

**NSAP****47th Annual Conference
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SECURING ANIMAL
AGRICULTURE AMIDST
GLOBAL CHALLENGES****ANALYSIS OF RESOURCE-USE EFFICIENCY OF CATFISH (*Clarias gariepinus*)
PRODUCTION IN JOS METROPOLIS, PLATEAU STATE, NIGERIA**¹Folorunso, S.T., ²Mailumo, S.S., ³Gomina A. and ¹Ezeabikwa, F.C.¹Department of Agricultural Economics and Extension, University of Jos, Nigeria.²Research Coordinating Unit, Forestry Research Institute of Nigeria, Ibadan, Nigeria.³Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria.***Corresponding Author: Folorunso, S.T.; solocom2012@gmail.com and folorunsos@unijos.edu.ng****ABSTRACT**

Analysis of Resource Use Efficiency of catfish production was conducted in Jos-Metropolis, Plateau State, Nigeria. Primary data was collected with the aid of questionnaires from 75 farmers drawn through multistage random sampling technique. Stochastic Frontier Production Function model was used for the analysis. The result of Stochastic frontier production analysis shows that the diagnostics of the model indicated goodness of fit of the model and the presence of inefficiency among catfish farmers. Important production and socioeconomic factors relating to production efficiency were fingerlings, fertilizers, feed, labour, fuel, water pond size, age, level of education, and fish farming experience and were all significant. Therefore, policies targeted more at young fish farmers, educated, experienced fish farmers and membership of cooperative associations should be formulated. Also, to increase efficient use of resources, it was recommended that farmers should be sensitised to adopt management strategies that will help in increasing on resource use efficiency. Policy encouraging access to subsidised fish production inputs delivery services are important.

Key Words: Resource-use Efficiency, Catfish Production, Jos-Metropolis, Plateau state, Nigeria.

INTRODUCTION

In agricultural production, inputs are transformed into goods and services called output. These inputs can be organized into a producing unit with the objective of maximization of profit, satisfaction or a combination of these enterprises (Olayide and Heady, 1982). Resource use efficiency in traditional agriculture is important especially if the level of agricultural productivity should be improved. Efficiency is at the heart of agricultural production and as a result, agricultural production can be expanded and sustained by farmers through efficient use of resources. Efficiency in resource use is an important factor of productivity in developing countries given that these input factors are limited and opportunities for developing better technologies are either limited or non-existent (Taru *et al.*, 2010). According to Shehu *et al.* (2010), efficiency is concerned with the relative performance of the processes used in transforming given inputs into outputs. The efficiency of agricultural production is crucial, especially in determining output from a given set of resources used. An introduction of new technology has been used as a standard for distinguishing between modern and traditional system and for improving the efficiency of the production. Therefore, measurement of productivity and efficiency in agriculture is of concern because of the increasing demand for food (Alene and Hassan, 2003). They further asserted that there is the need for quantitative analysis of an effective use of resource by the farmers. The reasons for estimation of efficiency is that increase in yield determines the supply of food and fibre to families and industries thereby improving the general welfare of the population. Measurement of efficiency is needed to facilitate productivity growth and policy formulation, which are essential for any effective growth in national economies. Estimates on the level of inefficiency assists in deciding whether to improve efficiency or develop new technologies to raise agricultural productivity. Oye, (2010) opined that efficiency is the first step in any process that might lead to resource savings and these have implications for welfare and food security. Given that efficient farmers are likely to generate higher output; such category of farmers has a better chance of surviving even in periods of declining food availability.

Aquaculture refers to cultivation of aquatic organisms under controlled or semi-controlled conditions for economic and social benefits (Ucha *et al.*, 2018). Literature revealed that aquaculture has the potentials of satisfying mankind's quest for fish and fish products. For instance, Amao, *et al.*, (2016) reported that aquaculture is capable of supplying the world with about 53 million tons of fish each year and over 7 percent of the animal protein for man consumption. Fish farming is one of the vital sectors that are being explored as it is the best and



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cheapest source of animal protein for human consumption. Fish farming otherwise known as aquaculture, is the production of fish under a controlled environment by manipulating some stages of their life cycle to ensure maximum yield. It is an important source of food, income generation, employment and recreation for people around the world (Ucha *et al.*, 2018).

