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ECONOMIC EFFICIENCY OF FISH FARMING IN ONDO STATE, NIGERIA

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Abstract

This study assessed economic efficiency of fish farming in Ondo State, Nigeria. The study used primary and secondary data to achieve the objective of the study. Primary data were collected with the aid of structured questionnaire from 72 Fish farmers selected using the multistage sampling technique. The analytical technique involved budgeting technique, stochastic frontier production and cost function analysis. The study discovered from the gross margin and net-revenue analysis that fish production was profitable judging by the positive value and size of the gross margin (₦175.55 per kg) and net revenue (₦170.96 per kg). The result of the stochastic frontier production function analysis showed that all the regressors used in the analysis had positive coefficient, indicating that all the inputs considered had direct relationship with farmers output. The result of the stochastic cost frontier function analysis showed that unit cost of labour, fingerlings, fertilizer and lime had positive regression coefficients, indicating that as these variables increase, the overall production cost of fish increases. The result also indicated that the presence of technical inefficiency had effects on fish production as depicted by the significant estimated gamma coefficient. The study recommends improvement in human capital development through education policy and training programme by extension education, opening of more market opportunities should be pursued and government should provide support to fish farmer's cooperative society by increasing their capital base.

Keywords: Economic, Efficiency, Fish, Farming, Ondo, Nigeria.

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1.INTRODUCTION

Fish provides valuable and cheapest source of animal protein to the increasing human population representing an average of over 70% of animal protein supplies around the globe.[1] The supply of which comes from both capture and culture fisheries. Formally, it was assumed that fish population in oceans and large bodies of fresh water were virtually inexhaustible, however [2] reported that valuable stock in the wild are already fully exploited or over-fished and relatively new stocks are opened to exploitation.

In Nigeria, the domestic demand has not been met by output from available aquatic resources while the gap between fish supply and demand increases annually with progressive increase in human population.[3] This is due to lack of fishing input, rising cost of trawling operation and emergence of water hyacinth curtailing artisanal production. A critical shortage already exists which fish importation was unable to meet due to dwindling foreign exchange which lead to restriction on importation of fish and fish products.
Pond fish culture in Nigeria is over 50 years old, but the pace of development is still very low. Private individuals undertake the practice at subsistence level, very few commercial levels and at pilot scheme by some government agencies. [2] Fish culture enterprise is classified into small commercial farms, which size range from less than a hectare to over 400ha and system adopted fall into three categories namely extensive, intensive and semi-intensive.

The level of intensity in operation or management is determined by technical, economic and social factors. Extensive cultivation involves large area, low operating cost, and low general management and tends to be labour intensive. While intensive systems are characterized by dense stocking, stock selection and manipulation, intensive management, environmental control and high production per unit area or volume of water. Semi-intensive culture system is characterized by use of organic fertilizer and supplementary feeding (Adebisi and Ajayi, 2019). [4] Fish provides valuable and cheapest source of animal protein to the increasing human population representing an average of over 70% of animal protein supplies around the globe. [1] The supply of which comes from both capture and culture fisheries. Formerly, it was assumed that fish population in oceans and large bodies of freshwater were virtually inexhaustible, however [5] reported that valuable stocks in the wild are already fully exploited or over-fished and relatively new stocks are opened to exploitation.

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Fish farming is practice in pond, within lakes and reservoir, in cages positioned along the course of running water and concrete block tanks. In all these cases except for cages, water is impounded and retained against seepage within the enclosures made from earth of clayey texture or concrete. [6] Modern fish culture or fish farming recently receiving attention and is a more reliable source of increasing fish farm protein in the diet of the teeming population. The first attempt at fish farming in Nigeria was in 1951 at a small experimental station in Onikan (Lagos State) and various tilapia species were used. [5] Mondern pond culture started with the establishment of a pilot of fish farm of about 20 ha in Panyam (Plateau State) for rearing the common Mirror carp (Cyprinus Carpio).Following the disappointment faced with rearing tilapias. Although the first years of Panyam fish farm.s existence were hardly satisfactory, the trial nevertheless generated sufficient interest that regional government established more fish farms. Small scale farms comprises of a range proportion of fish farms in Nigeria that range from homestead concrete ponds (24 – 40m2) operated by individual farmer or family to small earthen pond (0.02 – 2ha) operated as part-time or off-season occupation by communities, institutions, association or co-operative societies. [7]

