RESOURCE USE EFFICIENCY OF YAM/MAIZE CROPPING ENTERPRISE AMONG SMALL SCALE FARMERS IN BOSSO LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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ABSTRACT

Despite the contribution of inter cropping to the economy and food security of small scale farmers in particular and Nigeria in general, there is still widespread food shortage. This study therefore analyzed the resource-use efficiency among yam/maize intercropping enterprise in four villages in Bosso local government area of Niger state. A total of 80 yam/maize farmers were randomly selected for this study. Data was obtained from farmers using structured questionnaires. Production function and multiple regression analysis were used for the analyses. Findings showed that all the resources were inefficiently allocated with an efficiency index of 0.0083 for farm size. This implies that farm size was not efficiently utilized by the farmers it also indicates that the marginal factor cost (MFC)of acquiring an additional hectare of land is greater than the marginal value product (MVP), therefore the resource is being over utilized. The inefficient utilization of all the resources underscores the existence of marked mal- allocation and a great scope for improvement in output by re-allocating the existing resources more efficiently. Factors influencing efficiency in the study were farm size, fertilizer, labour and capital. It was recommended that small scale farmers needed to be enlightened on best practices in production.

Key words: intercropping, marginal factor cost, marginal value product, efficiency

INTRODUCTION

Agriculture belongs to the real sector of Nigerian economy. It is characterized by numerous small-scale farmers scattered all over wide expanse of land area, with small holdings ranging from 0.50 – 3.0 hectares per farm land, rudimentary farm system, low capitalization and low yield per hectare (Olayemi, 1994).

Tubers belong to a class of food that basically provides energy in human diet in form of carbohydrate. Yam is a member of this important class of food and is ranked second to cassava in Africa. A total of about 26 million tons of yam were produced on the continent annually in the 70's (Onwuene, 1978) but from more recent report of the International Institute of Tropical Agriculture (IITA) (2005) 37.5million tones of yam were produced worldwide in the year 2000, 96% of this was in Africa and Nigeria is leading producer with 26 million tones.

Maize (*Zea mays L.)* originated in Mexico in Central America. It is the most important cereal crop in the world after wheat and rice with regard to cultivation areas and total production (AID, 1974; Purseglove, 1992 and Osagie and Eka, 1998) and in Nigeria the third most important cereal crop after sorghum and millet (Ojo, 2004). In Nigeria, the traditional farmer finds it more satisfactory to plant diversity of crops than planting sole. In crop mixture co-operation is more apparent than competition. Yam intercrop with maize is productive and compatible because maize is a short season crop while yams are long duration (7-12months) crops (Ibeawuchi, 2004).

Intercropping /mixed system of farming is a common feature among small scale farmers in Nigeria and it is a form of multiple cropping in an attempt to meet family food security, cash need and to cover production cost in the face of risk of crop failure. Therefore measurement of efficiency is very important for the following reason; firstly, it is an indicator to success and a measurement of performance by which production units are evaluated; secondly, the ability to quantify efficiency provides the decision maker with a control mechanism with which to monitor the performance of production system.

The objective of this study therefore, is to ascertain the resource use efficiency in yam/maize crop production enterprise and identify the determinants of output in yam/maize enterprises in study area.

Conceptual Framework

Agricultural productivity is defined as a measure of efficiency with which an agricultural production system employs land, labour, capital and other resources. Economists have different types of productive efficiency and widely accepted definition is the one commonly quoted in literature. Farrell (1957) specified two types of efficiency: technical efficiency and allocative efficiency. He defined technical efficiency as the ability to extract the maximum output from a given level of input. Allocative efficiency refers to the farmers' ability to achieve the optimal mix i.e. having the right and efficient combination of inputs that gives optimal output.

The measurement of firm specific technical efficiency is based upon deviation of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier, it is perfectly efficient: if it lies below the frontier, then it is technically inefficient with the ratio of the actual to potential production defining the level of technical efficiency of the individual farm (Greene, 1993). Technical efficiency is just one component of overall economic efficiency. However, in order to be more economically efficient, a firm must be technically efficient, i.e. use the right mix of output given the set of prices.

