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Preliminary communication

ECONOMIC ANALYSIS OF INTERCROPPING OKRA WITH LEGUMES

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Abstract: A field study was carried out in a vegetable research field of the National Horticultural Research Institute, Ibadan, Nigeria during the late raining season of 2015 to determine the appropriate okra/legume-based cropping system that will increase crop yield and farmer's income. The experiment was arranged in a randomized complete block design (RCBD) with three (3) replicates. The treatments comprised intercropping okra with groundnut or cowpea planted at varying spacings (60 cm x 30 cm, 60 cm x 40 cm, 60 cm x 50 cm and 60 cm x 60cm). Okra was planted at a spacing of 60 cm x 40 cm, the plot size was 3 m x 2.4 m (7.4 m^2). Data collected was subjected to analysis of variance (ANOVA) and significant means were separated using the least significant difference (LSD) test at the 5% probability level. Economic analysis of the cropping mixture was carried out using gross margin analysis, monetary advantage index and benefit to cost ratio analysis. Results revealed that the land equivalent ratio (LER) of 1.62 was recorded in okra/groundnut at 60 cm x 40 cm and LER of 1.74 was observed in okra/cowpea at 60 cm x 30 cm. Okra/cowpea intercropping system spaced at 60 cm x 30 cm was the most remunerative (₦859,192/ha), followed by okra/cowpea spaced at 60 cm x 50 cm (₦744,212/ha) while okra/cowpea spaced at 60 cm x 60 cm was the least remunerative. The highest gross margin of ₦2,188,961/ha was obtained in okra/groundnut spaced at 60 cm x 40 cm. The least return was obtained in okra/groundnut spaced at 60 cm x 60 cm (₦700,103/ha). The economic analysis revealed that okra/cowpea spaced at 60 cm x 30 cm produced the highest gross margin of ₦859,192/ha and monetary advantage index of ₦450,447/ha while okra/groundnut spaced at 60 cm x 40 cm gave the highest gross margin of ₦2,188,961/ha and monetary advantage index of ₦924,642/ha.

Key words: intercropping, economic analysis, vegetable, legumes, land equivalent ratio.

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Introduction

Intercropping is a crop management system involving two or more economic species growing together for at least a portion of their respective production cycles and planted significantly close to each other so that inter-specific competition can occur (Usman, 2001). It plays a vital role in subsistence food production in both advanced and emerging countries (Adeoye et al., 2005). It tends to give higher yield than sole crops, greater yield stability and efficient use of nutrients (Seran and Brintha, 2009).

Intercropping systems mostly involve cereal legumes, particularly maize – soybean, maize – cowpea, maize – groundnuts, millet – groundnut, and rice – pulses (Matusso et al., 2012). Cereals and legumes have become a popular combination among farmers probably due to the ability of legumes to combat erosion and raise soil fertility levels (Matusso et al., 2012). Legumes can relocate fixed nitrogen to intercropped cereals through their joint growing period and this nitrogen is an essential resource for the cereals (Bhagad et al., 2006). Development of a feasible and economically viable intercropping system largely depends on the adaptation of planting pattern and selection of compatible crops (Seran and Brintha, 2009). Okra has also been used in the cropping mixture with legumes (Ijoyah and Jimba, 2012).

Okra is one of the most widely known and utilized species of the family *Malvaceae* (Naveed et al., 2009) and an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Oyelade et al., 2003). Okra production constitutes about 4.6 percent of the total staple food production in Nigeria within the period of 1970–2003 (CBN, 2004). It ranks first among other vegetable crops (Babatunde et al., 2007). Its cultivation and production have been widely practiced because of its importance to the economy development and it can be found in almost every market in Africa (Ngbede et al., 2014). The fruit contains some essential vitamins (vitamin C) and mineral salts such as calcium, magnesium, potassium and iron including a varying proportion of water (Shippers, 2000). Okra production worldwide is estimated at six million tonnes per year. India is the world largest producer followed by Nigeria and Sudan (Varmudy, 2011).

