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PRODUCTIVITY AND TECHNICAL EFFICIENCY OF FISH FARMING IN LAGOS STATE

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ABSTRACT
This study examined the productivity and technical efficiency of aquaculture production in Lagos state. A multi-stage sampling technique was employed in administering questionnaire. The study made use of a cross-sectional data obtained from fish farmers in the two zones of Lagos-state agricultural development project. The data were analysed using analytical tools like descriptive statistics, budgetary analysis and production frontier. Technical efficiency was estimated, the scores varied from 0.1 to 0.9 with a sample mean of 0.46 indicates a great potential for increasing fish production in Lagos state through improved efficiency. Stochastic frontier production function models revealed that feeds and operating cost were found to be the significant factors that contributed to the technical efficiency of fish production therefore, the proper choice of feeds composition and operative cost strategy is important to improving productivity as fish culture. The results therefore concluded that only years of experience is the significant factor in the inefficiency sources model. On the basis of findings, the study suggested that government of Nigeria should provide a conducive environment for the establishment of both concrete, earthen ponds and water recirculating system, encourages more citizenry,mostly youth to set up both pond systems in a bid to alleviate poverty status and unemployment rate in the state and the country at large.

KEYWORDS: productivity and technical efficiency, aquaculture production, Lagos State, Nigeria

INTRODUCTION

Fisheries resources have been identified as the most valuable natural food resources for mankind due to its importance as a veritable protein and other mineral resources, which are important for normal functioning of the body system. In Nigeria, fish and its product contribute about 40 percent of protein intake of the citizenry (Federal Ministry of National Planning 1981). As a measure for solving the problem of insufficient protein intake, steps should be taken to increase the supply of fish to the individual. This recommendation is based on the fact that fish is one of the cheapest sources of high quality protein in Nigeria. Similarly, the sector provides employment to about 8.23 million people in the primary sector while estimated employment secondary sector was 18.27 million FDF 2007; the sector contributed 4.0% to Gross Domestic Product GDP.

The government policy for agriculture of which fisheries is a sub-sector has not been stable since independence in 1960. This and other factors made growth almost impossible despite four successive development plans. The overall performance of the sector deteriorated visibly between 1970 and 1985 as noted by Federal Ministry of Agriculture Water Resources and Rural Development (1988).
Nigeria was a net importer of fish and fish product. The available statistics for 2007 trade revealed values of imports and exports to the tune of US $594.4 million and US $38.3 million respectively, leading to a trade deficit of US $556.1 million in fish product trade. (FDF 2007)

With present fish demand in Nigeria of about 2.66 million tones and a fall in domestic fish production of 620,000 metric tones (FDF 2007) due to lack of fishing inputs, rising cost of trawling operation and high interest rate, a critical shortage already exists which fish imports were unable to meet due to dwindling foreign exchange. While estimated fish demand showed a steady increase occasioned by increase in population. Prising per capita income and reduce role of meat due to the severe drought had severely affected the livestock industry. Added to these were the twin problems of desert encroachment (which reduce the availability of grazing pasture), the prevalent rinder pest diseases and low genetic potentials of indigenous breeds.

These factors have drastically reduced the level of animal protein supply and consumption of protein in Nigeria. The national per capita consumption of protein in Nigeria is about 3.0kg per annum from about 8.0kg per annum in 1999 (FAO 2003). This is very low much lower than the level of 11.0kg recommended by the World Health Organisation, (WHO) as the optimum for a normal health growth.

Fishery sub-sector is also important to Nigerian economy when considering the conservation of foreign exchange earnings. With increase in domestic production, this will lead to reduction and perhaps elimination of fish importation. When this happens the foreign exchange earning that would have been used for fish importation would be conserved for other uses in the economic development of the nation. An increased domestic production will make a good source of foreign exchange earnings for the country, if the fishery resources are developed and properly exploited. Nations such as Norway & Ice land to mention a few have benefited immensely from export of fish and its products (Fishstat Plus 2004).

Early model of aquaculture production focused on the biological and technical aspect of aquacultural production with little emphasis on the economic performance. For instance, Rauch et al (1975) and Allen and Johnson (1976) developed models for different components of aquaculture relating to the design and operation of aquaculture facility.

Recently, attention has been focused on the optimal harvesting strategies and lots of bio-economic models have been developed to determine the optimal time of harvest based on a number of different cost and price assumption (Bjohndal 1988, Heen 1994) with little or no emphasis on economic efficiency. Despite the potential embedded in aquaculture few studies on fish farms efficiency are available in the literature (Ajo 2001: Sharma and Leunga 1998, and Ojo, 2006).

