Agrosearch (2014) Volume 14(2):179-190 http://dx.doi.org/10.4314/agrosh.v14i2.8

PRODUCTION ELASTICITIES, RETURN TO SCALE AND ALLOCATIVE EFFICIENCY IN YAM PRODUCTION IN EDO STATE, NIGERIA.

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ABSTRACT

The study estimated the production elasticities, the return to scale and analysed the allocative efficiency of resources used in yam production in Edo State. A four-stage sampling process involving simple random sampling was employed to select 180 yam farmers and a set of questionnaire was used to collect data from the respondents. The Data collected were analysed using stochastic frontier production function and marginal analysis. The result of the study showed that none of the inputs used by the farmers was efficiently allocated and utilised. Land (15.72), planting material (7.27) and fertilizer (2.38) were under-utilised, while labour (0.63) and agrochemical (0.52) were over-utilised. This showed that there was the existence of disequilibria in the allocation and utilisation of inputs by yam farmers in Edo State. Also, production elasticity estimates indicated that the farmers' production was in stage 1 (irrational stage) of the production function indicating that there is room for expansion in output and productivity of yam farmers in Edo State. This can be actualised by cropping higher hectarage of farm land with increased quantity of planting material and controlled usage of higher quantities of fertilizer as these were found to be under-utilised. A return to scale of 1.434 indicated increasing returns to scale.

Keywords: Allocative Efficiency, Elasticity of Production, Return to Scale, Yam.

INTRODUCTION

Yam constitutes the predominant starchy staple especially in sub-Saharan Africa where food security for a growing population is a central issue (Fu *et al*., 2011). Although, Nigeria is the largest yam producer in the world accounting for 65% of the global production in 2008 (FAO, 2010) yet there has been a decline in yam production in Nigeria over the years (IITA, 2002). The area under cultivation and total yam output were also declining (IITA, 2002 and Ayanwuyi*et al*, 2011). Studies have shown that food crop farmers in Nigeria have low productivity because of inefficiency in resource use (Idiong*et al*, 2002). Production is the process of transforming inputs such as capital, labour and land into goods and services called output. One of the major targets of any society is the attainment of an optimal level of production with a given amount of effort. This has been the focus of many individuals, private and government organisations worldwide aiming at poverty alleviation, high productivity and food sufficiency, especially in developing countries including Nigeria (Jacobi, 1998; Mougeot, 2000). Thus, any increase in the productivity

of resources employed in the production enterprise would amount to progress. In view of this, productivity gains in agricultural production (including yam production) are considered as a pre–requisite for overall economic development (Mafimisebi and Adams, 2003). Efficiency analysis is an issue of interest among economists in recent times. Optimisation can be obtained either by minimising the cost of producing a given level of output or maximising the output attainable with a given level of cost. Both optimisation problems require the proper allocation of input for the goal to be achieved (Oluwatayo *et al.*, 2008). Maximum resource productivity implies obtaining the maximum possible output from the minimum possible set of input. In this context, optimal productivity of resources involves an efficient utilisation of resources in the production process as stated by Kyi and Oppen, (1998) and sited by Ezeaku *et al* (2013). To achieve economic optimum output and thus profitability, resources have to be optimally and efficiently utilized. Though, yam production in Edo State is a good source of income to the farmers, yet no records have shown it to have attained optimal level which proper allocation of inputs can achieve. The question therefore is whether yam farmers in Edo State are efficient in the allocation of the resources employed in the production process; what could be the value of their marginal product of the inputs? What are the production elasticities and the status of their input utilisation? Allocative efficiency studies help farmers to determine the extent to which they can appropriately adjust productive resources in order to achieve optimum productivity, therefore the need to carry out such a study.

The objective of this study therefore was to ascertain the level of allocative efficiency of resource use among yam farmers in Edo State with a view to facilitating investment decision making as well as give an indication of optimal input utilisation necessary to obtain maximum return. The specific objectives included the estimation of the value of marginal product, the production elasticities, return to scale and the determination of the input utilization status and hence the allocative efficiency.

RESEARCH METHODOLOGY

Study Area

The study was carried out in Edo State. The State lies approximately between longitude 06^0 04^l E and 06^0 43^lE and latitude 05^0 44^lN and $07^0$$34^l$N (NPC, 2006). It is bound in the south by Delta State, in the west by Ondo State, in the north by Kogi State and in the east by Kogi and Anambra States. It is important to note that Edo State is located in the yam producing belt of Nigeria (NFRA, 2007) where the crop plays an important role in the social and religious festivals of the people and it is viewed as an integral part of their heritage.

