Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.3, 2013

www.iiste.org

Assessment of intercropped sweet corn (*Zea mays* var. saccharata) and vegetable cowpea (*Vigna unguiculata* (L.) Walp) using competitive indices in the derived savannah of south-eastern Nigeria

Mbah[1], E. U. and Ogbodo[2], E. N.
[1]Department of Crop Production Technology,
Federal College of Agriculture, P. M. B. 7008, Ishiagu, Ebonyi State, Nigeria.

[2]Department of Crop and Soil Sciences, Ebonyi State University, Abakiliki,
Ebonyi State, Nigeria. E-mail: emmanwaogbodo@yahoo.com
Corresponding author. E-mail: *emmaukmbah@gmail.com*, phone: 08034608421

ABSTRACT
Field experiments were established in 2009 and 2010 cropping seasons at Federal College of Agriculture project farm, Ishiagu, Ebonyi State, Nigeria to assess the biological and economic productivity of intercropping sweet corn with varying plant populations of vegetable cowpea using additive series technique in the derived savannah of south-eastern Nigeria. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The plot size was 3 m x 3 m (9 m^2). On the average over both cropping seasons, sweet corn intercropped with vegetable cowpea, especially at the highest cowpea population gave higher yield advantage in terms of total land equivalent ratio, (1.41), crop yield equivalent for sweet corn (4.71 t ha^{-1}) and vegetable cowpea (2.03 t ha^{-1}), total gross monetary returns (6,763.88 US dollars), monetary equivalent ratio (1.13), and monetary advantage index (2,308.81 US dollars). Therefore, for maximum financial returns, intercropping sweet corn with high vegetable cowpea populations is important because of enhanced productivity of the system, bonus yield and improved protein intake of the farmers from the cowpea component.
Keywords: Sweet corn, vegetable cowpea, yield, biological and economic productivity.

Introduction

Sweet corn and vegetable cowpea are important food crops in Nigeria. Grains from sweet corn are used as food for human and animal consumption. It is also used as an industrial raw material for the production of starch, oil, gluten, flour, alcohol and lignocelluloses for other purposes. The stem and cob are used in the manufacturing of pulp, abrasives and even as fuel for cooking. Cowpea, which is a valued grain-legume, is grown for its pods that are rich in protein with high lysine content for human consumption. The prostrate type serves as a good ground cover crop and live mulch to check soil erosion and weed infestation as well as lower soil temperatures and conserve moisture (Singh and Ajeigbe, 2007). Also, it is a veritable nitrogen fixer that boosts the fertility of the soil at harvest.

In intercropping, some of the major factors that are important in plant interaction include growth habits (particularly stature of crops, rooting systems, and maturity periods), growth rates and competitive ability of crops species depending on the planting densities used (Beets, 1994). A number of field studies by Dapaah *et al.* (2003) on cassava/maize/soybean/cowpea and Muoneke *et al.* (2007) on maize/soybean intercrops showed that cereals and legumes are fast canopy forming and quick growing crops that have different growth stature, hence their demand for environmental resources occur at different growth levels, which implies that the crop species produce higher total grain yield than growing either crop sole.

Competition in intercropping is a major factor, which influences crop performance and yield relative to sole cropping and a number of indices such as land equivalent ratio (LER), competitive ratio (CR), aggressivity (A), crop performance ratio, (CPR), crop yield equivalent (CYE), actual yield loss (AYL), gross monetary return (GMR), monetary equivalent ratio (MER), and monetary advantage index (MAI) have been used to assess competition between crop species in mixtures. The objectives of the study were to examine the influence of vegetable cowpea plant population using additive series on yield of component crops and to determine the profitability of the intercropping system as to improve the management of growth resources for better productivity.

1. **Materials and methods**

Field studies were carried out in 2009 and 2010 at the project farm of the Department of Crop Production Technology, Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. The study area is situated at Longitude 07° 31' E, Latitude 05° 56' N and at an elevation of 150 m above sea level. The experimental site was ploughed, harrowed and levelled. There were six plots, each measuring 3 m x 3 m (9 m^2). Soil samples were collected randomly from the plots to a depth of 0 - 20 cm and bulked into a composite sample. A sub-sample was taken from the bulk for laboratory analysis of the physical and chemical properties if the soil. The treatments were randomly allocated into the experimental plots by piece of paper method. Randomized complete block design with three replications under rain-fed conditions was used. The soil type is ultisol and its texture is sandy loam according to Enwezor, *et al*. (1989). The physical and chemical properties of the soil are shown in Table 1.