Despite the popularity of farming in Nigeria however, the fish farming industry can be best described as being at the infant stage when compare to the large market potential for its production and marketing (Nwiro, 2012). Nigeria can substitute fish importation with domestic production to create jobs, reduce poverty in rural and peri-urban areas where 70 per cent of the population live and ease the balance of payments deficits (Areola, 2007). One of the major challenges of fish farming as with most other forms of production is inefficiency. Hence, increasing efficiency of resource use and productivity at the farm level is one of the pre-requisites for sustainable aquaculture (Iwu *et al.*, 2019). It is against this backdrop that the objective of the study was developed; to estimate the resource use efficiency of catfish production in the study area.

MATERIALS AND METHODS

The study was conducted in Jos Metropolis – which comprise of both Jos-North and Jos-South Local Government Areas of plateau state. It lies within latitudes 9°45'00"N to 09°57'00"N and longitudes 8°48 '00"E to 8°58'00"E. Jos is the administrative capital of Plateau State. Jos Metropolis covers parts of Jos North and Jos South Local Government Areas (LGAs). It is situated over 1,500m above sea level and has a cool temperate climate with an annual temperature of between 18 and 22°C; rainfall 131.75cm (52in) in Southern part to 146cm (57in) on the Plateau (Folorunso *et al.*, 2016).

Data for this study was obtained from primary source using structured questionnaire. A Multistage sampling procedure was employed in the selection of catfish farmers in Jos North and South using purposive sampling technique based on the intensity of catfish production in these areas. Gwom district (the only district in Jos North) was chosen in Jos North LGA while two districts namely; Du and Vwang districts were randomly selected in Jos North and South LGA respectively. From the three (3) districts, 25 catfish farmers were randomly selected to give a total of 75 catfish farmers from a sample frame of 750 catfish farmers, representing 10% of all the catfish farmers as obtained Fish Association of Nigeria (FISON, Plateau state chapter).

Model specification

Stochastic Frontier Production Model

The stochastic frontier production model can be used to determine the technical relationship between the inputs used and output obtained in farm production. Stochastic frontier model which was originally proposed by Aigner *et al.* (1977) is expressed in general form as; $y = g(x)e^{v-u}$ Eq.4.

The equation above can be simplified to give; $y = g(x)e^{v-u}$ Eq. 5. Where, y =

observed output; $g(x)$ = conditional mean function of given input x ; v = a mean-zero error term that represents measurement error; u = a firm-specific random effect that represent the firm's technical inefficiency. In this study, the production technology for catfish is characterized by a Cobb-Douglas production function and expressed as: $Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} e^{(v-u)}$ Eq.6.

A logarithmic transformation provides a model which is linear in the log of the inputs and easily used for econometric estimation (Coelli *et al.*, 1998). The empirical Cobb-Douglas production function model of the stochastic production frontier for this study is specified; $\ln Q_i = \ln \beta_0 + \beta_1 \ln X_{i1} + \beta_2 \ln X_{i2} + \beta_3 \ln X_{i3} + \beta_4 \ln X_{i4} + \beta_5 \ln X_{i5} + \beta_6 \ln X_{i6} + V_i - U_i$ Eq.7. Where; Y = Total Farm Output of catfish production (Kg); The independent variables are: X_1 = Stock of fingerlings (Number), X_2 = Feed quantity in Kg, X_3 = Labour (Mandays), X_4 = Medications/Vet. services (N), X_5 = Fuels (Litres), X_6 = Pond size (M²); U_i = Inefficiency effect and where; Z_1 = Gender, Z_2 = Age in years, Z_3 = Marital status, Z_4 = Household size in number, Z_5 = Education in years, Z_6 = Farming experience in years, Z_7 = Cooperative membership in years, β_0 = intercept. β_{ij} = vector of production function parameters to be estimated $i=1, 2, 3, \dots, n$ farms; $j=1, 2, 3, \dots, m$ inputs. v_i = random variability in the production that cannot be influenced by the farmer. μ_i = the deviation from maximum potential output attributable to technical inefficiency. The farm -specific technical efficiency is defined in terms of observed



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output (Y_i) to the corresponding frontier output (Y^*) using the available technology. $TE = \frac{Y_i}{Y_i^*} = \frac{E(Y_i/U_i X_i)}{E(Y_i/U_{i=0, X_i})} = E\left(\frac{-U_i}{\epsilon_i}\right) \dots\dots\dots(8)$