It is imperative to give more attention to fish production from aquaculture in order to bridge the gap between its demand and the supply. This will reduce importation of fish as well as increase Gross National Product (GNP) and the standard of living of local fish farmers (FAO 1997).

Hence this study will examine the effect of some selected variables on the estimated efficiency indices.

This research will provide answers to the following questions:
(i) At what level of efficiency are the fish farmers operating in Lagos State?

MATERIALS AND METHODS

This study was conducted in Lagos State Nigeria. The state lies extensively within the southern rain forest zone of the humid tropics. It lies between latitude 6^o and 7^o of North of the equator and longitudes 3^o and 4^o East of the Greenwich Meridian. Lagos State has a total area of about 4000km^2, out of which 3277km^2 (78%) is land. The state is bounded in the North and the East by Ogun State, on the West by the Republic of Benin and on the North by the Atlantic Ocean.

The topography that is undulating plain in its northern area is interspersed with swamps in the flood plains of the rivers that run through the state. The coastal belt of sandy ridges is interspersed by lagoons and creeks. This makes the state rich in water resources for fishing and aquaculture activities. The state experiences annual rainfall of 1312mm – 1726mm. The ambient temperature is fairly high (32^{o}C) though moderated by the Cool Coastal wind. The relative humidity is on the average over 60% throughout the year. The state has an estimated population of 10million (National Population Commission 2006). The State comprises of 20 local government areas.

The study will cover the two zones, East and West by Lagos State Agricultural Development Authority LSADA. The Eastern zone is made up of two divisions consisting of three local government councils (Epe, Ibeju-Lekki and Ikorodu LGS) while the Western zone consists of three divisions consisting of 12 local government councils (Agege, Alimosho, Eti-Osa Badagry, Ojo, Lagos Island, Lagos Mainland, Mushin, Oshodi-Isolo, Ikeja, Surulere and Shomolu). For the purpose of administrative convenience, the two zones were further stratified into sixteen blocks. Each block is being managed by a block extension Agent.

SAMPLING TECHNIQUE

A total of 100 fish farmers were selected using a multi-stage sampling technique. The first stage involved broken of a sample frame of 300 into sub-group strata in order to get adequate representation of the three organic zones. Secondly, random sampling was then used from each stratum or sub group among the list of fish farmers in each stratum.

MODEL SPECIFICATION

The stochastic frontier production model is specified as

$$Y_i \quad = \quad F(X_i\beta) + \varepsilon_i$$

Where: Y is output in a specified unit, X denotes the actual input rector, B is the vector of production function parameters. ε_i is the error term.

The farm model of the aquaculture farms is defined as follows.

$$\text{Log } Y_i = \beta_o + \beta_I \text{ Log } X_{iI} + \beta_2 \text{ Log } X_{2i}\text{Log } X_{3i} + \beta_4 \text{ x}_{4i\,+}$$
$$\beta_5 \text{ Log x}_{5i} + \beta_6 \log \text{x}_{6i} + \beta_7 \text{ Log } X_{7i} + V_i - \mu_i$$

Where $_i$ = The number of respondent farms $_i$ = 1, 2 …..

Y = Output of fish harvested (kg), X_i=Pond size (m^2), X_2=Stocking density(unit), X_3=Percent survival(unit), X_4=Feed(kg), X_5=PH Status as 0=Acidic,1/2=Alkaline, X_6=Operating expenses(Naira), X_7 Fixed cost(Naira)

V_i and U_i are as previously defined. β_o = constant term; β_i to β_5 variances of V (σ_v^2), μ (σ_u^2) and gammar (Y) are unknown scalar parametes to be estimated using the program FRONTIER 4.1 (Coelli 1994). Gamma is calculated as Y = σ_u^2 / σ_v^2

INEFFICIENCY MODEL

The inefficiency model is stated as

$$Q_i \quad = \quad \alpha_o + \alpha_1\beta_1 + + \alpha_2\beta_2 + \alpha_3\beta_3 + \alpha_4\beta_4 + \alpha_5\beta_5 + \mu$$

Where

β_1=Age of farmers (years),β_2=Years of formal education,β_3=Farmers income level, β_4=Years of experience,β_5=Household size

Where the parameters to be estimated through ordinary least square method OLS.