Sampling Procedure

A four stage sampling process was employed in selecting the samples needed for the study. Firstly, the study area was stratified based on the Edo State Agricultural Development

Programme delineation that is Edo South, Edo Central and Edo North agro - ecological zones, so as to get a State wide coverage. The second stage involved the simple random selection of two (2) wards which were the Local Government Areas (LGAs) from each of the agro ecological zones. The selected wards were Orhiomwon and Uhunmwonde for Edo South agro-ecological zone, Esan West and Esan South East for Edo Central agro-ecological zone, Owan East and Estako West for Edo North agro- ecological zone. The third stage involved the random selection of three villages from each ward, while the last stage involved a compilation of the list of yam farmers in each village to serve as the sampling frame out of which ten (10) yam farmers were selected using simple random sampling technique. The result of the above selection gave 30 respondents per ward, 60 respondents for each zone and 180 respondents State wide.

Data Collection

The primary data used in this study were collected with the use of a well-structured questionnaire and interview schedule personally administered to the 180 respondents sampled for the study.

Analytical Technique

- Simple descriptive statistics such as percentage and frequency distribution were used to describe the socio economic characteristics of the respondents.
- The Stochastic Frontier Production function (SFPF) using the Cobb –Douglas functional form was used to determine the production function in this study. This functional form has been used in other empirical studies (Emokaro and Erhabor, 2006; Agbaje*et al.,* 2008; Ojo*et al.,* 2009; Okon*et al.,* 2010; Shehu*et al.,* 2010; Areerat*et al*., 2012; Ezeh*et al*., 2012and Mohammed *et al*., 2011)) to assess both technical and allocative efficiencies. The SFPF estimates the regression coefficients that are used to calculate the marginal physical product (MPP) for the estimation of the value of marginal product (VMP)

  The production function model was explicitly specified in its linear form as:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \varepsilon_i \quad --(1)$$

  Where, ln = Natural logarithm
  Y = Quantity of yam produced (Kg)
  X_1 = Farm Size (Ha)
  X_2 = Planting Material (Yam Sett) (Kg)
  X_3 = Labour (Man days)
  X_4 = Quantity of Fertilizer used (Kg)
  X_5 = Quantity of Agro Chemicals used (Litres)
  β_0 - β_5 = Parameters to be estimated (Regression coefficients)
  ε_i= Composite error term defined as $V_i - U_i$

V_i = Random variables which are assumed to be independent of U_i, identical and normally distributed with zero mean and constant variance N (0, S_v^2).

U_i= Non – negative random variables which are assumed to account for the technical inefficiency in production and are often assumed to be independent of V_i such that U_i is the non-negative truncated normal distribution.

- **Marginal Analysis** Efficiency of resource/ input used was determined by the ratio of the Value of the Marginal Product (VMP)(which is MPPxP_y) to Marginal Factor Cost (MFC). The relationship (as indicated by Olayide and Heady (1982); Goni*et al.,* (2007), Tambo and Gbemu (2010) is given as:

$$r = \frac{VMP}{MFC} \quad -------(2)$$

The decision rule is that:

If r = 1, resource is efficiently utilised

r> 1, resource is under utilised

r< 1, resource is over utilised

where r = Efficiency coefficient

VMP = Value of Marginal Product which is the same as Marginal Value Product (MVP)

MFC = Marginal Factor Cost

MFC = P_x

P_x = Unit price of input Xi

The marginal physical product (MPP) for each of the production inputs was estimated from the regression coefficient of the SFPF and was used to determine the value of the marginal product (VMP) as explained above.. According to Adesimi (1982) and Fasasi (2006) the estimates with the widest application are those derived at the geometric mean of input, especially with the Cobb Douglas production function. The value of the marginal product (VMP) for this study as used by Fasasi (2006), Emokaro and Erhabor (2006), Tambo and Gbemu (2010) was given as

$$VMP = MPP.P_y \quad ----------(3)$$

Where,

MPP = Marginal Physical Product

P_y = Unit Price of Output

$$MPP = \frac{b.Y}{X_I}$$

Where

b = Regression Coefficient
X_i = Geometric mean of input X_i
Y = Geometric mean of Output

The elasticity of production which is the degree of responsiveness of the output to a unit change in input used was computed using the Cobb Douglas function. The coefficients of the independent variable (X_i) of the Cobb Douglas function were the direct elasticities of production. The value of the elasticity indicated whether each additional input used results in constant (Ep=1), increasing (Ep>1) or decreasing (Ep<1) productivity. The sum of the individual elasticities gave the rate of return to production and indicates the stage of production (that is whether stage 1, 2 or 3) where the respondent is operating (Olukosi and Ogungbile1989).