RESULTS AND DISCUSSION

Result of the Estimates of Stochastic Frontier Production Analysis

Maximum likelihood estimate of the Stochastic Frontier Production was carried out to determine the individual farmer's technical efficiencies in the study area as shown in Table 1. The sigma square (δ^2) and gamma (γ) estimated were 12.40 and 0.90, and they are significant at 1% and 10 % probability level respectively. The sigma square (δ^2) shows the goodness of fit of a model while the gamma (γ) shows the proportion of total deviation from frontier attributable to inefficiency of the farmers and the 0.90 observed in this study indicates presence of inefficiency in catfish production among the farmers. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model, and for this study, it has a log-likelihood ratio of -151.65 which further confirms the fitness of the model. Further estimates of the parameters of the stochastic production frontier of the elasticity of output with respect to the various inputs in catfish production (Table 1) revealed that all the inputs entered; Fingerlings (0.0193), feed (0.0021), labour (0.2800), Drugs (-0.0183), fuel (0.0652), pond size (0.0007) and Water (0.0007) were statistically significant at 1% levels of probability respectively. The coefficients of fingerlings, feed, labour, fuel, pond size were positive while the coefficient of drugs was negative. An increase of the positive coefficients by one unit will result in an increase in the output of catfish production by the values of the coefficients while an increase in the coefficient of drugs by one unit will result in a decrease in the output of catfish by the value of the coefficient. The existence of technical inefficiency paves way to find out the sources of efficiencies among catfish farmers in the study area. The entire model is statistically significant at 1% level of probability. Positive or negative signs on the

Table1: Parameter Estimates of the Stochastic Frontier Production Function of Catfish Production

Variables	Parameters	Coefficient	Standard-error	T-value
Efficiency Model				
Constant	β_0	4.2926	0.2818	15.23
Fingerlings (number)	β_1	0.0193***	0.0076	2.54
Feed (Kg)	β_2	0.0021***	0.0002	9.17
Labour (Man-days)	β_3	0.2800***	0.0287	9.76
Drugs (₦)	β_4	-0.0183***	0.0024	-7.66
Fuel (Litres)	β_5	0.0652***	0.0082	7.94
Pond size (M ²)	β_6	0.0007***	0.0002	3.10
Water (Litres)	β_7	-0.0120***	0.0042	-2.86
Inefficiency Model				
Constant	Z_0	5.3369	4.0030	1.33
Age	Z_1	-0.3361	0.2925	-1.15
Household size	Z_2	1.2982	1.3214	0.98
Educational qualification	Z_3	-11.2019***	2.5191	-4.45
Fish farming experience	Z_4	-3.3331***	1.0674	-3.12
Cooperative membership	Z_5	-15.8423*	9.7488	-1.63
Extension contact	Z_6	13.1176	9.5259	1.38

Diagnostic statistics



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Sigma-squared	δ^2	12.40***	0.91	13.68
Gamma		0.90*	0.52	1.74
Log likelihood function		-151.65		
LR test		201.15		

***, ** and * represent significance at 1%, 5% and 10% levels, respectively ***P<0.001, **P<0.05, and *P<0.1

coefficients indicate that increase in the variable increases or decreases efficiency, consequently productivity respectively. The estimated coefficient (-11.2019) for educational qualification (Z_3) was negative and statistically significant at 1% level of probability, farming experience had a negatively signed coefficient estimate (-3.3331) fish farming experience and was statistically significant at 1% level of probability while the coefficient estimate (-15.8423) for cooperative membership (Z_5) was negative and statistically significant at 10% level of probability. This means that increase in these variables will increase efficiency of catfish production in the study area.

CONCLUSION AND RECOMMENDATIONS

This study focused on the measurement of resource use efficiency in catfish production in Jos Metropolis, Plateau state, Nigeria. The diagnostics indicated goodness of fit of the model and the presence of inefficiency among catfish farmers. Important production and socioeconomic factors related to production efficiency were fingerlings, fertilizers, feed, labour, fuel, water pond size, age, level of education, and fish farming experience. Therefore, policies targeted more at young fish farmers, educated, experienced fish farmers and membership of cooperative associations should be formulated. Also, it was recommended that farmers should be sensitised to adopt management strategies that will help in increasing on resource use efficiency. Policy encouraging access to fish production inputs delivery services are important.

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