

Technical Efficiency of Catfish Farmers in Kaduna, Nigeria

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Abstract: This study examined the technical efficiency of catfish farmers in Kaduna metropolis Kaduna State, Nigeria using the stochastic frontier production function analysis. Primary data were obtained through the use of well structured questionnaire. The simple random sampling technique was used to select sixty farmers who were drawn from the list of Agricultural Development Programme (ADP) contact farmers in four Local Governments Areas (Chikun, Igabi, Kaduna North and Kaduna South) that make up the study area. Descriptive statistics were used to analyze the socioeconomic characteristics of catfish farmers while the stochastic frontier production function analysis was used to determine the technical efficiency of the farmers. Results showed that the estimated farm level technical efficiency ranged from 47.0 percent to 97.1 percent with a mean of 85.4 percent. About 90 percent of the farmer had technical efficiency exceeding 0.71. Some of the variables of interest such as fingerling, labour and pond size were efficiently allocated as their estimated coefficient value range between zero and one. Gender, household size and education were found to be negatively related to technical efficiency while experience and age were found to be positively related to technical efficiency. The result also showed that the return to scale was 0.664 which gives an indication that the farmers are in stage II of catfish production in the study area.

Key words: Technical Efficiency, Productivity, Stochastic Frontier production, Kaduna, Nigeria

INTRODUCTION

Statistics indicate that Nigeria is the largest African aquaculture producer, with production output of over 15,489 tonnes per annum, this is closely followed by Egypt with output of about 5,645 tonnes. Only five other countries: Zambia, Madagascar, Togo, Kenya and Sudan produce more than 1,000 tonnes each^[4].

F.A.O^[4], further showed that Nigeria imports about 560,000 tonnes of fish estimated at about \$400 million annually while annual domestic fish supply in Nigeria stands at about 400,000 tonnes. The fisheries sector accounts for about 2% of national G.D.P, 40% of the animal protein intake and a substantial proportion of employment, especially in the rural areas; the sector is a principal source of livelihood for over three million people in Nigeria.

As in much of Africa, the most commonly cultured species include catfish (*Clarias gariepinus*, *Clarias lazera*, and *Heterobranchus sp*), tilapia and carp. Many fish farms focus on catfish, as they can have a market value of two to three times that of tilapia^[3]. The International Finance Corporation^[7] estimated that some 60% of the fish consumed is catfish and it is increasingly contributing to the market which till date remains largely a live fish market. This will surely

open up employment opportunities and provide animal protein for millions of Nigerians.

The challenge to increase the efficiency in food production level in Nigeria appears to be more urgent now than it has ever been in the history of the country^[6]. The slow pace of the agricultural sector in Nigeria cannot keep up with the rapid population growth rate resulting in food shortage. The poor agricultural sector is due to the nature of agriculture in state. He the country such as small holding, low capital etc. The objective of this study was to analyse the technical efficiency of catfish farmers in Kaduna, Kaduna State, Nigeria. Also, the study sought to identify the factors affecting technical efficiency in the production process of catfish.

MATERIAL AND METHODS

Area and Scope of Study: The study was conducted in the metropolis of Kaduna (a City in North Western Nigeria) capital of Kaduna State. Kaduna State is comprised of 23 Local Government Areas with a total land area of about 46,053 km² and an estimated population of 6,066,562^[5]. Kaduna State is mostly populated by Hausa, Gwari, Katab and Banjjuu ethnic communities. The State is bordered by Sokoto, Katsina,

and Kano States to the North, Bauchi to the East, Plateau to the East and South, Niger to the West and Abuja (FCT) to the South. Kaduna metropolis is made up of four Local Government Areas (LGAs) namely: Chikun, Igabi, Kaduna North and Kaduna South. These LGAs constitute the area of study for this research

Sampling Technique and Data Collection Method:

The simple random sampling technique was used to select 60 respondents from the list of Agricultural Development Project (ADP) contact farmers in the study areas. Fifteen (15) catfish farmers were selected at random from Chikun LGA, twelve (12) from Igabi, twenty (20) from Kaduna South and thirteen (13) from Kaduna North LGAs. The data for the study were collected between December 2007 and March 2008, through personal interviews with respondents and the use of sets of well – structured questionnaire.

