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PRODUCTION FUNCTION AND PROFITABILITY ANALYSIS OF MAIZE-COWPEA INTERCROPPING IN NASARAWA-EGGON LOCAL GOVERNMENT AREA OF NASARAWA STATE, NIGERIA

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ABSTRACT

The study analyzed the Economics of maize-cowpea intercropping in Nasarawa- Eggon Local Government Area of Nasarawa State, Nigeria. Data were collected with the use of astructured questionnaire administered to 120 respondents on their socio-economic characteristics. Simple descriptive statistics, gross margin and regression analysis were the analytical tools used in achieving the outcomes. The result shows that 56.7% of thefarmers were male, while 43.3% were female and falls within the age group of 21- 40 years with 39.2% and 38.3% having attended secondary and primary schools. Most of the respondents were not visited by extension agents. Labour made up to 56.5% of the total variable cost, while Agro-chemical had the lowest proportion of 5.2% of the cost. The gross margin was estimated at ₦132,751.23, while the return per naira invested was found to be ₦1.99 indicating that for every naira invested, the farmers make₦2.0. Production function analysis expressed that the double log regression model had the best fit to the data, with 0.758, meaning that 76% of the variation in output was accounted for by the inputs included in the model. Labour had positive regression coefficients indicating adirect relationship with the output. High cost of inputs, inadequate capital, and pest and disease were identified as major constraints in the area. It is recommended that improved cowpea and maize, functional infrastructure, adequate extension contacts and accessible and affordable loanable funds be provided as incentives to boost cereal output.

Keywords: Analysis, Cowpea, Maize Intercropping, Production Function, Profitability

INTRODUCTION

The decline in the Nigeria's agricultural production coincides with the nation's oil boom of the 1960's. Onuk (2015) reported that some of the factors responsible for Nigeria's food insecurity are low crop yields, use of traditional low yielding crop varieties, inconsistencies in the macro-economic policies being experience occasioned by frequent changes in government and inadequate legislations the will ensure continuity of programmes and projects, pests and disease outbreak, wrong choice of enterprise combination and cropping systems. The food demand-supply gap that has been created resulted in increased for imports and high rate of food prices due to inadequate supply despite food importation caused by increased in the unpredictable foreign exchange being experienced in Nigeria and in some cases, non-availability of the external currencies needed to meet the needs of the importers.

Maize is a member of the grass family known as (*Gramineae*). It originated from South and Central America. It was introduced to West African by the Portuguese in the 10th century. Maize is one of the most important grains in Nigeria, not only on the basis of the number of farmers that engage in its cultivation but also in its economic value. It is a major cereal being cultivated in the rainforest and the derived savannah zones of Nigeria. Maize has been in the diet of Nigerians for centuries. It started as a subsistence crop and has gradually become a more

important crop and now it has graduated to a commercial crop on which many agro-based industries depend on as a source of raw materials (Iken and Amusa, 2004).

The bulk of maize grain produced in Nigeria used to be from the South Western part of the country. Ogunbodede (2001) reported that Western Nigeria generally produced about 50% of Nigerian green maize, the remaining 50% being splited between the North and East. Although alarge proportion of the green maize is still produced in the South-western part, there has been adramatic shift of dry grain production to the Savanna area which is regarded as the maize belt of Nigeria. In this zone, farmers now tend to prefer maize cultivation to sorghum. This trend may have been brought about for several reasons including theavailability of streak resistant varieties for all ecological zones in Nigeria; availability of high yielding hybrid varieties and increase in maize demand.

According to Khawar*et al. (*2007), maize has a variety of uses. Its grain is a rich source of vitamins, protein, starch, and mineral. Maize is a cereal plant that produces grains that can be cooked, roasted, fried, ground, or crushed to prepare various food items such as hot and cold pap, *tuwo, akple, nakia, gwate, egbo, donkwa, popcorn, kokori, ajepasi, elekute, abari, and aadun*. Apart from food, maize is also used as medicine, raw material for industries and livestock feed. Cowpea on the other hand, is a member of the widely cultivated genus Vigna. It is one of the most important food legume crops in the semiarid tropics covering Asia, Africa, Southern Europe, and Central and South America.

Data compiled by International Institute of Tropical Agriculture, Ibadan (IITA, 2000) showed that the largest acreage under cultivation with cowpea was in West Africa. Of the world's total of about 7.7million hectares devoted to cowpea production, about 6.1million hectares (80%) are in West Africa and 4 million hectares of this areas is in Nigeria (ibid) is a warm season crop and cannot stand cold weather. The warm and moist climate is favorable for this crop. It cannot tolerate heavy rainfall. Cowpea can grow in all types of soil, but sandy and sandy loam soils are best suited for it. The soil should be rich in organic matter.