RESULTS AND DISCUSSION

Table 1: Estimates of parameters of stochastic frontier models

	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-0.95068	2.6594	-0.71735	2.081
Pond size	0.03307	0.5418	0.08654	0.1394
Stocking	0.07384	0.6022	-0.18918	1.1573
Survival	0.007991	0.1569	0.0213	0.427
PH	-0.310119	1.8238	-0.17309	1.1018
Feed	0.30705	3.2995	0.17345	2.2156
Operating Cost	0.63575	7.1436	0.80616	11.0947
Fixed Cost	0.009035	0.6039	0.00873	0.5718

Technical Efficiency Analysis

The parameters of the stochastic production frontier (SPF) are presented in Tables 1. It should be mentioned that the SPF model was solved by the computer programme FRONTIER 4.1, developed by Coelli (1996). Except for PH status (Xs) the 8 coefficients associated with inputs variables (X_1) are estimated to be positive with only feeds being operating expenses and significance at 5 and 1 percent respectively. It means that feeds and operating expenses in the production frontier have a significant influence on fish production in Lagos State. The positive estimated coefficients imply that for every 100% percent increase in these variables the gross output (kgs) of fish will increased respectively by the margin of their coefficients. In other words, in Lagos State, there exists great potential for increasing fish farming through improvements in technical efficiency.

The parameter associated with the variances in the stochastic production frontier is estimated to 0.05. It indicates the proportion of variation in the model that is due to capacity utilization since the value is low not significantly different from zero, suggesting that very little variation in output between years due to differences in capacity utilization.
The gamma (Y) which measures the effect of technical inefficient in the variation of observed output. The estimated value y is 0.05 which means that 5 percent of the total variation in farm output is due to technical inefficiency.

The estimated technical efficiency scores for the sample fish farmer in Lagos State. The estimation technical efficiencies range from 10 to90%, with a mean efficiency level of 46%. For about 76% of the sample fish farm, the estimated technical efficiency score is 50% or below.

Table 2 Elasticity of Production and Returns to Scale

Variables	Elasticity of Production
Pond size	0.03307
Stocking Density	0.07384
Survival %	0.00799
P/H Status	0.31012
Operating Expenses	0.63575
Fixed Cost	0.00905
Return to Scale	1.06675

The estimated coefficient of parameters of the stochastic frontier production function of displayed in Table 2 model 1 are also the elasticities of production of the variables involved in the production process. All the, estimated coefficients of the variables had positive signs except P/H status that have negative sign and the value of each coefficients was between zero and less than unity. This implies that allocation and utilization of each of the factors (variables) was in stage II of the production functions or positive decreasing return to scale. Then allocation and utilization is efficient. The return to scale (RTS) which is the summation of the elasticities of production of the production function is used to determine the stage overall production in the production functions. As RTS is < I implies, there is a positive decreasing return to scale. Productions are quite optimal and efficient. Any increase in allocation of input results in increase in total output at a decreasing rate. This is the best stage of production that any producer (aquaculture farmer) strives to attain. If RTS >1, it implies increasing returns to scale or stage (and inefficient or irrational stage of production. Production once started should be expanded further in this stage. An RTS that is less than zero implies negative decreasing return to scale or stage III of production function and any further use of resource leads to reduction in total output therefore, production once in stage III of the production function should be stopped. Stage II of the production function is where the RTS is between zero and unity. This is the stage of positive decreasing returns to scale and efficient allocation of resources and production of output. The RTS shown in Table 3 was 1.06675. It implies that aquaculture production was in Stage I of the production function. Allocating more of the variables for more output and efficient productivity should expand its production. That the RTS of aquaculture production was in Stage I of the production function implies there is a bright future in aquaculture production in Lagos State.

Table 3: Technical inefficiency model:

	Coefficient	t-ratio
Constant	3.15856	17.41
Age	0.010438	0.24125
Experience	0.044128	3.6875
Education	0.062804	1.79928
Household	0.0010499	0.05650
Sigma Square	0.0519	0.05897
Grammar	0.181256	

Log Likelihood function -0.5393694+2

The inefficiency sources model shows that only years of experience is the significant factor. Thus, it can therefore be concluded that years of experience contributed significantly to the explanatory of inefficiency measures in aquaculture systems in Lagos State, Nigeria. The age coefficients being positive indicate that the older farmers are more inefficient than the younger ones due to their aggressive drive and ability in pursuing a business goal. The positive estimate of level of education indicates farmer with current years of schooling tend to be efficient, surprisingly it is not significant different from zero i.e education is not contribution to the explanation of inefficiency measures in aquaculture. Presumably, then efficiency could be due to their enhanced ability to acquire technical knowledge with respect to adoption of new technology. However this results and interpretations conform to the findings of Ajibefun *et al* (1996), Kareem et al (2007), Battese and Coelli (1995), and Omu *et al* (2000).

Table 4: The generalized likelihood ratio test for the parameter of the inefficiency sources model.