Efficiency can be considered in terms of the optimal combination of inputs to achieve a given level of output (an input orientation) or the optimal output that could be produced given a set of inputs (an output orientation). Efficiency of farms is estimated using various sofwares such as Linear Programming technique of Data Envelopment Analyses (DEA), LIMDEP and Frontier Production Function.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out in Bosso Local Government Area of Niger State. According to National Population Commission, (NPC) (2006) the State has a population of 147,359 (NPC, 2006).The area lies between latitude 90^0 41N and longitude 60^{0}33E . The Local Government Area has a land mass which have boundary with Chanchaga local government and bordered to the North and North East by Shiroro local government and the south East by Paikoro local government area while Gbako local government area is bordered to the south.

The vegetation is principally shrubs, grass land to wood land with pockets of trees. The topography is predominantly plain lands with interrupted undulations. The soil ranges from sandy loam to clay loam. The climate of the study area is a resemblance of the guinea savanna ecological region of Nigeria. The raining season last between 190-200 days (6-7 months) with October recording the highest of 300mm (11.7 inches). Mean monthly temperature is highest in March at 35°C (88°F) and lowest in August at 25°C (75°F). Bosso Local Government has a fertile land for the cultivation of crops like yam, cassava, guinea corn, rice, millet, sweet potatoes and maize (NSADP, 2005).

Sampling Procedure/ Data collection

The study employed multistage and purposive sampling techniques. Firstly Bosso local government was purposely selected because it has high concentration of farmers that practice yam / maize intercrop combination. Secondly, four villages namely: Maikunkele, Garatu, Shatta and Beji were purposively selected. Thirdly twenty farmers from each village given a total of 80 yam/ maize farmers were randomly selected.

Structured questionnaires were administered to the respondents with the assistance of the Niger State Agricultural Development Project (NSADP) extension agents as well as well trained enumerators in each of the locations. The questionnaires were supported with oral interview. A list of yam/maize intercrop farmers was obtained from the NSADP for these villages which served as the sampling frame. A proportionate selection of 10% of the farmers was selected to give the sample size for the study (Table 1).

Table 1: Sample Selection of Respondents

Villages	Total population of yam/maize intercrop farmers	10% of Total population of yam/maize intercrop farmers selected.
Maikunkele	201	20
Garatu	198	20
Shatta	196	20
Beji	204	20
Total	799	80

Source: Niger State Agricultural Development Project (NSADP), 2009

Data Analysis

Resource use efficiency and factors affecting yam maize intercrop were estimated using production function analysis. Four functional forms namely, linear, semi-log, double log and exponential were tried for this study.

Model Specification

The model adopted for this study is implicitly specified as

$Y = f(X_1, X_2, X_3, X_4, X_5, e)$ --------- (1)

Y = yield (Grain Equivalent Weight)

X_1 = farm size (hectares)

X_2 = Labour Input (man days)

X_3 = Fertilizer Input (kg)

X_4 = Value of other production inputs like seeds, cost of Agro-chemicals (₦), etc.

X_5 = Capital Inputs (depreciated value of farm machinery, implements and tools, interest payment on borrowed lands, rent on land etc). (₦)

e = Error term

Grain Equivalent Weight (GEW) was used to standardize the outputs in the mixed cropping by multiplying them with given conversion factors based on the grain values of the crops. The conversion factors provided by Clark and Haswell (1970) were used for the purpose of standardization. (See Appendix 1).

Four functional forms namely linear, Cobb Douglas, Exponential and Semi log were tried for this study. However, the exponential model gave the best fit and was selected for further discussion, based on statistical significance of the estimated regression coefficients as well as apriori expectation. The explicit form of the model is presented below:

1. Exponential: $\ln Y = bo + b_1X_1 + b_2X_2 + b_3X_3 + b_4x_4 + b_5X_5 + e$ ---- (2)

Where,

$\ln Y$ = Yield (GEW)

b_o = constant,

$b_1, b_2\ b_3 \ldots b_n$ = regression estimates

Measuring Resource use efficiency or allocative efficiency

The allocative efficiency of resources was achieved using marginal analysis. The marginal value products of resources were estimated and compared with their marginal factor productivities. The condition of optimum use of input *xi* as predicted by the theory of equilibrium in factor markets under profit maximization is that the marginal value product (MVP) equals the price of the input (*P*i).Hence, profit is maximized where the marginal value products to opportunity cost ratio is equal to one. This is also the point of efficient resource utilization. If MVP is lower than *P*i were the ratio of marginal value products to opportunity costs is less than one or negatively signed this suggests over utilization of a given resource. Lowering the quantity used at the current price will increase the MVP and restore optimality. On the other hand, if MVP is greater than *P*i and the ratio of marginal value products to opportunity costs is greater than one or positively signed this suggests the resource is under-utilized and using more of it will bring additional gains to the producer.