The major raw material required for production is the cowpea seed which can be sourced mainly from the Northern part of the country due to the climatic condition of the area. Some of the cowpea producing States in Nigeria are; Adamawa, Borno, Zamfara, Sokoto, Kano, Yobe, Niger, Nasarawa, Benue, Kogi, Kaduna and Gombe. Cowpea flour is used in the preparation of Akara (Fried cowpea paste), can wake (cowpea dumpling), moi-moi (steamed cowpea) and also the grains can be cooked and eaten solely or in a mixture with other grains. Cowpea adds nitrogen to the soil and serves as fodder for animals. Cowpea contains abioactive antioxidant such as vitamin c, carotenoids, and phenolic compounds.

Intercropping is the growing of two (2) or more crops on the same piece of land within the same year (Sullivan, 2003). Intercropping is advocated due to its benefit for yield increase (Chen *et al.,* 2004), control of weeds (Poggio, 2005) and control of legume root parasite infections (Fenandez-Aparicio*et al.,* 2007). Maize-cowpea intercropping is currently receiving attention because of its unique importance such as suppression of weeds by the spreading cowpea plant, complementary relationship between the maize and cowpea in the use of nutrient, adding stability to the cropping system and as safeguard against failure of some crops. In order to ensure and promote sustainable agricultural development, Coker *et al*. (2014) opined that the United National Rio plus 20 conference on sustainable development, amongst other programmes agreed on the need to establish comprehensive policies and programmes that will ensure effective and efficient management and utilization of land resources and soil fertility for sustainable agricultural development.

Problem Statement

Though Nigeria is blessed with vast land and other resources suitable to produce enough food for her population, theoutput of crops has constrained her food sufficiency efforts. Going by the rapid rate of population growth in Nigeria, it is logical to conclude that the rate of growth in output of food crops may not be sufficient to satisfy the demand for food by the increasing population (Muhammad-Lawal*et al.,* 2014). The continuous cultivation of a particular piece of land by farmers with little or no measures to improve the soil condition seriously affects the productivity of the farmers not only in terms of maize crops but themajority of crops being cultivated.

This calls for production of mixtures of crops with different growth behavior, chemical, biological composition, nutrient requirements and maturity period. Intercropping of cereals and legumes is widespread among farmers due to the ability of the legumes to contribute to addressing the problem of declining levels of soil fertility being experienced in many parts of the country.

Objectives of the Study

i. describe the demographic variables of maize-cowpea farmers in the study area
ii. determine the influence of inputs on the output of maize and cowpea
iii. determine cost and return of maize-cowpea mixture in the study area
iv. identify the major constraints to maize-cowpea intercropping in the study area

METHODOLOGY

The study was carried out in Nasarawa-Eggon Local Government Area (LGA) of Nasarawa State, Nigeria. It covers a land mass of about 1,208km^2. It lies between latitude 8^0 51'N and longitude 5^{0}05'E. It is bounded on the North by Akwanga in the East by Wamba, in the West by Kokona and in the South by Lafia. The LGA has an estimated population of 196,560 as at the year 2016 (NPC, 2006). The major occupation of the inhabitants is farming and crops commonly cultivated include cowpea, maize, rice, sorghum, groundnut, yam, sweet potatoes, sugarcane, and pepper. Tree crops grown in the area are cashew and orange. The study area is heterogeneous in ethnic composition. The LGA as an agrarian local government area has a great percentage of the populace engaged in farming as an occupation. The LGA has a tropical climate, characterized by dry and wet seasons. The rainy season commences early in April to October whereas the dry season starts from November to March. The annual average rainfall in the LGA ranges between 180 mm and 200 mm. The climate, soil type, and hydrology allow for thecultivation of most staple foods, grazing land for animals, fresh water for fishing and forestry.

Sampling Technique and sample size

The study employed multi-stage sampling techniques in the selection of respondents in maize-cowpea intercropping in the study area. In the second stage, two wards each were chosen from each district. In the third stage, from the selected wards, two villages were selected proportionally to the size of the wards selected as thefirst sampling frame.

In the final stage, a list consisting of all the names of maize-cowpea farmers in each of the twelve (12) villages was obtained, numbered and squeezed, this formed the second sampling frame. Thereafter, at random, farmers were selected from each village. A total of one hundred and twenty farmers were chosen for the study in a ratio proportional to the size of their population.

