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Production and Productivity of Crustacean in Nigeria

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ABSTRACT The study examined the Productivity and Technical Efficiency (TE) of Crustacean Production in Nigeria using the stochastic frontier production function analysis. Primary data were collected using a set of structured questionnaire administered on 100 crustacean producers who were selected using a multistage sampling technique. Producers were selected from five villages in Ilaje Local Government Area of Ondo state, Nigeria. Results showed that Crustacean production was in the rational stage of production (stage II) as depicted by the Returns to Scale (RTS) of 0.8045. Foundation stock, feeds, labour cost, equipment cost, and other costs were efficiently allocated and used, as confirmed by each variable having estimated coefficient value of between zero and unity. The Technical Efficiencies of the producers varied between 0.45 and 0.98 with a mean of 0.70 and about 40% of the producers had TE exceeding 0.70. This study further revealed that feeds and equipment cost significantly affected TE while other socioeconomic variables such as age of producers led to decrease in TE but family size increased TE. Thus these variables are important policy variables for improving Crustacean production in Nigeria.

INTRODUCTION

There is a wide disparity between food supply and demand in Nigeria. This has led to a food demand supply gap resulting in deficit food supply, increased food importation bills, and high food price increases. The result of this is widespread hunger and malnutrition in Nigeria. More importantly there is a large deficit in animal protein consumption in diets of most Nigerian (Amos, 2000). This is more apparent in the rural areas, which constitute the majority of Nigerian populace. The importance of animal protein for healthy living cannot be overemphasized. Crustacean is an important source of animal protein especially for the rural dwellers.

Cray fish has very high protein contents and quality that exceed those of other animal protein sources (Amos, 2000). Food and Agricultural Organisation in 1965 pointed out that the estimated protein requirement of 32 grams per day is substantially expected to be obtained from animal protein. The situation has not changed much in the present day. More than half of the world's population depends on fish as a principal source of animal protein (Shang, 1981) and a considerable source of minerals and vitamins (Onyioha, 1984). Freshwater Crustacean farming is growing in popularity around the world.

There are very few crustacean fishermen in Nigeria much more lower than the percentage of fresh water or even Brackish water fishermen. Basically, the major producers of Crustacean in Nigeria are fishermen in the Niger-Delta States Ondo inclusive. With recent development of proven production guidelines, stronger more unified growers' associations and co-operative ventures, growth and expansion of the industry is expected. Hence this study is designed to investigate the resource use and productivity of the producers with a view to identifying the relative importance of the factors of production and the level of technical efficiency of the crustacean farmers in the study area.

Analytical Framework

This study employs the frontier production function analysis. The use of this tool has gained prominence in econometric and applied economic analysis in the last two decades. Early applications of this tool include those of Aigner et al. (1977). They applied the tool in the analysis of the US agricultural data. Ojo (2004) recently applied the tool in poultry production in Nigeria. Other notable studies recently include those of Battese et al. (1993); Ajibefun and Abdulkadri (1999), Ojo and Ajibefun (2000), Ajibefun and Daramola (2003).

The production frontier can be specified as:

$$Y_i = f(X_i, Á) \exp (V_i - U_i)_i = 1, 2\ldots\ldots, n$$

Where V_i is a random error, which is

associated with random factors not under the control of the farmer, while U_i is the inefficiency effects. The model is such that the possible production Y_i is bounded above by stochastic quantity, $f(X_i, Á) \exp(V_i - U_i)$ hence the term stochastic frontier. There are some other assumptions of the model. This include the fact that the random error Vi is assumed to be independent and identically distributed as N $(0,ä^2_v)$ random variables independent of the U_is, which are assumed to be non-negative truncations of the N $(0,ä^2_v)$ distribution (i.e half-normal distribution) or have exponential distribution.

The technical efficiency of an individual farm from the above can be defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology. The technical efficiency is thus empirically measured by decomposing the deviation into a random component (U) (Ojo, 2004).

In that case,

Technical efficiency (TE) = Y_i / Y^*_i

= $,f(X_i Á) \exp(V_i - U_i) / f(X, Á) \exp(V_i)$

= $\exp(-U_i)$

where Y_i is the observed output and Y^*_i is the frontier output. This is such that $0 \leq TE \leq 1$. The stochastic frontier production function model is established using the Maximum Likelihood Estimation procedure (MLE).

MATERIALS AND METHODS

Study Area: The data used in this study were collected from a cross-sectional survey of fish farmers in Ondo State, Nigeria. The State is one of the 36 States in Nigeria. It is located in the rain forest belt of the country. It is located in the Southwestern part of the country. With total population of about 2.6 million people and a land area of 14,769.71-squared kilometer, the vegetation of the State is characterized by rain forest type in the south and savanna in the north. The State lies between longitude 04^0 30' and 06^0 00'E and Latitudes 05^0 45'N and 08^0 15'N.

The State is agrarian, and well suited to the production of crops, livestock and fish. The annual rainfall is between 1200 and 1500mm with a high temperature of about 30 ^{0}C. The people live mostly in organized settlements, towns and cities.