Dada (2015) reported that Nigeria has considerable potentials for commercial fish farming with over one million hectares of land available and despite this fish farming production is very low, estimated below 10,000 metric tones per year from total water surface of 5,500ha [8] and distributing less than 10% of the total annual fish production. The reason for the low production level are attributed to the level of intensity of operation, lack of technical skill as well as limited data and information on research and development required for fish production. The level of intensity in operation is governed by technical, social and economic factors.

Efficiency analysis is an issue of interest among economists in recent time, given the overall productivity of an economic system is directly related to the efficiency of production of the components with the system is coupled with the current level of technologies. The study of resource use generally is important because it is the first step in a process that might lead to substantial resources saving with its implication for fish farming in Nigeria. The study sought to analyze economic efficiency of fish farming in the study area. The specific objectives were to determine the profitability of fish farming, determine the resource-use efficiency of variables involved in fish production and estimate technical, economic and allocative efficiency of fish farming in the study area.

2.METHODOLOGY

The Study Area

The study was carried out in Ondo State, Nigeria. The State is one of the six States in South-West of Nigeria. Ondo State is bounded in the West by Osun and Ogun States and in the North by Ekiti and Kogi States. Ondo State also shares boundaries with Edo and Delta States in the East and in the South by the Atlantic Ocean. [9]The State is made up of 18 Local Government Area with a total population of about 3.4 million inhabitants. [10] Ondo State has three distinct ecological zones; the mangrove forest to the South, the rain forest in the middle and the guinea savannah to the North. The State is well suited for the production of both permanent and arable crops and fishery products from both artisanal and aquaculture sub-sectors. [11]

Source of Data and Sampling Technique

Primary and secondary data were used for this study. Primary data were collected using structured questionnaire administered to the fish farmers in the study area. Secondary data on aquaculture fish farming were obtained from sources such as research publications, statistical bulletins, annual reports, the internet, textbooks etc.

A multi-stage sampling technique was adopted bfor this study. Purposive sampling technique was used in the selection of the Local Government Areas used for the study(LGAs). The LGAs selected for the study were Okitipupa, Ilaje, Ose and Akure South LGAs. These LGAs however were chosen due to the increased activities of fish farming in the area. The probability sampling method used was a random sampling of eighteen (18) fish farmers from each of the four LGAs. Hence, balloting technique was used to select the farmer from plot of fish farms in the farmers study area. A total of 72 fish farmers were therefore sampled for the study. Selection of fish farmers was done in conjunction with Ondo State Agricultural Development Project (ADP).

Data were collected on the socioeconomic characteristics of fish farmers which include age, level of education, fish farming experience and labour utilization. Other data collected include; quality of fish harvested and price per kg, number of fingerlings stocked and price per unit, quantity of fish feeds used per kg, quantity of fertilizer in kg and price per kg, labour used in mandays both hired and family and wage rate, size of ponds, age of ponds and other variables influencing fish production.

3.Data Analysis

The budgeting analysis was employed to determine the profitability of fish farming in the study area. This includes gross margin and net revenue. The Gross Margin (GM) specified is represented by:

$$GM = TR - TVC$$
$$= \Sigma PiQi - \Sigma CXi$$
$$I{=}1 \qquad i{=}1$$

Where; TR denotes the total revenue or value of fish produced; TVC denotes total variable cost (that is operating expenses which includes amount spent on transportation, fertilizer, liming, cost of feeds, labour, fingerlings and so on); Pi denotes price price per unit of output in ₦/kg; Qi denotes fish production in kg; Ci denotes price per unit input used in ₦ and Xi = quantity of variable input; if GM > 0, then fish farming is profitable.