Method of Data collection

The data for the research was mainly from aprimary source. These were obtained through a structured questionnaire, which was distributed to maize-intercropped farmers in the study area.

Data collected from the farmers covered 2015/2016 cropping season. Secondary data/information was also obtained from printed materials such as journals, text books, internet, periodicals, conference proceedings as well as yearly records of production from relevant agencies.

Information collected includes variables on the respondent's socio-economic characteristics such as; age, marital status, household size and farm size. Also, information on the inputs used in cowpea and maize production such as labour, seeds, etc were as well collected.

Methods of data analyses

The methods of data analyses used include: descriptive statistics and budgeting techniques. The budgeting technique was employed to estimate costs and returns from maize-cowpea inter-cropped. The net income is the difference between the gross margin and the total fixed cost. Thus, it is known that gross margin is the difference between the value of production and that of total variable cost employed in the production process. The net income analysis is thus used to determine the performance of theenterprise, that is, the productive component of a firm to obtain information as pertains the business strength or weakness that will help the respondents to effect suitable changes that will bring in about more prosperity. In other words, the net income involves evaluation of the efficiency of theindividual enterprise. The net income analysis was used to achieve objective two (2) of the study. The value of production was the gross income obtained from maize-cowpea and in Naira/kilogram, whereas the variable costs considered were costs of inputs like fertilizer, labour, transportation, ploughing etc. Mathematically, Gross Margin is given as:

GM = TR- TVC

Where;

GM = Gross margin

TR = Total revenue

TVC = Total variable cost,

NFI = GM – TFC (TR – TC)

TFC = Total fixed cost

TC = Total cost (TVC + TFC)

Descriptive statistics such as frequency distribution and percentage were used to achieve objective (i), and (iv). Production function analysis was used to achieve Objective (ii). Linear, semi log and double log (cobb-douglas) functional forms were used. The general form of the production function is given as:

$$Log(Y) = \beta_0 + \beta_1 \log(X_1) + \beta_2 \log(X_2) + \beta_3 \log(X_3) + \beta_4 \log(X_4) + e$$

Where

Y= Quantity of maize and cowpea (₦/ha)

X_1= Labour (₦/ha)

X_2 = Seeds (₦/ha)
X_3 = Fertilizer (₦/ha)
X_4 = Agrochemical (₦/ha)
β_0 = constant term
$\beta_1 - \beta_4$ = regression coefficients
e = error term

RESULTS AND DISCUSSION

Demographic variables of the respondents

The distribution of the respondents according to their demographic variables of the respondent**s** including Age, gender, marital status, household size, farm size, farming experience, level of education and frequency of extension visit is presented in Table 1

Table1. Socio economic characteristics of maize cowpea farmers in the study area

Variables	Frequency	Percent
Age		
<20	7	5.8
21-30	48	40.0
31-40	42	35.0
41-50	11	9.2
51 and above	12	10.0
Total	120	100
Gender		
Male	68	56.7
Female	52	43.3
Total	120	100
Marital status		
Married	63	52.5
Single	25	20.8
Widowed	4	3.3
Divorced	28	23.3
Total	120	100
Household Size		
1-5	26	21.7
6-10	66	55.0
10 and above	28	23.3
Total	120	100
Farm Size		
<1	109	90.8
1-3	11	9.2
Total	120	100
Farming Experience (Years)		
1-10	49	40.8
11-20	41	34.2
21-30	17	14.2
31-40	12	10.8
Total	120	100
Level of education		
No formal education	17	14.2
Primary	46	38.3
Secondary	47	39.2
Tertiary	10	8.3
Total	120	100
Frequency of extension visit		
None	60	50.0
Once	35	29.2
Twice	20	16.6
Thrice or more	5	4.2
Total	120	100

Source: Field survey, 2016

Distribution of the respondents according to Age

The Age of the respondents presented in table 1 revealed that 75% of maize-cowpea farmers fall within the age group of 21-40 years indicating that a good number of them where within their active age. This finding agrees with that of Awudu and Bernard (2003) who stated that efficiency increased with age until a maximum efficiency

was reached. This is understandable since it is expected that as farming household head becomes older his or her productivity will decline.

Distribution of the respondents according to Gender

Table 1 further revealed that maize-cowpea intercropping was dominated by males with 56.7% as against females with 43.3%. This result compares favourably with the finding of Bakoji (2013) who noted that 70.8% of maize-cowpea intercrops farmers in Akko Local Government Area of Gombe State were males.