Considering the importance of okra, low yield resulting from poor nutrient status of the soil has been one of the major factors limiting its production. A number of research efforts on okra based intercropping system in Nigeria have been made. These include those of Ijoyah and Anyam (2013), Ijoyah and Jimba (2012), and Orluchukwu and Udensi (2013). However, these studies did not reveal the economic viability, particularly in the cropping combination. Evaluating a cropping system is an imperative to select the best performing system among the existing ones in terms of biological productivity and economic potential for a particular area (Seran and Brintha, 2009). Furthermore, in order to adequately

analyse the efficiency of the intercropping system, an economic analysis must be carried out since vegetables vary in yield, price and production cost year-round (Rezende et al., 2005). The objective of this study was therefore to determine appropriate okra/legume-based cropping system that will increase crop yield and consequently farmer's income.

Materials and Methods

The experiment was conducted at the Vegetable Research Farm of the National Horticultural Research Institute (NIHORT), Ibadan, Oyo state, Nigeria ($3^{0}56^{1}$E and $7^{0}33^{1}$N 168 m above sea level) between August and November, 2015. The site lies within the rain forest agro-ecological zone of Nigeria where the monthly rainfall distribution pattern is bimodal with peaks in June and September and annual rainfall between 1250 mm and 1500 mm spanning eight months (March to October) with a dry spell in August. The experiment was arranged in a randomized complete block design (RCBD) with three (3) replicates. The treatments comprised intercropping okra with groundnut or cowpea at a varying spacing (60 cm x 30 cm, 60 cm x 40 cm, 60 cm x 50 cm and 60 cm x 60 cm). Okra (NHAe47-4) obtained from NIHORT was planted at a spacing of 60 cm x 40 cm both in intercrop and sole crop while cowpea (Ife Brown) and groundnut (Kampala) bought from a local market were sown at a different spacing on a plot with dimension of 3 m x 2.4 m (7.4 m^2). Land preparation was done by ploughing and harrowing after which planting was done in August. Weeding was done at two and five weeks after sowing. Five plants were randomly tagged in each plot and data was collected on yield and yield components of okra, groundnut and cowpea. Data collected was subjected to analysis of variance (ANOVA) and significant means were separated using the least significant difference (LSD) test at the 5% probability level.

An economic analysis of the performance of the cropping mixture was carried out using gross margin analysis, monetary advantage index and benefit to cost ratio analysis. Thus:

Gross returns = TR – TVC, where: TR = Total revenue, TVC = Total variable cost;

Monetary advantage index = Value of combined intercrops x LER-1/LER;

LER = Land equivalent ratio.

The gross returns were computed for each treatment using the prevailing farm gate price in the study area. Monetary advantage index was used to assess the yield of okra and the legume in the intercropping/sole cropping system. The higher the index value the more profitable is the cropping system (Mahaptra, 2011) while the benefit to cost ratio was employed to ascertain viability of the cropping mixture.

Results and Discussion

Yield and yield components

Intercropping either groundnut or cowpea with okra had a significant effect ($p \leq 0.05$) on number of fruits per plant, fruit yield and dry matter of okra (Table 1). This is because intercropping systems are known to make a more efficient use of growth factors as they capture and make a better use of radiant energy (Matusso et al., 2012), available water and nutrients (Sullivan, 2003), prevent pest and diseases, suppress weeds and maintain and improve soil fertility (Sanginga and Woomer, 2009; Seran and Brintha, 2010). Okra sown sole also produced the highest fruit yield of 8.9 t/ha, but this was not significantly different from okra intercropped with groundnut at a spacing of 60 cm x 60 cm that produced 8.1 t/ha and also okra intercropped with cowpea at a spacing of 60 cm x 30 cm that produced 8.1 t/ha. This indicated that adequate space available due to these treatments to the crop during the growth period ultimately enhanced higher fruit yield. Similar types of results were reported by Jha et al. (2000) and Das et al. (2002). Okra intercropped with groundnut at a spacing of 60 cm x 30 cm and 60 cm x 40 cm together with okra intercropped with cowpea at a spacing of 60 cm x 50 cm produced dry matter comparable with that of sole okra (Table 1).