Data Collection: The data used for this study were primary data obtained from 100 Crustacean farmers from five villages in Ilaje Local Government Area (LGA) of the State. A multi stage sampling technique was used for selecting the respondents. The first stage involved a purposive selection of five villages based on the population of Crustacean producers in the Local Government Area. The second stage involved the random sampling of 20 producers from each village.

Data were collected through the use of a structured questionnaire designed to collect information on output, inputs, prices of output and inputs, and some other socio-economic characteristics of the Crustacean producers in the study area. Data were collected on the following variables:

Value of Output: The value of output was obtained by adding the quantity of Crustacean produced and sold with that consumed by the household members and the quantity given out as gifts. This was multiplied by the current market price per kilogram of Crustacean in the area.

Inputs: The inputs considered include the labour (man days), Operating expenses and other costs (depreciation values on implements). These were considered to determine the productivity of the farmers.

Socio-economic Characteristics: These variables include age of respondents, experience in farming/Crustacean production and years of schooling of farmers. The influence of these variables on TE was considered.

Analytical Technique: For this study, a combination of Descriptive statistics (mean, standard deviation) and stochastic frontier production function were used to analyze the socio-economic characteristics, productivity and the TE of the farmers respectively.

Cobb-Douglas frontier production function was assumed for the production technology of the farmers (Amos, 2004). This is specified as follows:

$$In Œ_i = In ß_0 + ß_1 InX_{1i} + ß_2 InX_{2i} + ß_3 InX_{3i} + ß_4 InX_{4i} + ß_5 InX_{5i} + V_i - U_i$$

Where

Œ = Value of Crustacean produced per hectare

X_1 = Cost of Feeds (Naira)

X_2 = Labour used (man-days)

X_3 = Cost of equipment (Naira)

X_4 = Cost of Foundation stock (Naira)

X_5 = Other Cost (Naira).

V_I = Random errors.

U_i = Technical inefficiency effects.

The Technical inefficiency effects U_i is defined by

$U_i = ä_o + ä_1Z_{1i} + ä_2Z_{2i} + ä_3Z_{3i} + ä_4Z_{4i}$.

Where: Z_1 to Z_4 represent, Age of farmer, Level of Education of farmer, Family size and Leadership status respectively. The possibility of contribution to and influencing technical inefficiencies of the farmers informed the decision to include these variables in the model. The ßs, and äs are scalar parameters that are to be estimated. The variances of the random errors $ä_v^2$ and that of the technical inefficiency effects $ä^2$ are related as follows:

$\sigma^2 = \sigma^2_v + \sigma^2_u$ and the ratio $\gamma = \sigma^2_u / \sigma^2$, measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battesse and Corra, 1997). The estimates for all the parameters of the stochastic frontier production function and the inefficiency model are simultaneously obtained using the program frontier version 4.1 (Coelli, 1994).

Two different models were estimated in this study. The first model is the traditional response function in which the inefficiency effects are not present. It is a special case of the stochastic frontier production function model in which the total variation of output from the frontier output due to technical inefficiency is zero, that is, $\gamma = 0$. The second model is the general model where there is no restriction and thus $\gamma \neq 0$.

The two models were compared for the presence of technical inefficiency effects using the generalized likelihood ratio test, which is defined by the test statistics, Likelihood Ratio $(LR) = -2 \ln\{H_o/H_a\}$

Where LR has a mixed chi-square distribution with the degree of freedom equal to the number of parameters excluded in the unrestricted model. H_o is the null hypothesis that $\gamma=0$. It is given as the value of the likelihood function for the frontier model and H_a is the alternative hypothesis that $\gamma \neq 0$ for the generalized frontier model. The first model was finally excluded since the null hypothesis was rejected. Since the calculated chi-square was significant at 5% level with a value of 6.02.

Table 1: Summary statistics of variables of fish farmers in Nigeria.

Variables	*Mean*	*Standard deviation*
Revenue (Naira)	2,095,237.00	532094.87
Labour cost (Naira)	183,284.5	26333.67
Cost of Feeds (Naira)	33,853.33	3004.56
Cost of Foundation stock (Naira)	18,878.79	1082.86
Cost of Equipment (naira)	971,160.00	23000.03
Age (years)	46.2	10.01
Family size (number)	8	4.3
Years of schooling	15	3.86

Source: Survey data, 2005.
1$=₦ 420.00

RESULTS AND DISCUSSION

Summary Statistics: Table 1 presents the summary statistics of variables for the frontier estimation. The mean value of Crustacean produced was ₦ 2,095,237.00 per hectare. Comparing this value with the total cost of production (₦1, 207,176.62) shows that the production of Crustacean in the area was profitable. A net returns of ₦888,060.38 further confirms this assertion.

The respondents are well educated with about 15 years in school. The producers are relatively young with a mean age of about 46.2 years with 10 years of standard deviation. These may be the reason for the high standard of management of the enterprise and thus the high profit level. The family size of eight is considered moderate given the tendency for Nigerians to have a large family member who serve as help hand on their farms if they are farmers.