Data Analysis Technique: The Stochastic Frontier Production Function (SFPF) was used to analyze the productivity and technical efficiency of catfish farmers. The production technology of the farmers in Kaduna State, Nigeria was assumed to be specified by the Cobb-Douglas frontier production function^[12,9].

$$\text{Log } Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + (V_i - U_i) \dots \dots \dots (1)$$

Where Log= Natural logarithm.

- Y = Quantity of catfish (kg)
- X₁ = Number of Fingerlings
- X₂ = labour (man hour)
- X₃ = feed consumed (kg)
- X₄ = Pond size (m²)
- β₀, β₁, β₂, β₃ and β₄ = Regression Coefficients

V_i = are random variables which are assumed to be independent of U_i, identical and normally distributed with zero mean and constant variance N (0, s_v²).

U_i = which are non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be independent of V_i such that U is the non-negative truncated (at zero) of half normal distribution with |N (0, s_u²)|.

The inefficiency of production, U_i was modelled in terms of the factors that are assumed to affect the efficiency of production of the farmers. Such factors are related to the socioeconomic variables of the farmers. The determinant of technical inefficiency is defined by: $U = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \dots \dots \dots (2)$

Where:

- U = technical inefficiency
- Z₁ = Gender
- Z₂ = Age
- Z₃ = Household size
- Z₄ = Education
- Z₅ = farming experience
- δ₀ to δ₅ = inefficiency parameters

These variables are assumed to influence technical efficiency of the farmers. The gamma ($\gamma = \delta_u^2 / \delta^2$) which is the ratio of the variance of U (δ_u^2) to the Sigma squared (δ^2) which is a summation of variances of U and V ($\delta_u^2 + \delta_v^2$) were also determined. The Maximum Likelihood Estimate Method using the computer FRONTIER version 4.1 was used to estimate the parameters of the SFPF^[1].

The technical efficiency of an individual firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i^{*}) given the available technology. This could be expressed mathematically as:

$$T.E. = Y_i / Y_i^* \dots \dots \dots (3)$$

Where Y_i is the observed output

Y_i^{*} is the frontier output

Equation 3 can also be expressed as:

$$T.E. = Y_i / Y_i^* = \text{Exp} (X_i \beta + V_i - U_i) / \text{Exp} (X \beta + V_i) \dots \dots \dots (4)$$

So that, = 0 ≤ TE ≤ 1

RESULTS AND DISCUSSION

Summary Statistics of Catfish Farmers: The summary statistics of the farmers are presented in Table 1 below. The mean value for age indicated that the average age of the farmers was 44 years. Onogogu and Nnadozie^[11] observed that the age bracket of 30-50 years represents an active productive age bracket in agriculture. There is no age restriction in going into catfish farming in the study area. Also, the average household size was five persons while the average framing experience was five years. Olagunju *et al.*^[10] did observe that household sizes of the majority of catfish farmers in Ibadan Metropolis were between the ranges of five to ten while Mafimisebi^[8], studied the demographic characteristic of fish farmers in Ondo State, Nigeria, and also found that majority (71%) of fish farmers were new to the business with less than five years farming experience. The farmers had about 13 years of formal education on the average. The high level of education might be due to the location of the study area in a metropolitan city. The

implication is that the respondents will be very receptive to new innovations in their methods of production^[2]. With an average pond size of 580m² the farmers were able to harvest approximately 2,400kg of fish. This is an indication that Nigerian agriculture is characterized by small scale farmers.