Table 1. Yield and yield components of okra intercropped with groundnut and cowpea at different spacings.

Treatment	Number of fruits/plant	Average fruit weight (g)	Fruit yield (t/ha)	Dry matter (t/ha)
Okra + Groundnut (60 X 30)	11.33c	12.44	5.77d	2.58a
Okra + Groundnut (60 X 40)	12.33bc	13.07	6.77bcd	2.68a
Okra + Groundnut (60 X 50)	13.33abc	11.19	6.22cd	1.51bc
Okra + Groundnut (60 X60)	12.67bc	15.33	8.08ab	1.29c
Okra + Cowpea (60 X 30)	16.00a	12.18	8.13ab	1.58bc
Okra + Cowpea (60 X 40)	15.00ab	11.87	7.33abcd	1.87b
Okra + Cowpea (60 X 50)	12.00c	13.23	6.58bcd	2.45a
Okra + Cowpea (60 X 60)	12.33c	15.06	7.70abc	1.49bc
Sole okra	16.00a	13.42	8.89a	2.53a
F sig. ($P \leq 0.05$)	*	Ns	**	**

Groundnut sown sole at all different spacings produced comparable seed weight per plant and seed yield, but significantly higher than those intercropped with okra. Likewise, cowpea sown sole produced significantly higher seed weight per plant and seed yield than those intercropped with okra (Tables 2 and 3). These results are in agreement with those reported by Das et al. (2002) as they found a reduction in yield of a base crop due to intercrop competition.

Table 2. Yield and yield components of groundnut at different spacings in sole crop and intercropped with okra.

Treatment	Seed weight/ plant (g)	Number of pods	Seed yield (t/ha)	Dry matter (t/ha)
Okra/Groundnut(60 cm x 30 cm)	202.67bc	208.00	12.14bc	20.41
Okra/Groundnut(60 cm x 40 cm)	292.50abc	200.67	14.63b	23.18
Okra/Groundnut (60 cm x 50 cm)	200.67bc	208.00	8.03bc	18.18
Okra/Groundnut(60 cm x 60 cm)	110.92c	110.33	3.31c	23.13
Sole groundnut (60 cm x 30 cm)	434.03a	316.00	26.04a	23.67
Sole groundnut (60 cm x 40 cm)	338.41ab	267.67	16.92ab	19.26
Sole groundnut (60 cm x 50 cm)	311.40ab	196.33	12.46bc	15.71
Sole groundnut (60 cm x 60 cm)	441.59a	389.67	15.98b	15.54
F sig. ($P \leq 0.05$)	*	ns	**	ns

Table 3. Yield and yield components of cowpea at different spacings in sole crop and intercropped with okra.

Treatment	Seed weight/ plant (g)	Seed yield (t/ha)	1000 seed weight	Dry matter
Okra/Cowpea (60 cm x 30 cm)	119.82f	7.19cd	19.17	34.32
Okra/Cowpea (60 cm x 40 cm)	87.77g	4.39e	21.14	36.62
Okra/Cowpea (60 cm x 50 cm)	167.80d	6.71d	22.35	37.94
Okra/Cowpea (60 cm x 60 cm)	117.85f	3.54f	20.99	41.82
Sole cowpea (60 cm x 30 cm)	148.70e	8.92b	20.97	55.58
Sole cowpea (60 cm x 40 cm)	314.32a	15.72a	19.92	48.43
Sole cowpea (60 cm x 50 cm)	234.65c	9.39b	18.86	29.18
Sole cowpea (60 cm x 60 cm)	253.78b	7.61c	20.09	32.49
F sig. ($P \leq 0.05$)	**	**	Ns	ns