- Likert scale was used to determine the level of seriousness of the various constraints of the yam farmers. The responses to the various constraints were scored such that the most serious constraint was assigned the highest score as shown below:
  Very serious = 5 Serious = 4 Moderately serious = 3
  Least serious = 2 Not serious = 1
  The Mean Item Score (MIS) was calculated and the constraint with MIS between 3.0 and5.0 was considered to be significant while those with MIS < 3.0 were assessed as not relevant.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

Table 1 shows the socio-economic characteristics of yam farmers in Edo State. More males (83.33%) were involved in yam farming than females (16.67%). This result was similar to that of Agbaje*et al*., (2008) who note that yam farmers were mostly males in Ondo State. Majority of the respondents were married (87.22%), while the others were either single (0.56%), separated (8.89%) or divorced (3.33%). The result further showed that the farmers were fairly educated with about 45.56% of the respondents having secondary school education and 35.56% had primary school education. The average age of yam farmers in Edo State was 51 years which showed that yam farmers in the study area were relatively old. This finding corroborated that of Ajibefun and Abdulkadiri (1999), stating that small scale farmers in Nigeria were old and ageing. It further corroborated the finding of Pius and Odjuvwuedrhie (2006) that concluded that yam farmers in south-eastern Nigeria were relatively old, with a mean age of 43years. They had an average household size of six persons, indicating that yam farmers in the study area had relatively low household size. This finding has implications for labour source, productivity and efficiency of yam

production, as most of the farmers were likely to depend more on hired labour for the yam production activities. These findings are closely supported by those of Ekunwe*et al.,* (2008) who indicate that yam farmers in Delta and Kogi States had an average of seven and nine persons per family respectively. The yam farmers in the study area were relatively experienced with an average farming experience of fifteen years, implying a reasonable level of specialization and expertise in yam production. This compared favourably with the findings of Oluwatusin (2011) that indicate a farming experience of 14 years for yam farmers in Osun State.

Table 1. The Socio-Economic Characteristics of Respondents

Characteristics		Frequency	Percentage	Mean
Sex				
	Male	150	83.33	
	Female	30	16.67	
Marital Status				
	Single	1	0.56	
	Married	157	87.22	
	Separated	16	8.89	
	Divorced	6	3.33	
Educational Level				
	No Formal Education	28	15.56	
	Primary	64	35.56	
	Secondary	82	45.56	
	Tertiary	6	3.33	
Age				
	30 – 39	13	7.22	
	40 – 49	59	32.78	51
	50 – 59	99	55.00	
	≥ 60	9	5.00	
Household Size		82		
	≤ 5	65	45.56	
	6 – 8	27	36.11	6
	9 – 12	6	15.00	
	>12		13.00	
Farming Experience		6		
	? 5	55	3.33	
	5– 10	52	30.56	15
	11 – 15	30	28.89	
	16 – 20	10	16.67	
	21 – 25	27	5.56	
	>25		15.00	

Allocative Efficiency levels of Inputs Used in Yam Production

The estimated results of the ordinary least squares (OLS) and the maximum likelihood estimates (MLE) of the production function for yam farmers in Edo State are presented in Table 2. The sigma square value of 2.910 indicated a good fit and the correctness of the specified distributional assumption of the error term. The gamma estimate of 0.9910 indicated that 99.10% variation of the output of yam in Edo State was due to the inefficiency factors. The ratio of the log likelihood function when compared to the joint effect of efficiency on output was 31.614. This diagnostics statistics confirmed the significance of the stochastic frontier production function (SFPF). This compared favourably with the findings of Pius and Odjuvwederhie (2006) who report that the average response function is not an adequate representation for yam production in south eastern Nigeria and Ojo*et al*., (2009) who concluded that the OLS is not an adequate representation for yam production in Niger State.

The allocative efficiency level of inputs used in yam production was presented in Table 3. The results indicated that farmland (15.72), planting material (7.27) and fertilizer (2.38) were underutilized. This implies that yam farmers could increase their output and profit by increasing these resources. This finding was in consonance with that of Fasasi (2006), Sanusi and Salimonu (2006), Olorunsanya*et al*., (2009), with results showing under utilisation of land input by yam farmers in Ondo, Oyo and Ekiti States respectively. These values were more than unity confirming the existence of disequilibria. This result supported the findings of Ekunwe*et al.,* (2008) who reported the under utilisation of planting materials (yam sett) by farmers in Delta and Kogi States and Fasasi (2006), for farmers in Ondo State.

Labour and agrochemicals were over utilised with efficiency ratios of 0.62 and 0.52 respectively. On the whole, these results imply that none of the inputs were being efficiently utilized by yam farmers in Edo State since it was either over utilised or under- utilised.