The marginal value product is calculated as:

$MVP_1 = MFC_1$ ----------------------

But $MVP_i = MPP_i.P_y$ ---------------------- (7)

MVP is the monetary value of the marginal physical product (MPP). ---------------------- (8)

Where P_y = Price of unit of Output

But $MPP = \frac{\partial y}{\partial x}$ ---------------------- (9)

Therefore the allocative efficiency index K_{ij} for each enterprise would be computed.

K_{ij}

$\frac{MVPxi}{MFCxi} = \frac{MPP.Py}{MFCxi}$ ---- 10

Where K_{ij} = Allocative Efficiency Index

Maximum or absolute efficiency is attained if $K_{ij} = 1$

If $K_{ij} = \frac{MVPxi}{MFCxi} = 1$ = efficient resource use

If $K_{ij} = \frac{MVPxi}{MFCxi} < 1$ = implies that the resource is over utilized

If $K_{ij} = \frac{MVPxi}{MFCxi} > 1$ = implies that the resource is under utilized

RESULTS AND DISCUSSION

Resource Use Efficiency of Resources

The allocative efficiency of resources was examined using the efficiency index analysis whereby the marginal value product (MVP) of resources was compared with the marginal factor cost (MFC).

Table 2: Resource Use Efficiency of Yam/Maize production

Resources	MFC (Acquisition Cost)	B=Bi.Xi (Elasticities)	Py (₦)	MVP	MVP/MFC	% Deviation Optimality (1-MVP/M X 100)
Farm size	3500	0.7293	39.80	29.026	0.0083	99
Labour	400	0.2886	39.80	11.486	0.0287	97
Fertilizer	100	0.2695	39.80	10.726	0.1073	89
Capital	1.18	0.1170	39.80	4.406	3.7339	-273.4

Source: Field survey, 2009.

Py =Price of unit output. Price of 1kg of yam= ₦19.60, price of 1kg maize = ₦60 therefore Py for the mixture = ₦39.80

Results in Table 2 indicated that all the resources were inefficiently allocated; the efficiency index for farm size was 0.0083. This implies that farm size was not efficiently utilized by the farmers it also indicates that the Marginal Factor Cost (MFC) acquiring an additional hectare of land is greater than the Marginal Value Product (MVP) therefore the resource is been over utilized. This means that, farmers are operating in stage III of the classical production function. To maximize the return from yam/maize intercropping enterprise, farmers should reduce their farm sizes. Similar studies by Bretet et *al.* (2008) showed that the variable farm size under study in Millet/Sorghum intercropping was highly underutilized this was adduced to the fact that the efficiency ratio of land was greater than unity, revealing underutilization of inputs. From this it can also be inferred that the results of underutilization of farm size in the study is caused by lack of good management practices.

The result in Table 2 also indicated that capital inputs with a percentage deviation from optimality value of -273.4% is the most inefficiently utilized resources been the farthest from optimality. The least inefficiently allocated resources the closest to optimality is fertilizer with the percentage deviation value of 89.0%. Overall all the resources were inefficiently utilized and the result underscores the existence of marked mal-allocation and a great scope for improvement in output by re-allocating the existing resources more optimally.

Econometric Tests of Variables

Table 3: Multicollinearity tests

	Y	Fsize	Lab	fert	agrchm	Cap
Y	1					
Fsize	0.793183	1				
Lab	0.816716	0.904258	1			
Fert	0.793195	0.610355	0.572912	1		
Agrchm	0.415334	0.444327	0.498473	0.376176	1	
Cap	0.13557	-0.07764	-0.09191	0.15748	0.12467	1

Source: Field survey, 2009

Table 3, shows the pair wise correlations between the output (Y) and the explanatory variables farm size, labour, fertilizer, agrochemicals and capital under investigation. It can be inferred that there is no existence of multicollinearity among the variables, and the assumption of multicollinearity is not violated.

Table 4: Normality Tests

Variables	Y	fsize	Lab	fert	agrchm	cap
Kurtosis	9.460696	4.544273	10.1291	11.40063	2.914239	17.81796
Skewness	3.067141	1.989091	2.956999	3.231683	1.723296	3.797945

Source: Field survey, 2009

The skeweness and kurtosis test is a measure of ascertaining the distribution of the variables hence presenting whether the variables are normally distributed or not. From the results of the skeweness tests, it shows that variables range from 1.7 to 3.7, this reveals that variables are not completely skewed to the right or left and are all positive depicting a normal distribution. Hence the assumption of normality is not violated.