Productivity

In this study, all intercropping systems showed advantages compared with monocropping systems, and all the intercropping systems recorded high LER compared with monocropping systems (Table 4). A similar finding was reported by Susan and Mini (2005) for okra and amaranth intercropping and Seran and Brintha (2009) for radish and vegetable amaranth. LER values exceeding unity indicate yield advantages from intercropping compared with monocropping. From Table 4, LER values of 1.62 from okra/groundnut at 60 cm x 40 cm and 1.74 from okra/cowpea at 60 cm x 30 cm indicated that the area planted with monocultures would need to be 62% and 74% respectively greater than the intercropping area for the two to produce the same combined yields.

Table 4. LER, aggressiveness and percentage land saved in intercropping over the sole crop.

Treatment	Yield (t/ha)	LER	Aggressive ness	Percentage land save (%)
Okra/Groundnut (60 cm x 30 cm)	5.77	1.41	-0.63	29.08
Okra/Groundnut (60 cm x 40 cm)	6.77	1.62	-0.65	38.27
Okra/Groundnut (60 cm x 50cm)	6.22	1.34	0.33	25.37
Okra/Groundnut (60 cm x 60 cm)	8.08	1.12	4.13	17.71
Okra/Cowpea (60 cm x 30 cm)	8.13	1.74	0.65	42.53
Okra/Cowpea (60 cm x 40 cm)	7.33	1.10	3.21	0.00
Okra/Cowpea (60 cm x 50 cm)	6.58	1.46	0.17	31.51
Okra/Cowpea (60 cm x 60 cm)	7.70	1.34	2.36	25.37

Economic analysis of intercropping systems

Okra/cowpea combination at 60 cm x 40 cm incurred the highest cost of production (₦219,828/ha). This was followed by okra/cowpea spaced at 60 cm x 60 cm (₦219,828/ha). The duo of okra/cowpea at 60 cm x 50 cm incurred the least cost (₦187,908/ha) out of the four okra/cowpea combinations (Table 5). For cowpea at different spacing regimes, the highest cost was incurred when cowpea was spaced at 60 cm x 30 cm (₦166,368/ha) followed by cowpea spaced at 60 cm x 40 cm (₦165,828/ha) while the least cost of production was incurred in sole cowpea spaced at 60 cm x 60 cm (Table 5). Higher costs were incurred in the intercrops compared to the sole. This may be attributable to additional costs involved in the procurement of seed and field management.

The highest cost was incurred for okra/groundnut spaced at 60 cm x 40 cm (₦227,039/ha), followed by okra/groundnut spaced at 60 cm x 30 cm (₦208,410/ha) while the least cost was incurred by okra/groundnut spaced at 60 cm x 50 cm (₦194,321/ha) (Table 5). Higher cost of 227,039/ha incurred in okra/groundnut spaced at 60 cm x 40 cm was due to higher cost of harvesting and planting of the crops in the combination. For sole groundnut at different spacing regimes, the highest cost was incurred when sole groundnut was spaced at 60 cm x 30 cm (₦174,810/ha) and was followed by sole groundnut at 60 cm x 40 cm (₦173,039/ha) while the least cost was incurred when sole groundnut was spaced at 60 cm x 60 cm (₦152,697/ha).

Okra/cowpea spaced at 60 cm x 30 cm was the most remunerative (₦859,192/ha), followed by okra/cowpea spaced at 60 cm x 50 cm (₦744,212/ha) while okra/cowpea spaced at 60 cm x 60 cm was the least remunerative. The highest returns in sole cowpea were obtained when cowpea was spaced at 60 cm x 40 cm (₦1,158,972/ha) while the least was obtained in sole cowpea spaced at 60 cm x 60 cm (₦490,812/ha).

For the okra/groundnut crop combination, the highest gross margin of ₦2,188,961/ha was obtained in okra/groundnut spaced at 60 cm x 40 cm followed by okra/groundnut spaced at 60 cm x 30 cm (₦1,819,590/ha) (Table 5). The least return in okra/groundnut mixture was obtained in okra/groundnut spaced at 60 cm x 60 cm (₦700,103/ha).