Weather pattern of the experimental area is bi-modal with significant monthly rainfall that alows cropping activities from April till October of each year while November to March are characterized by little or no rainfall. Air temperatures and sunshine hours were relatively high and did not appear significantly limiting at any period of the two cropping seasons. The mean annual monthly air temperature (°C) and relative humidity (%) range are relatively constant throughout the year. The vegetation is derived savannah.

Sweet corn [Oba super 2 (HB)] and early maturing semi-prostrate vegetable cowpea (IT 98K-692) were sown in ratio mixtures as follows:

1. Sweet corn, (100 %) 53,000 plants ha^{-1} (75 x 25 cm) + vegetable cowpea, (100 %) 55,500 plants ha^{-1} (60 x 30 cm);
2. Sweet corn, (100 %) 53,000 plants ha^{-1} (75 x 25 cm) + vegetable cowpea, (75 %) 41,700 plants ha^{-1} (60 x 40 cm);
3. Sweet corn, (100 %) 53,000 plants ha^{-1} (75 x 25 cm) + vegetable cowpea, (50 %) 27,780 plants ha^{-1} (60 x 60 cm);
4. Sweet corn, (100 %) 53,000 plants ha^{-1} (75 x 25 cm) + vegetable cowpea, (25 %) 13,900 plants ha^{-1} (60 x 120 cm);
5. Sole Sweet corn, (100 %) 53,000 plants ha^{-1} (75 x 25 cm);
6. Sole vegetable cowpea (100 %) 55,500 plants ha^{-1} (60 x 30 cm).

Four crop mixtures were formed using additive series technique as described by Ebwongu *et al*. (2001). Additive series implies that the plant population of one crop species is constant while that of the other crop species is added or superimposed on it, which amounts to increasing the total plant populations of the crop species per unit area, above 100 per cent.

Sole sweet corn and vegetable cowpea were established for assessing the productivity of the system. The crops were sown on the same day using the appropriate plant spacing to correspond with the required planting density in the treatment plots. Weeding was done at 3 and 6 weeks after planting (WAP). N.P.K. fertilizer was applied immediately after the first weeding at the rate of 200 kg ha^{-1}. The insecticide, Cypermethrin (10 % EC) was applied at the rate of 100 ml 20 litres-^{1} of water in a knapsack sprayer to control insect pests of vegetable cowpea at flowering and podding stages of growth.

At Maturity, number of kernels cob^{-1}, fresh cob yield ha^{-1} of sweet corn were determined, while grain yield ha^{-1} adjusted to 15 % moisture content (MC) according to Beets (1994) was also obtained and recorded. Data on vegetable cowpea were collected on number of pods $plant^{-1}$, fresh pod yield ha^{-1}. Legume grain yield adjusted to 13 % MC from the experimental net plots was collected, weighed and yield converted into tons $hectare^{-1}$.

The biological productivity from the mean yield data of both sole and the intercropping systems was determined using the following indices:

Land equivalent Ratio (LER), which is the sum of the ratio of the yields of the intercrops to those of the sole crops. LER = Ls + Lv = {(Yis / Yss) + (Yiv /Ysv)}, where, Ls and Lv = Partial LERs of crops ‘s’ (sweet corn) and ‘v’ (vegetable cowpea); Yis and Yiv are yields of intercropped sweet corn and vegetable cowpea, respectively, while, Yss and Ysv are yields of sole sweet corn and vegetable cowpea, respectively. The values of LER greater than unity indicate a yield advantage, (Ofori and Stern, 1987).

Land equivalent coefficient (LEC), which assesses the measure of interaction as it relates to the strength of relationship between the two crops. LEC = L*a* x L*b,* where, **L*a*** = LER of main crop (sweet corn or vegetable cowpea); **L*b*** = LER of intercrops. For a two-crop mixture, the minimum expected productivity coefficient (PC) is 25 %, which shows that a yield advantage is obtained if LEC value exceeds 0.25, (Adetiloye *et al*., 1983).