The Net Revenue (Nr) was specified as presented by:

$$NR = TR - (TVC + TFC)$$
$$= TR - TC$$
$$= PQ - TC$$

Where; TFC denotes total fixed cost (annual cost of farm implements such as spade, nets, cutlass etc) and TC denotes total cost of production (TVC + TFC). In order to calculate the gross margin and net revenue from this, input cost was valued at prices paid by farmer; labour was valued at opportunity costs or wage paid for the operation. However

cost was inputed for family labour utilization.
Stochastic frontier production function was used to examine the resource-use efficiency and also to compute technical efficiency index of each fish farm. The stochastic frontier function model is defined thus:

$Yi = f(\beta jXj) + (Vj - Ui)$

Where: Yi is the output of the i-th aquaculture farm; f is a suitable functional form to present the fish production frontier; Xj is a vector of j-th inputs used by i-th aquaculture farm, βj is a vector of parameter o0f j-th input to be estimated. The systematic component Vi are random error terms assumed to be independent and identically distributed (iid) with zero mean and constant variance, as vi – N(0,σ2v), and ui are non-negative random variables associated with the technical inefficiency effects of the farmers which are assumed to be independent and identically distributed (iid) with mean μi but truncated ads ui – N+(μi , σ2u) and independent of vi.

Following the parameterization of vi and ui as implemented in the software (FRONTIER 4.1 written by Coelli, 1996) [12] employed in this study, the stochastic frontier variance parameters are expressed in terms of σ2 = σ2u and Y = σ2u / σ2. The larger value of Y implies that the variance of the inefficiency effects represent larger proportion of the total variance of the terms, ui and vi. The restriction that Y equals to zero can be tested to determine if stochastic frontier regression is appropriate for the data set.

Accordingly, the technical efficiency to the i-th aqualculture farm, denoted by TE is defined as the ratio of the mean of production for the i-th aqualculture farm, given the value of the explanatory variables, xi, and its technical inefficiency effect {Σ(y/xi, u=0)} (Battese and Coelli, 1995). The TE can be specified as:

$TE = \{ (\Sigma(y/xi,u))/(\Sigma(y/xi,u=0)) \}$

Thus, $0 \leq TE \leq 1$

The model allow heterogeneity in the mean inefficiency term to investigate sources of differences in technical efficiencies of the farms (inefficiency effect). [13] With this, the farm specific mean inefficiency (μ) is introduced and subsequently truncated at zero, such that non-negative error terms is ensured. The model is defined as:

$\mu = \delta 0 + \delta kZk$

Where: μ denotes mean inefficiency, zk is the matrix of k-th farmer's socio-economic variables for the i-th aquaculture farm to explain determinant of technical inefficiency of the farms and δk is a vector of parameters to be estimated.

Stochastic Frontier Cost (SFC) Function Model

As in Bravo-Ureta and Rieger (1991) and [14] cost decomposition procedure was followed in this study which yields measures of economic efficiency using cost function as specify below:

$CI = G(Pj,Yi;\alpha j) + (Vi + Ui)$

Where: Ci represents observed total production cost; Yi represents output produced, Pi represents unit cost of inputs used in course of production, αj represents parameters of cost function, vi are as earlier defined above. However, because the focus of this section is to estimate economic efficiency via specify cost function, the random error terms ui are assumed to be independent and identically distributed (iid) with half normal distribution thereby setting μi = 0 as ui – N+(0, σ2u) while ui is also believed to be independent of vi.

Applying Shepherd's Lemma, the minimum cost of input demand equation is derived from cost efficiency above as:

$\partial Ci/\partial Pj = Xee(Pj,Yi;\alpha j)$

However, the economically efficient input demand vector (Xee) is obtained by substituting a firm's input prices and output quantity into equation. Xee is both allocatively and technically efficient input point. The implication of the Shepherd's Lemma decomposition is that, cost efficiency can provide a measure of economic efficiency. Hence, economic efficiency (EE) is defined as the ratio of minimum observed total production cost. If there was no cost inefficiency (c/x;p,u=0) to actual total production cost given the cost inefficiency effects (c/x;p,u). EE can be specified as:

$EE = \{ (\Sigma(c/x;p,u))/(\Sigma(c/x;p,u)=0,) \}$

EE takes value between 0 and 1.