Test of Heteroskedasticity

The Breush Pagan test for heteroskedasticity was employed to carry out this test. Results revealed that chi2 (1) = 139.42 and Prob > chi2 = 0.000, this implies a strong rejection of homoskedasticity given the value of probability, and the assumption of homoskedasticity is not violated. The non violations of the assumptions of multicollinearity, normality and heteroskedasticity implies that further analysis can be carried out using the ordinary least squares regression analysis.

Factors Affecting Yam/Maize Production in Study Area

The allocation efficiency of resources for yam/maize cropping enterprise was observed by comparing the MVP and the MFC of resources employed. A production function was estimated economically to generate ordinary least square (OLS) estimated which guided the computation.

Table 5: Regression Results of Yam/Maize Intercrop enterprise in Bosso Local Government Area of Niger State, Nigeria.

Variables	Linear	Semilog	[+]Exponential	Double-Log
Constant	-2662.576 (-3.492)***	-124858.9 (-3.492)***	7.200 (64.361)***	2.599 (2.916)***
Farm size	1328.691 (0.636)	1213.095 (0.299)	0.374 (4.699)***	0.166 (1.639)
Labour	134.036 (4.637)***	13790.096 (2.730)***	0.003 (2.607)**	0.733 (5.819)***
Fertilizer	49.171 (7.118)***	8147.196 (2.695)***	0.002 (7.047) ***	0.495 (6.574)***
Other inputs	-59.132 (-0.549)	1816.186 (0.945)	0.001 (0.303)	0.012 (0.256)
Capital	0.923 (2.380)**	4836.383 (1.283)	2.86E-005 (0.056) *	0.076 (0.812)
R^2	0.839	0.579	0.890	0.877
R^2 Adjusted	0.829	0.551	0.883	0.869
F value	(77.172)***	(20.375)***	(120.262)***	(105.532)***

[+] Lead Equation

Sources: Field survey data, 2009. Figures in parenthesis are the respective t-ratios;
***, ** and * implies statistically significant at 1%; 5% and 10% respectively.

Results in Table 5 revealed the exponential function as the lead equation. It has an R^2 value of 0.890 which implies that about 89.0% of the variation in the output of yam/maize enterprise is explained by variable $X_1 - X_5$ which are (farm size, labour , fertilizer, other inputs and capital) included in the model while the remaining 11.0% could be as a result of non-inclusion of some important explanatory variables as well as errors from estimation. The F-value is also statistically significant at 1% level. This implies that the explanatory variables ($X_1 - X_5$) adequately explained the model. In particular, the estimated regression coefficients for farm size, 0.374 and fertilizer, 0.002 were positive and statistically significant at 1% level. This implies that there is a positive significant relationship between farm size and fertilizer with output of yam/maize intercrop enterprise. This suggests that as the farm size increase the output of yam/maize intercrop also increases.

The factors affecting yam/maize intercropping system were observed using the OLS regression techniques. Result in Table 5 indicate that the factors affecting yam/maize intercropping system with respective regression coefficients were farm size (0.374), labour (0.003), fertilizer (0.002) and capital (2.8E-005).

In particular, farm size with an estimated regression coefficient was positive which agrees with *a priori* expectation. It also indicates that as the farm size increases, the output realized from yam/ maize intercropping system also increases. Larger farm sizes coupled with good management practices should translated into improved output.

CONCLUSION AND RECOMMENDATION

It is concluded that all the resources were inefficient utilized and the result underscores the existence of marked mal-allocation and a great scope for improvement in output by re-allocating the existing resources more efficiently.

Based on the findings, the following recommendation were made:

1. Farmers should be adequately enlightened on the benefit of engaging in this system of farming with view of solving the problem of food insecurity in the country.
2. The level of observed efficiencies has been shown to be significantly influenced by farmsizes, capital labour and fertilizer. The economic implication these factors must be considered by policy maker when designing agricultural policy that is central focused on how best to improve the production efficiency of the farmers.

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Appendix I: Indices for Conversion into Kg-Grain Equivalents

Crops	Index
Rice (rough)	0.80
Rice (clean)	1.19
Maize	0.75
Millet	0.68
Sorghum	0.60
Groundnut (shelled)	1.83
Groundnut (unshelled)	1.30
Soybean	1.30
All pulses	1.12

Source: Clark and Hasswell (1970)