Table 2. The Ordinary Least Square (OLS) and Maximum Likelihood (MLE) Function for Yam Production

Variable	Parameter	OLS Function	MLE Function
Constant	b_0	4.564	1.363
		(2.451)	(1.754)
Farm land (Ha)	b_1	0.783	0.495
		(2.306)*	(3.599)**
Yam sett (kg)	b_2	0.478	0.540
		(3.528)**	(8.254)**
Labour (Man day)	b_3	0.061	0.367
		(0.390)	(6.698)**
Fertilizer (kg)	b_4	0.056	0.040
		(1.141)	(2.221)*
Agro chemical (litres)	b_5	0.057	0.008
		(0.492)	(0.193)
Sigma square	σ_s^2		2.910
			(8.517)**
Gamma	?		0.990
			(120.175)**
Log likelihood ratio			31.614

Figures in parentheses are t-ratios, ** Significant at 1% level of significance
* Significant at 5% level of significance

Table 3. Allocative Efficiency Levels of Inputs Used in Yam Production

INPUT	MPV	MFC	RATIO	INFERENCE
Farm Land	60871.02	3871.43	15.72	Under-utilised
Yam sett	324.36	44.62	7.27	Under-utilised
Labour	485.55	766.67	0.63	Over-utilised
Fertilizer	150.66	63.30	2.38	Under-utilised
Agro Chemical	900.63	1732.59	0.52	Over-utilised

Elasticity of Production and Return to Scale

The estimated coefficients of the regression model were also elasticities of production, presented in table 4. The result showed that elasticities for farm size, yam sett, labour and fertilizer were 0.495, 0.540, 0.367 and 0.040. The elasticities less than unity were estimated to be positive decreasing functions indicating that the allocation and utilisation of the variables were in stage of economic relevance of the production function (Stage II). The elasticity for agro-chemical (-0.008) less than zero showed a negative decreasing function to the factors, indicating the over-utilization of the input implying that its allocation and utilisation were in irrational stage of production (stage III) of the production process.

The return to scale was 1.434, which was an indication that on the whole, yam production in the study area was in stage 1 implying that inputs were under-utilized by the yam farmers. This suggested that yam farmers could benefit from the economies of scale linked to increasing returns. At this stage of irrational production (stage 1), production could be increased by using more of the production resources. This result was in consonance with the findings of Ojo*et al.,* (2009), that yam farmers in Ondo State operated in the irrational stage (stage 1) of the production function with a return to scale of 1.269 and Oluwatusin (2011) that concluded that yam production in Osun State was in the irrational stage (stage 1) with return to scale of 1.119.

Table 4. The Elasticities of Production and Return to Scale

Variable	**Production Elasticities**
Farm Size	0.495
Yam sett	0.540
Labour	0.367
Fertilizer	0.040
Agro chemical	-0.008
Return to Scale	**1.434**

The Production Constraints of Yam Farmers

The constraints faced by yam farmers in the study area were presented in table 5. The major constraints identified to confront yam farmers in the study area were high cost of acquiring land (X =4.86), inadequate capital (X =4.28), high cost of labour (X =4.24), difficulty in acquiring land (X = 3.96) and difficulty in accessing quality planting materials (X = 3.84). The others also identified included transportation problems (X = 2.73), pest and disease attack (X = 2.36) and

high cost of fertilizer and agro chemicals (X = 2.30). This result compares favourably with the findings of Sanusi and Salimonu (2006), that inadequate capital to invest in yam production, scarcity of labour and storage problems were major problems facing yam production in Oyo State.

Table 5. The Production Constraints of Yam Farmers

Constraints	Mean ($\bar{X}$)
High Cost of acquiring land	4.86
Inadequate capital	4.28
High cost of labour	4.24
Difficulty in acquiring land	3.96
Difficulty in accessing quality Planting materials	3.84
Transportation problems	2.73
Pest and Disease attack	2.36
High cost of fertilizer and agro chemicals	2.30

CONCLUSION

The study showed that yam farmers in Edo State were not efficient in the use of production resources, while farmland, planting materials (yam sett) and fertilizer were under-utilized, labour and agrochemical were over-utilized. This showed that none of the production inputs was optimally allocated and utilised. The overall productivity of yam was however in the irrational stage of production (stage I) suggesting that there was room for expansion in output and productivity. This can be actualised by cropping higher hectarage of farmland with increased quantity of planting material and controlled usage of higher quantity of fertilizer as these were found to be under-utilised. Since the under-utilsation of some of the resources may not be unconnected with inadequate capital, the yam farmers should be given assistance in form of loans or organise themselves into cooperatives to curb the problem of inadequate finance and also afford the high cost of inputs especially labour and land as these were their major constraints.

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