Distribution of the respondents according to marital status

The result also showed that majority (52.50%) of the respondents were married whereas 23.30%, 20.80%, and 3.30% were divorced, singled and widowed respectively. This indicates that about 79% of the respondents were in one way or the other married before or are still married. This could suggest that, more children and invariably high availability of family labour could be obtained but subject to their ages and interest in supporting the family in any business activities including farming.

Distribution of the respondents according to Household size

The result shows that 55.0% of maize-cowpea farmers in the study area had afamily size of between 6 and10 persons per household, while 23.30% and 21.70% had above 10 persons per house hold respectively. (Bayacag, 2001) stated that greater family size increases efficiency. This can be explained by the fact that readily available family labour will allow for the timely execution of important farm activities such as fertilizer application and weeding, thus contributing to higher yields.

Distribution of the respondents according to farm size

Table 1 also shows that a large proportion of the respondents 90.83% had farm size of less than or equal to 1 hectares while only 9.17% of them had 2-3 hectares. This means that all of them were small-scale farmers. Rahman (2003) reported that farm size has a positive and significant relationship with technical efficiency.

Distribution of the respondents according to Farming experience

About, 40.8% of the respondents had between less than 10 years of farming experience, about 34.2% had between 11-20 years of experience, 14.2%had between 21-30 years of experience and 10.8% had 31-40 years of experience. This shows that maize-cowpea farmers in the study area were relatively experienced implying a significant level of specialization and expertise in production.

Distribution of the respondents according to Level of education

Analysis of theeducational level of the respondents shows that 39.2% attained secondary education, 38.3% attained primary education, and 14.2% without formal education, 8.3% attained tertiary education meaning 86% had aformal education with only 14% that have never been to school. Adewuyi and Okumadewa (2001) stated that education enhances thelevel of understanding. Education has apositiveeffect on the adoption of farming techniques because it enables farmers to perceive and implement skill acquired from friends or extension agents. This shows that quite a number of the respondents are educated in the study area. It is noteworthy that education is one of the major socio-economic factors that have animpact on the output and productivity of the farmers. Farmers with formal education are privileged to have early contact with new innovations and improved technologies which are designed to improve output and productivity, moreover, such farmers are early adopters and risk aversion tendency reduces with formal education. This is collaborated by Adams (2009) who reported that in poultry industry, formal education affords farmer especially, those that have training in agriculture the opportunity to understand proper management of resources in poultry production

Distribution of the respondents according to frequency of extension visit per annum

About 50.0% of the respondents were not visited by extension agents while 29.2% were visited once. (Ogaji, 2010) stated that farmers that have extension contacts are likely to be more efficient than those without any extension contacts. Extension visit plays an important role in making farmers gained more understanding of their farming activities.

Influence of inputs on the output of maize and cowpea

The result of the production function analysis shows that the double log regression model form had the best fit to the data. Labour had positive regression coefficient indicating adirect relationship with the output. The result presented in Table 2 showed that the co-efficient of multiple determinations (R^2) is 0.758 that is, 75% of the variation in the dependent variable was explained by the independent variables. The F-test value of 90.252 is significant at 1%. The result revealed that the regression coefficient for labour was 0.966. This implies that if labour is increased by 1% the value of the output of maize-cowpea will increase by approximately 0.96% and it is significant at 1%. The result also shows that seeds, fertilizers, and agrochemicals were not significant but have negative coefficient indicating that an increase in each variable will leads to decrease in revenue.

Enterprise budget for one hectare of maize-cowpea in the study area

The cost and return analysis of maize-cowpea intercrops are presented in Table 3. The study revealed that labour contributed most to the total cost of production with 56.5% followed by seeds with 25.4% while thecost of agro-chemical had the lowest proportion of 5.2%. This finding agrees with that of Bamire and Segun-Olasanmi

(2010) who found that labour constituted the highest component of the total variable cost, representing about 50% and 43% of the cost expended by male and female maize-cowpea intercrop farmers respectively in Oyo State. This implies that maize-cowpea production is labour intensive.