Table 1: Summary statistics of respondents' Characteristics

Variables	Mean
Age (years)	44
Household Size(number)	5
Farming Experience (years)	5
Educational level (years)	13
Quantity of Harvest of fish(Kg)	2,400
Pond Size m ² (ha)	580 (0.06)

Source: Derived from Field Survey Data, 2008

Maximum Likelihood Estimate: The maximum likelihood estimates of the SFPP for catfish production in Kaduna, Kaduna State, Nigeria are presented in Table 2. The results show that there was presence of technical inefficiency effects in catfish production in the study area. This was confirmed by a test of hypothesis for the presence of inefficiency effects using the generalized likelihood ratio test. The computed chi-square was 25.040 while the critical value of the chi-square at 5% level and seven degree of freedom was 14.067. Thus the null hypothesis of no inefficiency effects in catfish production was rejected. The estimated gamma coefficient of 0.856 indicates that about 85.6% of the variation in catfish production among the farmers was due to the differences in their technical efficiency.

Table 2: Maximum Likelihood Estimates of the Stochastic Frontier Production Function for Catfish Farmers

Variables	Parameter	Coefficient.
General model		
Constant	β_0	1.517 (0.527)
Cost of Fingerling	β_1	0.032 (0.237)
Labour	β_2	0.765 (4.639)*
Feed consumed	β_3	-0.141 (-1.729)
Pond size	β_4	0.008 (0.279)
Inefficiency model		
Constant	δ_0	-1.274 (-0.614)
Gender	δ_1	-0.450 (-1.116)
Age(years)	δ_2	0.014 (1.145)
Household size	δ_3	-0.029 (-0.391)
Education (years)	δ_4	-0.067 (-1.499)
Experience (years)	δ_5	0.146 (0.861)
Diagnosis statistics		
Sigma squared	δ^2	0.092 (1.176)
Gamma	γ	0.856 (6.229)*
Log likelihood function		21.294
Log ratio		25.040

Figures in parenthesis are t-ratios *Significant at 5% level

Source: Derived from Field Survey Data, 2008

The results of the estimated parameters show that feed consumed has a negative coefficient. This imply that feed contributes negatively to output of catfish

while the other variables (number of fingerlings, labour and pond size) contribute positively to output of catfish. Moreover the analysis showed that only labour was statistical significant at 5% level.

Determinants of Technical Efficiency: The result of the inefficiency model is also presented in Table 2. The sign of the estimated coefficients in the model have important implication on the technical efficiency of the catfish farmers. The estimated coefficients of age and farming experience were positive, indicating that these variables led to increase in technical inefficiency or decrease in technical efficiency. While the estimated coefficient of gender, household size and education were negative, indicating that these variables led to decrease in technical inefficiency or increase in technical efficiency. The a priori expectation is that technical efficiency should increase with increase in education, and experience. The results indicate that the few years of experience (five years) in catfish production caused the decreased in technical efficiency.

Range of Technical Efficiency: The predicted farm specific technical efficiency ranged between 0.470 and 0.971 with a mean of 0.854. This imply that in the short run, there is a scope for increasing catfish production by about 14.6 % by adopting the technology and techniques used by the best practiced catfish farms. One of such actions of course will be to tackle the negative elasticity of feed consumed. The range of the frequency distribution of the technical efficiency is presented in Table 3. It shows that about 90% of the catfish farmers had technical efficiency over and above 0.71.

Table 3: Frequency Distribution of Technical Efficiency in Catfish Production

Range	Frequency	Percentage
41-50	1	1.7
51-60	3	5
61-70	2	3.3
71-80	9	15
81-90	18	30
91-100	27	45
Total	60	100

Mean Technical Efficiency 85.4%

Minimum Technical Efficiency 47.0%

Maximum Technical Efficiency 97.1%

Conclusion: The study noted that technical efficiency of the catfish farmers varied due to the presence of technical inefficiency. Variables such as farming experience and age caused a decrease in technical efficiency. The farmers should be encouraged to give more attention to farm activities such as supervision and management in other to gain the relevant experience in running a catfish farm and increase their technical efficiency.

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