Competitive Ratio (CR), which indicates the number of times by which one component crop is more competitive the other. It shows the ratio of individual LERs of the two component crops and takes into account the proportion of the crops on which they are initially sown. For species a (sweet corn) = CRa = {(LERa / LERb) X (Zba / Zab)}, For species b (vegetable cowpea) = CRb = {(LERb / LERa) X (Zab / Zba)}, where, LERa = Land equivalent ratio of sweet corn,

LERb = Land equivalent ratio of vegetable cowpea; Zab = Proportion of crop 'a' (sweet corn) grown in association with crop 'b' (vegetable cowpea); Zba = Proportion of crop 'b' (vegetable cowpea) grown in association with crop 'a' (sweet corn). If CR is greater than unity, crop 'a' is more competitive than crop 'b' and if the value is less than unity, than crop 'a' is less competitive than crop 'b'. The reverse is true for crop 'b', (Putman *et al*., 1984).

Aggressivity (A) index was used to assess the competitive relationship between two crops in a mixture. A_{ab} (sweet corn) = {Yab / (Yaa X Zab)} - {Yba / (Ybb X Zba)};

A_{ba} (vegetable cowpea) = {Yba / (Ybb X Zba) } - {Yab / (Yaa X Zab)}, where, Yaa and Ybb are yields of sweet corn and vegetable cowpea as sole crops, respectively; Yab and Yba are yields of sweet corn and vegetable cowpea in intercrops, respectively; Zab and Zba are the sown proportions of crop 'a' (sweet corn) and crop 'b' (vegetable cowpea), respectively. If the value of A_{ab} is zero, both crops are equally competitive. If the value of A_{ab} is positive, then sweet corn is dominant in the intercrop. If the value of A_{ab} is negative, then sweet corn is the dominated crop in the mixture, (Ghosh *et al*., 2006).

Crop Performance Ratio (CPR): The difference in yield per unit area as a result of resource uptake was evaluated using the index - CPR, which is the productivity of an intercrop per unit area of ground compared with that expected from the sole crops sown in the same proportions.

CPR = $(Y_{ia} + Y_{ib}) / (P_{ia} + Y_{sa}) + (P_{ib} + Y_{ab})$, where, Y_{ia}, Y_{ib} = Productivity in unit area in the intercrop of sweet corn and vegetable cowpea; Y_{sa}, Y_{ab} = Productivity in unit area in the sole crop of sweet corn and vegetable cowpea; P_{ia}, P_{ib} = Proportion of intercrop area sown with sweet corn and vegetable cowpea, (Azam-Ali *et al*., 1990). For each crop species, the productivity in the intercrop was expressed as partial CPR. A value of CPR greater than unity implies an intercrop advantage and a value less than unity, an intercrop disadvantage.

Crop yield equivalent (t ha^{-1}) was calculated according to the procedure below:

Crop yield equivalent (t ha^{-1}) = Yield of crop 'a' (sweet corn) or crop 'b' (vegetable cowpea) / Prevailing market price of crop 'a' or 'b' x Prevailing market price of the intercrop (a +b), where, 'a' = Yield of sweet corn or vegetable cowpea in sole 'a + b' = Yield of sweet corn and vegetable cowpea in intercrop, (Prasad and Srivastava, 1991).

In assessing the economic advantage of intercropping, the yield of all sweet corn and vegetable cowpea in intercropping and sole cropping as well as their economic return in terms of monetary value were evaluated to find out whether the system was profitable or not. It was calculated with the following indices:

Gross monetary return (GMR) (₦ ha^{-1}) was computed for each treatment based on the prevailing farm gate price per unit weight of the produce in the study location. For this calculation, farm gate price was used because it provides the actual gross return, which the farmer receives.

Monetary equivalent ratio (MER) was determined by the method outlined by Adetiloye and Adekunle (1989).