Table 1, presents the gross margin per Kg of the fish cropped in the study area. The cost elements in variable cost include labour cost, cost of fingerlings, cost of transport, cost of fertilizer, cost of lime, cost of organic matter and cost of feeds. The revenue represent the sales accrue from sales of cropped mature fishes. The average total revenue obtained was N5,112,318 per annum with a standard deviation of N416,285.73. The average gross margin per kg was N175.55 while the net return per kg was N170.96. The findings suggest that fish production in the study area was profitable. Thus, fish farmers in the study area were able to recover their operating cost per kilogram of fish produced. This result confirms the finding of Akinbogun [15] on economic efficiency of fish farming in Oyo State, Nigeria, that fish production is profitable with gross margin per kg of 139.73 and net returns per kg of 128.63.

The summary statistics of variables employed for the estimation of the stochastic frontier production model is presented in the upper part of table 2. Average total fish farm output of 19,942.03 was produced the mean pond size was 1,759.17M2, the mean total labour used was 3,611.61 man days and an average feed of 363.27kg. An indication that fish farm production is labour intensive and high level of feed, probably to feed the fish in order to reach market size on time. [16,17]

The cost function from table 2 revealed that, the mean total cost of production was N1,703,055, an average wage per day of labour of N562.72, the average cost of fertilizer was N85.12, the average cost of fingerlings used by the farmers was N10.24 and the mean cost of feed was N219.61/kg

4.Distribution of Economic Efficiency

Table 3, presents Ordinary Least Square (OLS) and Maximum Likelihood Estimate (MLE) of the production function parameters. The OLS function provides estimate of average production function while MLE model yields estimates of stochastic frontier production model. The entire estimated coefficients for MLE had positive coefficient as expected a-priori. This is an indication that all the considered inputs have direct relationship with the farm output. The higher the value of input, the higher the total quantity of fish produced by the farmers. Also all the variables in production function are significantly different from zero. The significance is confirmed by the t-ratio test significance at 1% level of significance. Meaning that,

Results and Discussion

Table 1: Net-Returns Analysis

Variables	Mean	Standard Deviation
Pond Price (M2)	1,103.17	513.21
Total Variable Cost (TVC)	1,611,413	592,411.14
Total Fixed Cost (TFC)	91,642.37	115,212,32
Total Cost (TC)	1,703,055	483,939.17
Total Revenue (TR)	5,112,318	416,285.73
Gross Margin (GM)	3,500,905	5,451,332.22
Net Revenue (NR)	3,409,263	5,529,551.77
GM/Kg	175.55	388.73
NR/Kg	170.96	393.76

Source Field survey,2020

Table 2: Summary Statistics of the Variables for the SFP and SFC models

Variables	Unit	Mean	Standard Deviation
Production Function Variables			
Output	kg	19,942.03	21,117.64
Pond Size	M2	1,759.17	439.28
Labour	Man days	3,611.61	1,582.44
Fingerlings Stocked (Seed)	Pieces	21,005.21	22,511.23
Fertilizer	Kg	203.43	366.72
Feed	Kg	363.27	1,389.52
Lime	Kg	152.55	424.33
Age of Farmer	Years	46.50	9.21
Years of Experience	Years	12.72	17.14
Education	Years	14.11	0.52
Cooperative Membership	Dummy	0.62	0.32
Technical Assistance	Dummy	0.81	0.59
Access to Market	Dummy	0.78	0.23
Cost Function Variables			
Average total Production cost	Naira (₦)	1,703,055	439.28
Average Wage/day	Naira (₦)	562.72	201.96
Average Operating Cost	Naira (₦)	986,782.77	16,233.52
Average Price of feed/kg	Naira (₦)	219.61	922.31
Average depreciation Cost	Naira (₦)	894.54	158.33
Average Price of Fertilizer/kg	Naira (₦)	85.12	71.13
Average Price of Lime/kg	Naira (₦)	52.74	69.84
Average Price of Fingerlings (Seed)	Naira (₦)	10.24	3.11
Output	Kg	19,942.03	21,117.64

