Southern Guinea Savanna of Nigeria.Journal on Environment (Abia State University Environmental Review) 5 (1): 37-47.

Egbe, O.M. and Ali, A. (2010). Influence of soil incorporation of common food legume stover on the yield of maize in sandy soils of Moist Savanna Woodland of Nigeria.Agriculture and Biology Journal of North America, 1(2): 156-162.

Egbe, O.M., Idoga, S. and Idoko, J.A. (2007). Preliminary investigation of residual benefits of pigeonpea genotypes intercropped with maize in Southern Guinea Savanna of Nigeria.Journal of Sustainable Development in Agriculture and Environment,3:58-75.

Giller, K.E. (2001). Nitrogen fixation in tropical cropping systems.CAB International, Wallingford, UK.

Hiebisch, C.K. and McCollum, R.E. (1987). Area x time equivalency ratio: a method of evaluating the productivity of intercrops.Agronomy. Journal, 79: 15-22.

Keerthisinghe, G., Zapata, F. and Chalk, P. (2003).Plant nutrition: Challenges and tasks ahead.Agro-Chemical Report 3(3): 17-26.
Kowal, J.M. and Knabe, D.T. (1972). An agroclimatological atlas of the Northern States of Nigeria with explanatory notes. Ahmadu Bello University Press, Zaria.
Kumar, Rao, J.V.D.K, Dart, P.J. and Sastry, P.V.S.S. (1983). Residual effect of pigeonpea (Cajanus Cajan) on yield and nitrogen responsse of maize.Experimental Agriculture, 19: 131-141.
Ofori, F. and Stern, W.R. (1987). Cereal –legume intercropping systems.Advances in Agronomy 41: 41-90.
Ortese, J.T. (1986). Mixed cropping as a strategy of improving crop yields of small-scale farmers. Paper presented at Crop Production Seminar, 19th Nov.1986, at Benue State Agricultural and Rural Development Project, Makurdi, Nigeria.
Peoples, M.B., D.F., Herridge, J.K. Ladha. (1995). Biological nitrogen fixation: an efficient source of nitrogen for sustainable agricultural production? Plant and Soil, 174:3-28
Valenzuela, H. and Smith, J. (2002). Pigeonpea.Sustainable Agricultural Green Manure Crops,Aug.2002,SA-GM-8
Vanlauwe, B., Aihou, K., Iwuafor, E.N.O., Houngnanadan, P., Diels J.,Manyong,V.M. and Sanginga, N. (2002). Recent developments in soil fertility management of maize-based systems.The role of legumes in N&P nutritionof maize in the moist savanna zone of West Africa.http://www.cgiar.org/spipm/news/ccropmtg/results/ccb1/CCBEN1.htm

(Recieved 30 July 2010; accepted 18 March 2011)