Monetary advantage index (MAI) is used to assess the yield of sweet corn and vegetable cowpea in intercropping and sole cropping systems and their economic return in terms of monetary value to find out whether sweet corn yield and additional vegetable cowpea yield are profitable or not. The index was calculated thus: **MAI = $(P_{scn} \times P_{vcp}) \times (LER - 1) / LER$,** where,

$P_{scn} = P_{sc} \times Y_{sc}$; $P_{vcp} = P_{vc} \times Y_{vc}$, where, P_{sc} = Price of sweet corn; P_{vc} = Price of vegetable cowpea; Y_{sc} = Yield of sweet corn; Y_{vc} = Yield of vegetable cowpea. The higher the index value the more advantageous or profitable is the cropping system, (Mahapatra, 2011).

For each year, all data from each crop were separately subjected to analysis of variance relevant to RCB using Genstat computer package (Genstat, 2003). Means were compared using the least significant difference (LSD) at 5 % level of probability according to Obi (2002).

2. Results and discussion

Yield and yield components

Significant differences (P<0.05) were observed between the treatments in the number of kernels cob^{-1}, fresh cob yield (t. ha^{-1}) and grain yield (t. ha^{-1}) (Table 2). Number of kernels cob^{-1} varied between 290 and 349 (2009) and 240 and 312 (2010) with an average of 325 (2009) and 289 (2010). Sole sweet corn had the highest number of kernels cob^{-1}, fresh cob yield $hectare^{-1}$ and grain yield $hectare^{-1}$ relative to the intercropped treatments. Among the crop mixtures, 100 % sweet corn intercropped with 100 % vegetable cowpea had the lowest number of kernels cob^{-1} but higher fresh cob yield $hectare^{-1}$ and grain yield $hectare^{-1}$ due to increased aggregate planting density $unit^{-1}$ area. The trend was the same in both cropping seasons. The results obtained corroborate findings by Filho (2000) in maize/cowpea intercrop in which he surmised that growth resources such as water and solar radiation are better utilized in intercropping than sole crop. Also, Egbe *et al*. (2010) in their assessment study of some extra-early and early-maturing cowpea varieties intercropped with maize in southern guinea savannah of Nigeria reported that intercropping had no significant (P>0.05) effect on yield and yield components of the crop species in the system relative to their sole crops, hence the resultant yield advantage, which was obtained through land equivalent ratio, area by time equivalent ratio and land equivalent coefficient indices.

Productivity

Land equivalent ratio (LER) values were greater than unity in all the intercropped plots, indicating the advantage of intercropping over sole cropping in regard to efficient use of environmental growth resources in both years (Table 3). The results showed that between 30 and 47 % (2009) and 25 and 40 % (2010) more land would be required under sole systems to obtain the same amount of yield relative to intercropping. The result is consistent with similar studies by Manu-Aduening and Boa-Amponsem (2005) on spatial arrangement in yam/maize/pepper as well as Azam-Ali *et al*. (1990) on light use, water uptake and performance of crops in sorghum/groundnut intercrops. The variations in performance among the intercrop treatments could be attributed to the difference in total plant population $unit^{-1}$ area, especially for vegetable cowpea, resulting in differences in the intercrop competition.

In the two cropping seasons, LEC ranged from 0.377 to 0.486, which was consistently high under 100 % sweet corn intercropped with 100 % vegetable cowpea. Similar results were obtained by Adetiloye *et al*. (1983) in their study on simple complex mixtures in which they surmised that the minimum expected production before a yield advantage can be obtained in a two-crop mixture is an LEC greater than 0.25, which implies a productivity coefficient greater than 25 %.

Competitive ratio and aggressivity, which are indices for assessing intercropping advantages, indicated that at 100 % sweet corn intercropped with 100 % vegetable cowpea, that vegetable cowpea was the more competitive component, perhaps due to the higher population advantage and its ability to fix atmospheric nitrogen. However, at the lowest vegetable cowpea mixture population, sweet corn was aggressively more competitive. These productivity results were consistent with the findings of Mahapatra (2011) in Sebai grass (*Eulaliopsis binata*) and black gram (*Vigna mungo*) intercrop grown in warm humid monsoon climate of India, Egbe and Idoko (2009) in sweet potato varieties/pigeon pea intercrop in southern guinea savannah of Nigeria, as well as Yilmaz *et al*. (2008) in maize/legume intercropping systems in the east Mediterranean region.