Table 2: Estimates of double log production function for maize-cowpea intercrop

Variable	Coefficient	Std. Error	T-statistic	Prob.
Constant	1.986086	0.590950	3.360836	0.0011
Labour X_1	0.965925	0.060563	15.94898	0.0000*
Seed X_2	-0.001528	0.006977	-0.219051	0.8270
Fertilizer X_3	-0.003973	0.004314	-0.920998	0.3590
Agrochemical X_4	-0.005732	0.006096	-0.940302	0.3490
R^2 = 0.758				
Adjusted R^2 = .750				
F – test = 0.252				

Source: Field survey, 2016 * significant at 1%

The gross margin (GM) was calculated and documented as ₦132,751.23 per hectare. The return per Naira invested was as well estimated at N1.99, that is, for every 1 Naira invested there was a gain of ₦1.99. These positive values showed that maize-cowpea production in Nasarawa- Eggon Local Government Area of Nasarawa State is a profitable enterprise. The result is in line with Onuk*et al*. (2017) who conducted a similar study Economic analysis of Yam-Cowpea intercropping system in Obi Local Government Area, Nasarawa State, Nigeria. Their study revealed a gross margin of N13,068.45/ha.

Table 3: Enterprise budget per hectare for Maize-Cowpea intercropping in the study area

Item		**Percentage**
Revenue/ha:		
Maize	94,693.33	
Cowpea	104,679.58	
Total Revenue (TR)	199,372.92	
Variable Costs/ha		
a. Cost of Labour		
b. Planting materials	39,418.33	56.5
i.Maize	7,553.17	10.3
ii. Cowpea	10,749.03	15.1
c. Fertilizer		
i. NPK	4,863.58	10.7
ii. Urea	653.33	2.2
d. Agro-Chemicals	3,384.25	5.2
Total Variable Cost (TVC)	66,621.69	100
Gross margin (GM)	132,751.23	
Return on naira invested (ROI)		
N1.99		
Benefit cost ratio (BCR) = 2.99		
Operating cost ratio (OCR)	0.334	

Source: Field survey, 2016

Constraints faced by maize cowpea farmers in the study area

Table 4 revealed the problems faced by maize-cowpea farmers in the study area. The result indicates that high cost of inputs ranked 1st with (86%), followed by pest and diseases and soil infertility with 2nd and 3rd rank respectively. The high cost of transportation, inadequate storage facilities, and inadequate extension contact were ranked4th, 5th, and 6th respectively). Inadequate capital and poor marketing outlet were ranked least in the order of magnitude of importance with 7th and 8th respectively.

Table 4: Constraints faced by Maize-Cowpea intercropping in the study area

Constraints	**Frequency**	**Rank**
High cost of inputs	86	1st
Pest and diseases	81	2nd
Soil infertility	48	3rd
High cost of Transportation	34	4th
Storage problem	30	5th
Inadequate extension contact	28	6th
Inadequate capital	13	7th
Poor marketing outlet	11	8th

Source: Field survey, 2016 *Multiple responses

Conclusion

The results of the socio-economic characteristics survey revealed that maize-cowpea intercropping was dominated by male. A good number of the farmers were in their active productive age. Most of them were married and had large households. Most of them did not experience any extension visit. The gross margin was estimated at ₦132,751.23, while the return per naira invested was found to be ₦1.99 indicating that for every naira invested, the farmers make₦2.0 signifying a 200% returns and this confirms the profitability of maize-cowpea inter-cropped in the study area. The results of the production function analysis expressed that the double log regression model form had the best fit to the data, with R^2 value of 0.758, meaning that 76% of the variation in maize-cowpea output was accounted for by the inputs included in the model. Labour had positive regression coefficient indicating adirect relationship with the output while seeds, fertilizer and agro-chemical were not significant but have negative coefficients indicating that an increase in either of the variable will lead to decrease in revenue. However, maize-cowpea intercrop was constrained by high cost of inputs, pest and diseases, loss of soil fertility among others. Despite these odds, maize-cowpea inter-cropped is a profitable enterprise in the study area

Recommendations

Based on the findings of the study, the following recommendations are made to improve production of maize and cowpea;

i. Improved seeds of maize and cowpea should be developed and made available to the farmers at affordable prices. This can be achieved either through the establishment of community seed multiplication or through serving as out-growers to the seed s and research institutes for a certification and with payments through the branded seeds

ii. Infrastructural facilities such as roads, electricity, pipe borne water and schools should be provided in the rural areas to encourage effective youths participation and by minimizing rural-urban migration that will minimize labour scarcity the rural areas and thereby makelabour for agricultural production and other related services.

iii. More financial institutions are established, supported and encouraged to provide more credit facilities to the farmers at the required time, place and reasonability.

iv. More extension agents should be trained and posted to farming communities. These extension agents should be equipped with training tools and supported with the required mobility to ease transportation and ensure wider coverage so that they can disseminate information to the farmers on relevant and available technologies for higher performance.

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