Estimates of the Stochastic Frontier Production Function Parameters: Table 2 shows the Maximum likelihood estimates of the stochastic production function for Cray fish production in Nigeria. There was presence of technical inefficiency effects in Crustacean production in the study area as confirmed by a test of hypo-thesis for the presence of inefficiency effects. The LR computed was 2.76 with a mixed chi-square (χ^2) distribution showed the presence of technical inefficiency effects in Crustacean production. The null hypothesis of no inefficiency effects in Crustacean production was rejected. Model 1 was therefore not used as it was not appropriate but model 2 was preferred and used for the study. The estimated gamma parameter of the model was 0.69, which indicate that about 69% of the total variation in Crustacean output among the producers is attributed to differences in their technical efficiencies.

Factors Affecting the Technical Efficiency: Table 2 shows the factors affecting the TE of the

Crustacean producers in the area. The results show that age and level of education were positively related to inefficiency among the producers, thus indicating that these variables led to decreases in technical efficiencies among the Crustacean producers in the study area. This is contrary to *a priori* expectation since increase in years of schooling and age is expected to be positively correlated with the adoption of improved technologies. The probable reason could be that the more educated the producers, the less time they devote to Crustacean production but get involved in other activities such as politics and merchandising. This was done as means of diversifying income. Educated Nigerians are said to be involved in other enterprises and occupation due to the unhealthy state of the Nigerian economy (Ojo, 2003). The significant factors affecting the production of Crustacean are cost of equipment, Age, Family size and other costs of production.

The coefficients of family size and leadership role show that TE increases with increase in family size and leadership role thus reducing inefficiency in Crustacean production. This is plausible as it is expected that the larger the family size, the larger the number of people to give helping hand in this enterprise as well as the availability of some societal variables available for use in the enterprise.

The estimated elasticity of the explanatory variables of model 2 as shown in Table 3 were positive decreasing functions of the variables. This is indicative of the fact that the producers are in stage II i.e. the stage of economic relevance in the production process. The Returns to Scale was 0.8045 confirming that the production of Crustacean was in stage II of the production region. Investing more in production equipments such as outboard engines could increase the productivity of the Crustacean producers. Also using better fishing nets so that the producers could move further into the high seas for fishing activities.

Technical Efficiency Analysis: From Table 4, the range of TE is between 0.30 and 0.99. About 39% of the producers had TE above 0.70 while those with less than 0.50 were about 12%. The predicted enterprise specific technical efficiencies ranged between 0.323 and 0.976 with a mean of 0.669. This implies that in the short run, there is the possibility for increase of about 33% of total output of Crustacean production by the adopting the techniques and technology adopted by the best producer.

Such could be the use of motorized outboard engine and better fishing net with standard approved nets.

Table 2: Maximum likelihood estimates of the stochastic frontier production function in Crustacean production in Nigeria.

Variable	*Parameter*	*Model 1*	*Model 2*
General Model			
Constant	β_0	-0.1865	-0.1204
Other cost	β_1	0.1559*	0.1371*
		(0.0670)	(0.0649)
Labour cost	β_2	0.0224	0.0256
		(0.0382)	(0.0351)
Cost of Feeds	β_3	0.0552	0.0542
(0.0628)		(0.0413)	
Cost of Foundation stock	β_4	0.0108	0.0268
		(0.0616)	(0.0611)
Cost of Equipment	β_5	0.5657*	0.5608*
		(0.0569)	(0.0422)
Inefficiency model Age	δ_1	0	0.3931*
		(0.1287)	
Family size	δ_2	0	-0.2689*
		(0.1102)	
Education	δ_3	0	0.2382
		(0.2356)	
Leadership role	δ_4	0	-0.0442
		(0.1055)	
Sigma squared	σ^2	-	0.0264
Gamma	γ	-	0.69
Log likelihood function	Llf	-	53.64

Source: Field Survey, 2005. * = Significant at 5% level.

Table 3: Elasticity of production and returns to scale (RTS).

Variable	*Elasticity*
Other cost	0.1371
Labour cost	0.0256
Cost of Feeds	0.0542
Cost of Foundation stock	0.0268
Cost of Equipment	0.5608
RTS	0.8045

Table 4: Frequency distribution of TE of Crustacean producers.

Deciles range of TE	*Frequency*	*%*
0.20 - 0.29	0	0.0
0.30 - 0.39	8	8.0
0.40 - 0.49	5	5.0
0.50 - 0.59	12	12.0
0.60 - 0.69	32	32.0
0.70 - 0.79	21	21.0
0.80 - 0.89	16	16.0
0.90 - 0.99	6	6.0

CONCLUSION AND RECOMMENDATION

This study has observed that TE of Crustacean production varied due to the presence of technical inefficiency effects in Crustacean production. Family size and leadership roles increased TE of the producers. Cost of equipments and other production costs were also observed to influence production of Crustacean in Nigeria.

Producers are to be encouraged to use better fishing nets and motorized outboard engine to increase their production and thus their productivity.

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