In the two cropping seasons, total CPR showed that some of the crop mixtures had values that were above unity, indicating intercrop yield advantage compared to sole crop, especially at 100 % sweet corn and 100 % vegetable cowpea combination as shown in Table 4. Similar results were obtained by Seran and Brintha (2009) in their biological and economic study of radish (*Raphanus sativus* L.) and vegetable amaranthus (*Amaranthus tricolor* L.) in Sri-Lanka as well as Manu-Aduening and Boa-Amponsem (2000) in complex mixture such as yam/maize/pepper intercrop in Ghana. Crop yield equivalent of sweet corn was consistently higher in all the mixtures relative to vegetable cowpea. The trend was the same in both cropping seasons. The results obtained corroborate findings of Mbah and Ogidi (2012) in cassava/soybean as well as Mohamed *et al*. (2009) in maize/common bean intercrops, indicating yield advantage in the whole intercropping systems. Actual yield loss showed that the component crops had varying degrees of losses. AYL (total) showed yield losses with the least crop yield loss values of 58 % (2009) and 60 % (2010) in 100 % sweet corn/100 % vegetable cowpea intercrop. The findings corroborate studies by Takim (2012) in maize/cowpea intercrop in the southern guinea savannah ecological zone of Nigeria.

In Table 5, some economic assessment indices such as GMR, MER and MAI showed that the intercropping combinations were profitable than sole crops. 100 % sweet corn intercropped with 100 % vegetable cowpea had the highest monetary return and advantage index in the two cropping seasons. The results were consistent with the findings of Mahapatra (2011) in his study on grass/legume and Mbah *et al*. (2009) in cassava/soybean intercrops.

Conclusion

The results from this study pointed to the potential and sustainability benefits of intercropping system. Sweet corn and vegetable cowpea intercrop may increase, decrease or even not affect crop yields of the component crops depending on total plant population per unit area. However, intercropping sweet corn and vegetable cowpea, especially at 100 % of the component crops showed strong biological and economic land use efficiency and crop yield advantage.

References

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

Adetiloye, P. O. and A. A. Adekunle. 1989. Concept of monetary equivalent ratio and its usefulness in the evaluation of intercropping advantages. Trop. Agrci., 66:337 – 341.

Azam-Ali, S. N., R. B. Mathew., J. H. Williams., J. M. Peacock. 1990. Light use, water uptake and performance of individual components of a sorghum-groundnut intercrop. Expl. Agric., 26: 413 - 427.

Beets, W. C. 1994. Multiple cropping of maize and soybean under a high level of crop management. Netherlands J. Agric. Sci., 25: 95 – 102.

Dapaah, H. K., J. N Asafu-Agyei., S. A. Ennin., C. Yamoah. 2003. Yield stability of cassava, maize, soybean and cowpea intercrops. J. Agric. Sci., 140: 73 -82.

Ebowaogu, M., E Adipala., C Sseambembe., S. Kyamanywa., A. S. Bhagsaril. 2001. Effect of intercropping maize and Solanum potato on yield of the component crops in central Uganda. African Crop Sci. J., 9 (1): 83 – 96.

Egbe, O. M., S. E Alibo. and I. Nwueze. 2010. Evaluation of extra-early- and early- maturing cowpea varieties for intercropping with maize in southern guinea savanna of Nigeria. Agric. and Bio. J. N. Am, 1(5):849–858. www. scihub.org/ABJNA.

Egbe, O. M. and J. A. Idoko. 2009. Agronomic assessment of some sweet potato varieties for intercropping with pigeon pea in southern guinea savanna of Nigeria. Agro- science J. Trop. Agric. Food, Environ. and Exten., 8 (2): 74 – 83.

Enwezor, W. O., E. J. Usoroh., K. A. Ayotade., J. A. Adepetu., V. O. Chude. and C. I. Udegbe. 1989. Fertilizer use and management practices for crops in Nigeria. Series, No.2, Federal Ministry of Agriculture and Natural Resources (FMANR), Lagos, 16pp.

Filho, J. M. P. L. 2000. Physiological responses of maize and cowpea to intercropping. Pesquisa Agropecuaria do Tropico semi-arido (CPA TSA), Brasilia, 35 (5):915- 921.

Genstat. 2003. Genstat for windows release 4.23 DE Discovery Edition, VSN International Limited, Hemel Hempsteins, UK http//www.discovery genstat.co.uk.