Table 5. Economic analysis of the okra intercrops with legumes.

Treatment	Total cost ₦/ha	Gross returns ₦/ha	Gross margin ₦/ha	Monetary advantage index	Benefit to cost ratio
Okra/Cowpea 60 cm x 30 cm	199,968	1,059,160	859,192	450,447	5.3
Okra/Cowpea 60 cm x 40 cm	219,828	776,400	556,572	70,581	3.5
Okra/Cowpea 60 cm x 50 cm	187,908	932,120	744,212	293,682	5.0
Okra/Cowpea 60 cm x 60 cm	201,788	728,560	526,772	184,856	3.6
Sole cowpea 60 cm x 30 cm	166,368	748,800	582,432	-	4.5
Sole cowpea 60 cm x 40 cm	165,828	1,324,800	1,158,972	-	8.0
Sole cowpea 60 cm x 50 cm	153,108	788,400	635,292	-	5.2
Sole cowpea 60 cm x 60 cm	147,588	638,400	490,812	-	4.3
Sole okra	89,148	496,000	406,852	-	5.6
Okra/Groundnut 60 cm x 30 cm	208,410	2,028,000	1,819,590	587,702	9.7
Okra/Groundnut 60 cm x 40 cm	227,039	2,416,000	2,188,961	924,642	10.6
Okra/Groundnut 60 cm x 50 cm	194,321	1,464,000	1,269,679	371,463	7.5
Okra/Groundnut 60 cm x 60 cm	207,897	908,000	700,103	97,286	4.4
Sole groundnut 60 cm x 30 cm	174,810	2,256,000	2,081,190	-	12.9
Sole groundnut 60 cm x 40 cm	173,039	2,368,000	2,194,961	-	13.6
Sole groundnut 60 cm x 50 cm	159,521	1,740,000	1,580,479	-	10.9
Sole groundnut 60 cm x 60 cm	152,697	2,240,000	2,087,303	-	14.7

Okra/groundnut system gave better returns compared to the okra/cowpea cropping system. This may be attributable to higher unit price of groundnut compared to cowpea. Based on the performance of the crop combination, intercropping okra with groundnut was found to be the best for better remuneration and yield.

Monetary advantage index (MAI) values were positive in all the cropping systems evaluated indicating a yield advantage in the intercropping systems. The values of MAI were higher in okra/groundnut intercropping system compared to okra/cowpea intercropping system. The highest MAI value of ₦924,642/ha was obtained in okra/groundnut at 60 cm x 40 cm while the minimum MAI value of ₦70,581/ha was obtained in okra/cowpea at 60 cm x 40 cm spacing. This implied that okra/groundnut at 60 cm x 40 cm was the most valuable economic mixture.

The result of the benefit to cost ratio (BCR) analysis indicated that the highest BCR in okra/cowpea mixture (5.3) was obtained when okra/cowpea was spaced at 60 cm x 30 cm, followed by okra/cowpea spaced at 60 cm x 50 cm (5.0) while the

least BCR was obtained in okra/cowpea spaced at 60 cm x 40 cm (3.5). Sole cowpea spaced at 60 cm x 40 cm gave the highest BCR ratio of 8.0 while the lowest BCR ratio of 4.3 was obtained when cowpea was planted at 60 cm x 60 cm.

The highest BCR of 10.6 was obtained in okra/groundnut spaced at 60 cm x 40 cm followed by okra/groundnut spaced at 60 cm x 30 cm while the lowest (4.4) was recorded in okra/groundnut spaced at 60 cm x 60 cm. Sole groundnut at 60 cm x 60 cm produced the highest BCR of 14.7 compared to other spacing when groundnut was planted sole. The benefit to cost ratio obtained for the cropping mixture that was greater than one indicates the viability of the cropping mixture.