Source: Field Survey, 2020

Table 3: Stochastic Frontier Production Estimates

Variables	Parameters	Average OLS	Frontier MLE
General Model			
Constant	β0	2.325*(3.862)	0.264*(2.358)
Pond Size	β1	0.060*(7.322)	0.053*(7.311)
Labour	β2	0.171*(2.343)	0.085*(2.881)
Seed	β3	0.812*(9.077)	0.892*(5.567)
Feeds	β4	0.016*(3.542)	0.071*(3.286)
Fertilizer	β5	0.009*(2.349)	0.009*(2.286)
Lime	β6	0.033*(3.428)	0.041*(5.628)
Inefficiency Model			
Constant	δ0	0	0.043*(2.832)
Age	δ1	0	0.081*(3.311)
Experience	δ2	0	0.415*(4.525)
Education	δ3	0	- 0.176*(2.651)
Cooperative	δ4	0	- 0.185*(2.698)
Technical Assistant	δ5	0	- 0.179*(6.642)
Market (Accessibility)	δ6	0	- 0.411*(3.873)
Variance Parameters			
Sigma Square	σ2	-	0.675*(2.883)
Gamma	γ	-	0.992*(8.005)
Log-likelihood Function		-42.663	- 30.327
Return to scale		1.101	1.151

, included variables are important factors in fish production in the study area. The return to scale computed as the sum of input elasticity yielded 1.151. This suggests that, if the inputs are jointly increased by 1%, the fish production will increase by 1.1%. An indication that an average fish aquaculture farms in the study area operates in the stage of increasing return to scale.The estimated maximum likelihood (MLE) parameters show that all the variables were positive. This implies cost of production increases as the variables with positive signs increases. Thus conforming to the a-apriori expectation that, overall cost of production of firm increases when the budget share of variables unit that makes up of such firms increases. However, the negative coefficient of depreciation is in line with a-priori expectation that depreciation cost of fixed asset decreases as the span increases thereby contributing less to the total production cost yearly. The estimates of sigma-squared (σ2) for fish production was 0.675 and significant at 0.01 probability level, indicating that it's significantly different from zero. It assures us of goodness-of-fit as well as the correctness of specified distributional assumptions of the composite error term. The value of the gamma (γ) was as high as 0.992 and showed that the unexplained variation in output of fish production is the major source of error. It also indicates that about 90% of the variation in output of fish was caused by inefficiency of the producers.

5.Determinants of Economic Inefficiency

The result of the determinants of economic inefficiency is presented in the lower part of Table 3. The results indicated that in fish production, age of farmer (δ1) was found to be positive and significant at 1%. This implies that as the age of farmers increases,economic inefficiency of fish farmers reduces. Years of experience (δ2) were positive and statistically significant at 1% level. This implies that as the years of experience of farmers increases, economic inefficiency in fish aquaculture farms reduces. Education level (δ3), cooperative membership (δ4), technical assistant (δ5) and market accessibility (δ6) were found to be negative. This implies that an increase in any of these variables will lead to an increase in economic inefficiency of fish farming in the study area.

6.Conclusion and Recommendations

The fish farmers are yet to achieve their best as confirmed by the presence of technical inefficiency in the estimated model. The significant contribution of years of schooling, cooperative membership, technical assistance and marketing incentive to the technical efficiency should be exploited as variables of policy concern to decrease the technical inefficiency observe from the study area. The study thus recommends improvement policy in better feeding management, fertilizer usage and genetic improvement, in fish stocks should be pursue in the country. Human capital development through education policy and training programme by extension education would lead to reduction in inefficiency of the farmers. Opening of more market opportunities should be pursued and government should provide support to fish farmers cooperative society by increasing their capital base.

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