Ghosh, P. K., M. C. Manna., K. K. Bandyopadhyaya., A, K. Tripathi., R. H. Wanjari., K. M. Hati., A. K. Misra, C. L. Acharya., R. Subba. 2006. Inter-specific interaction and nutrient use in soybean/sorghum intercropping system. Agron. J., 98: 1097-1108.

Mahapatra, S. C. 2011. Study of grass-legume intercropping system in terms of competition indices and monetary advantage index under acid lateritic soil of India. Am. J. Expl. Agric., 1(1): 1-6. www.sciencedomain.org.

Manu-Aduening, J. A. and K. Boa-Amponsem. 2006. Influence of spatial arrangements on performance of a yam-maize-pepper intercrop. Ghana J. Agric. Sci., NARS. Ed., 1: 29 - 35.

Mbah, E. U., C. O. Muoneke. and D. O. Okpara. 2009. Evaluation cassava (*Manihot esculenta* Crantz) planting methods and soybean (*Glycine max* (L.) Merrill) sowing dates on the yield performance of the component species in cassava/soybean intercrop under the humid tropical lowlands of southeastern Nigeria. African J. Biotech., 8 (1):042 047. www.academicjournal.org/AJB.

Mbah, E. U. and E. C. Ogidi. 2012. Effect of soybean plant populations on yield and productivity of cassava and soybean grown in a cassava-based intercropping system. Trop. and Subtrop. Agro-ecosyst., 15: 241- 248.

Mohamed, I. D., J. M. Wilkinson, and D. J. Pilbeam. 2009. Interactions between plants in intercropped maize and common beans. J. Sci. Food and Agric., 89: 41 - 48. www.interscience.com.

Muoneke, C. O., M. A. O. Ogwuche, and B. A. Kalu. 2007. Effect of maize planting density on the performance of maize/soybean intercropping system in a guinea savannah agroecosystem. African J. Agric. Res., 2 (12): 667 - 677.
Obi, I. U. and E. Obi. 2002. Statistical Methods of Detecting Differences Between Treatment Means and Research Methodology issues in Laboratory and Field Experiments. 2nd Ed., AP Express Publishing Company Limited, Nsukka, Nigeria, 116 pp.
Ofori, F. and W. R. Stern. 1987. Cereal–legume intercropping systems. Advanced Agron., 41: 41- 90.
Prasad, K. and R. C. Srivastava. 1991. Pigeon pea (*Cajanus cajan*) and soybean (*Glycine max*) intercropping system under rain-fed situation. Indian J. Agric. Sci., 61: 243 – 244.
Putnam, D. H., S. J. Herbert, and A. Vargas. 1984. Intercropped corn-soybean density studies. 1. Yield complementarity. Expl. Agric., 21: 41 - 51.
Seran, T. H. and I. Brintha. 2009. Biological and economic efficiency of radish (*Raphanus sativus* L.) intercropped with vegetable *amaranthus* (*Amarantus tricolor* L.). The Open Hort. J., 2:17-21.
Singh, S. B. and H. Ajeigbe. 2007. Improved cowpea-cereals based cropping systems for household food security and poverty reduction in West Africa. J. Crop Improvement, 19 (1 & 2): 157 – 172.
Takim, F. O. 2012. Advantages of maize-cowpea intercropping over sole cropping through competition indices. J. Agric. Biodiv. Res., 1(4):53-59. www.onlineresearchjounals.org/JABR.
Yilmaz, S., M. Atak, and M. Erayman. 2008. Identification of advantages of maize-legume intercropping over solitary cropping through competition indices in the East Mediterranean region. Turkish J. Agric., 32: 111 - 119.

Table 1: Physical and chemical properties of the soils (0 - 20 cm) of the experimental areas 2009 and 2010 cropping seasons.

Year	Soil physical properties				Soil chemical properties							
	Sand (%)	Silt (%)	Clay (%)	pH (H_20)	Org.M (%)	Org. C (%)	Total N (%)	Available P (mg Kg^{-1})	Exchangeable bases (cmol Kg^{-1}) Ca		K	Mg
2009	66.40	18.80	14.80	5.93	1.27	0.74	0.06	21.0	2.00	0.14	1.20	0.131
2010	74.60	15.70	9.70	4.64	2.75	1.59	0.13	26.35	2.80	0.27	1.60	0.330

Source: Soil Science Laboratory, National Root Crops Research Institute, Umudike, Abia State.