Conclusion

The study indicates that sole okra produced higher fruit yield while okra intercropped with groundnut at closer spacing produced a higher number of fruits per plant. Okra intercropped with cowpea at any of different spacings produced significantly higher fruit yield than those intercropped with groundnut except with groundnut at a wider spacing. Intercropping okra with cowpea at 60 cm x 30 cm gave the highest LER value of 1.74 while okra intercropped with groundnut at 60 cm x 60 cm was most aggressive, followed by okra intercropped with cowpea at 60 cm x 40 cm. More land was saved by intercropping okra with cowpea at 60 cm x 30 cm (42.53%). The economic analysis revealed that okra/cowpea spaced at 60 cm x 30 cm produced the highest gross margin of ₦859,192/ha and monetary advantage index of ₦450,447/ha while okra/groundnut spaced at 60 cm x 40 cm gave the highest gross margin of ₦2,188,961/ha and monetary advantage index of ₦924,642/ha.

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EKONOMSKA ANALIZA ZDRUŽENE SETVE BAMIJE I LEGUMINOZA

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R e z i m e

Poljski ogled je sproveden na eksperimentalnom polju Nacionalnog instituta za istraživanja u hortikulturi u Ibadanu u Nigeriji krajem kišne sezone 2015. godine kako bi se odredio odgovarajući sistem gajenja zasnovan na bamiji i leguminozama koji će povećati prinos useva i prihod poljoprivrednika. Ogled je organizovan po slučajnom blok dizajnu (engl. *randomized complete block design* – RCBD) sa tri (3) ponavljanja. Tretmani su obuhvatali združenu setvu bamije sa kikirikijem ili vignom sejanih na različitim rastojanjima (60 cm x 30 cm, 60 cm x 40 cm, 60 cm x 50 cm i 60 cm x 60 cm). Bamija je sejana na rastojanju od 60 cm x 40 cm, a veličina parcele bila je 3 m x 2,4 m (7,4 m^2). Prikupljeni podaci su podvrgnuti analizi varijanse (ANOVA), i značajne srednje vrednosti su odvojene korišćenjem testa najmanje značajne razlike (engl. *least significant difference [LSD] test*) na nivou verovatnoće of 5%. Ekonomska analiza združivanja useva sprovedena je korišćenjem analize bruto marže, indeksa monetarne prednosti i analize odnosa primanja i troškova. Rezultati su pokazali da je LER indeks (engl. *land equivalent ratio* – LER) od 1,62 zabeležen u združenom usevu bamija/kikiriki na rastojanju od 60 cm x 40 cm, dok je LER indeks od 1,74 uočen u združenom usevu bamija/vigna na rastojanju od 60 cm x 30 cm. Združeni sistem bamija/vigna na rastojanju od 60 cm x 30 cm bio je najunosniji (₦859.192/ha), zatim je sledio združeni usev bamija/vigna sa rastojanjem od 60 cm x 50 cm (₦744.212/ha), dok je združeni usev bamija/vigna na rastojanju od 60 cm x 60 cm bio najmanje unosan. Najviša bruto marža od ₦2.188.961/ha postignuta je u združenom usevu bamija/kikiriki na rastojanju od 60 cm x 40 cm. Najmanji prihod je ostvaren kod združenog useva bamija/kikiriki na rastojanju od 60 cm x 60 cm (₦700.103/ha). Ekonomska analiza je pokazala da je kod združenog useva bamija/vigna pri rastojanju od 60 cm x 30 cm postignuta najviša bruto marža od ₦859.192/ha i indeks monetarne prednosti od ₦450.447/ha, dok je u zdrženom usevu bamija/kikiriki na rastojanju od 60 cm x 40 cm ostvarena najviša bruto marža od ₦2.188.961/ha i indeks monetarne prednosti od ₦924.642/ha.

Ključne reči: združena setva, ekonomska analiza, povrće, leguminoze, LER indeks.

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