Table 2: Yield and yield components of sweet corn and vegetable cowpea in additive series intercropping system in 2009 and 2010 cropping seasons.

Crop	Yield parameter	SC, 100 % + VC, 100 %	SC, 100 % + VC, 75 %	SC, 100 % + VC, 50 %	SC, 100 % + VC, 25 %	Sole sweet corn,
2009						
Sweet corn	No. of kernels cob^{-1}	290	322	326	338	349
	Fresh cob yield (t. ha^{-1})	5.68	6.07	7.24	7.61	7.92
	*Grain yield (t. ha^{-1})	1.40	1.52	1.71	1.95	2.14
Vegetable cowpea	No. of pods plant^{-1}	30.24	34.21	40.37	52.85	-
	Fresh pod yield (t. ha^{-1})	4.95	4.68	3.95	3.43	-
	†Legume grain yield (t. ha^{-1})	1.24	1.17	0.99	0.86	-
2010						
Sweet corn	No. of kernels cob^{-1}	240	279	304	312	310
	Fresh cob yield (t. ha^{-1})	4.17	5.92	5.64	6.01	6.18
	*Grain yield (t. ha^{-1})	1.70	1.78	1.90	2.18	2.65
Vegetable cowpea	No. of pods plant^{-1}	24.6	20.7	29.1	30.6	-
	Fresh pod yield (t. ha^{-1})	3.64	3.53	3.32	2.94	-
	†Legume grain yield (t. ha^{-1})	1.18	1.03	0.91	0.82	-

SC = Sweet corn, VC = Vegetable cowpea, *Grain yield of sweet corn at 15 % MC, †legume grain yield at 13% MC, s.e.d = Standard error of difference between two means.

Table 3: Land equivalent ratio, land equivalent coefficient (LEC), competitive ratio and aggressivity of sweet corn and vegetable cowpea in additive series intercropping system in 2009 and 2010 cropping seasons.

Treatment	Land equivalent ratio (LER)			LEC[3]	Competitive ratio (CR)		Aggressivity (A)	
	†Partial		‡Total		SC[1]	VC[2]	SC[1]	VC[2]
2009	SC[1]	VC[2]						
Sweet corn, 100 % + vegetable cowpea, 100 %	0.65	0.77	1.42	0.50	0.840	1.185	-0.120	0.120
Sweet corn, 100 % + vegetable cowpea,75 %	0.71	0.72	1.43	0.51	2.958	0.338	0.470	0.483
Sweet corn, 100 % + vegetable cowpea, 50 %	0.80	0.61	1.41	0.49	2.623	0.381	0.495	0.210
Sweet corn, 100 % + vegetable cowpea, 25 %	0.91	0.53	1.44	0.48	6.868	0.146	0.778	0.303
Sole Sweet corn, 100 %	1.00	-	1.00	-	-	-	-	-
Sole vegetable cowpea, 100 %	-	1.00	1.00	-	-	-	-	-
2010								
Sweet corn, 100 % + vegetable cowpea,100 %	0.64	0.76	1.40	0.49	0.842	1.188	-0.113	0.113
Sweet corn, 100 % + vegetable cowpea,75 %	0.67	0.63	1.30	0.42	3.191	0.313	0.463	0.404
Sweet corn, 100 % + vegetable cowpea, 50 %	0.72	0.53	1.25	0.38	2.711	0.368	0.452	0.172
Sweet corn, 100 % + vegetable cowpea, 25 %	0.82	0.46	1.28	0.38	7.130	0.140	0.707	0.259
Sole Sweet corn, 100 %	1.00	-	1.00	-	-	-	-	-
Sole vegetable cowpea, 100 %	-	1.00	1.00	-	-	-	-	-

SC1= Sweet corn, VC2 = Vegetable cowpea, Land equivalent coefficient3 (LEC). † Partial LER for SC1 and VC2 were obtained by dividing each intercrop yield by its corresponding sole crop yield. ‡Total LER was the sum of the partial LERs from SC1 and VC2 in the intercropping system.

Table 4: Crop performance ratio, Crop yield equivalent and Actual yield loss of sweet corn and vegetable cowpea in additive series intercropping system in 2009 and 2010 cropping seasons.

Treatment	Crop performance ratio (CPR)			Crop yield equivalent (t ha^{-1}) (CYE)		Actual yield loss (AYL)		
	Partial		Total			Partial		Total
2009	SC[1]	VC[2]		SC[1]	VC[2]	SC[1]	VC[2]	
Sweet corn, 100 % + vegetable cowpea, 100 %	0.654	0.765	1.42	4.57	1.79	-0.35	-0.23	-0.58
Sweet corn, 100 % + vegetable cowpea, 75 %	0.711	0.241	1.00	4.51	1.76	-0.29	-0.37	-0.66
Sweet corn, 100 % + vegetable cowpea, 50 %	0.799	0.306	1.11	4.24	1.66	-0.20	-0.69	-0.89
Sweet corn, 100 % + vegetable cowpea, 25 %	0.911	0.133	1.04	4.08	1.62	-0.09	-0.87	-0.96
Sole Sweet corn, 100 %	1.00	-	1.00	-	-	-	-	-
Sole vegetable cowpea, 100 %	-	1.00	1.00	-	-	-	-	-
2010								
Sweet corn, 100 % + vegetable cowpea, 100 %	0.642	0.755	1.40	4.85	2.28	-0.36	-0.25	-0.61
Sweet corn, 100 % + vegetable cowpea, 75 %	0.672	0.209	0.88	4.39	2.03	-0.33	-0.79	-1.12
Sweet corn, 100 % + vegetable cowpea, 50 %	0.717	0.265	1.00	4.11	1.93	-0.28	-0.74	-1.02
Sweet corn, 100 % + vegetable cowpea, 25 %	0.823	0.116	0.94	4.11	1.94	-0.18	-0.88	-1.06
Sole Sweet corn, 100 %	1.00	-	1.00	-	-	-	-	-
Sole vegetable cowpea, 100 %	-	1.00	1.00	-	-	-	-	-

SC1= Sweet corn, VC2 = Vegetable cowpea.

Table 5: Gross monetary return, monetary equivalent ratio and monetary advantage index of sweet corn and vegetable cowpea in additive series intercropping system in 2009 and 2010 cropping seasons.

Treatment	Gross monetary return (GMR)			Monetary equivalent ratio (MER)	Monetary advantage index (MAI)
	Partial		Total		
2009	SC[1]	VC[2]			
Sweet corn, 100 % + vegetable cowpea,100 %	252,000	570,400	822,400	1.10	345,408.00
Sweet corn, 100 % + vegetable cowpea,75 %	273,600	538,200	811,800	1.09	244,107.69
Sweet corn, 100 % + vegetable cowpea, 50 %	307,800	455,400	763,200	1.02	221,923.40
Sweet corn, 100 % + vegetable cowpea, 25 %	351,000	395,600	746,600	1.00	228,127.78
Sole Sweet corn, 100 %	385,200	-	385,200	-	-
Sole vegetable cowpea, 100 %	-	745,200	745,200	-	-
2010					
Sweet corn, 100 % + vegetable cowpea,100 %	408,000	754,800	1,162,800	1.16	332,228.57
Sweet corn, 100 % + vegetable cowpea,75 %	427,200	627,300	1,054,500	1.05	243,346.15
Sweet corn, 100 % + vegetable cowpea, 50 %	456,000	530,400	986,400	1.00	197,280.00
Sweet corn, 100 % + vegetable cowpea, 25 %	523,200	464,100	987,300	0.99	215,971.88
Sole Sweet corn, 100 %	636,000	-	636,000	-	-
Sole vegetable cowpea, 100 %	-	999,600	999,600	-	-

(SC1) Sweet corn, (VC2) Vegetable cowpea. Yield of the component crops (SC1 and VC2) were sold at the prevailing market prices of ₦180:00 kg-1 and ₦460:00 kg-1, respectively, (2009); ₦240:00 kg-1 and ₦510:00 kg-1, respectively, (2010), cropping seasons. 1 US Dollar in 2009 was ₦145:00 (Nigerian Naira) and in 2010 it was ₦148:50 (Nigerian Naira).