Log Likelihood	X^2 Statistics	X^2 0.995	Decision
-539.37	288	7.87	Accept H0

Table 4 showed that the X^2-calculated is less than the X^2-tabulated. Thus, null hypothesis that specifies that inefficiency sources model have effects in the use of resources is accepted. The implication is that the variables estimated contributed significantly to the inefficiency of the fish farmers in the study area.

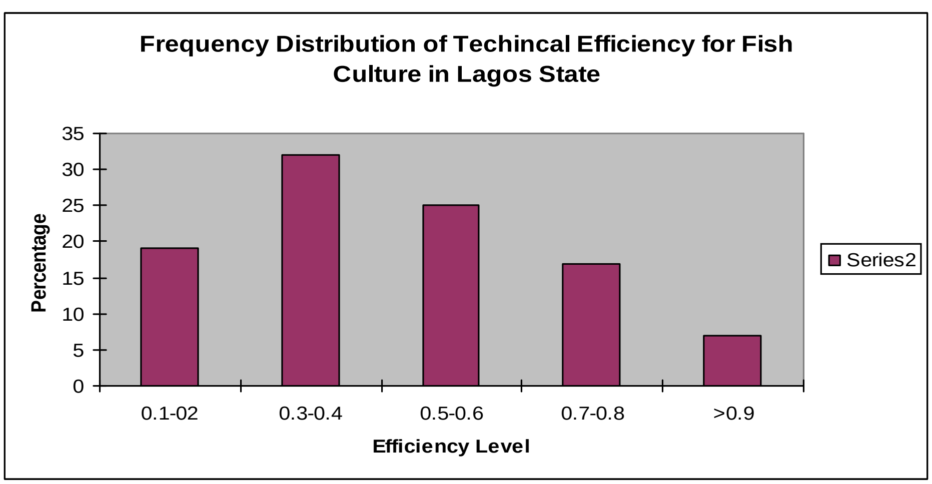
Generalized Likelihood ratio test of technical inefficiency effects

A major test used to determine the existence of a frontier (i.e. H_o:g=0) I the one-sided generalized likelihood ratio test of Coelli (1995). Since the alternative hypothesis is that O < g < I, the test has an asymptotic distribution, the critical values of which are given by Kodde and Palm (1986) if the hypothesis is accepted, there is no evidence of under utilization of capacity in the data and the production frontier is identical to a standard production function.

The critical value at the five percent level of significance is 11.911 with six degrees of freedom and 10.371 for five degrees of freedom.

Since the calculated value of the LR test can be seen to be 5.34 and 3.81 in this case, both models do not satisfy the requirements of the test (because the values are less than the critical values) which suggests that in the both cases estimates of capacity utilization may be spurious. Also the model does not satisfy at 10 percent level of significance critical value of 9,998 and 8.574.

The result of the log likelihood however shows that the farm variables were jointly not significant in explaining inefficiencies at 5 percent level of significance.



SUMMARY

This study focused on the analysis of productivity and technical efficiency of fish farming in Lagos State The study made use of two stage random sampling to sample each of the fish farms. The selected respondents were chosen from a list of fish farms obtained from the Fisheries Department of the state Ministry Of Agriculture and natural resources. Data collected were analyzed using descriptive statistics, budgetary techniques and non-parametric frontier analysis.
This study revealed that the average age of the fish farmers was 44 years, and most of them were married males with a high level of formal education. Most of the farmers had been producing fish for an average of 10 years. Most of the fish farmer are not full time fish farmers, with an average pond size was 0.182 hectares. 56.5% of the farmers produced *Clarias gariepinus/Tilapia guinensis* and 70% employed hired labour.

A Stochastic Production Frontier was estimated in order to assess the level and determinants of technical efficiency for a sample of fish data and in Logos-State, the fish production data and other relevant information in the field survey are analyzed by estimating Cobb-Douglas Stochastic production Frontier involving a model for technical inefficiency effects. The production Frontier involves six input variables, including seed, feed, and other inputs. Similarly, the technical inefficiency model includes Five Farm specific variables namely age education, experience and house-hold sizes.

The mean technical efficiency for the sample fish farms, estimated by the stochastic production frontier, is quite low (47%). This indicates that there is great potential for increasing fish production in Lagos State by improving technical efficiency.

All B-coefficients in the stochastic production frontier are estimated to be positive and insignificant except for the coefficient for feed and operating expenses. These results indicate the these inputs make a positive and significant contribution to fish production culture in Lagos State. The budgetary techniques and profitability ratios revealed that fish farming is a profitable venture as suggested by the level of profit realized, benefit-cost; expense structure and gross revenue ratios. This is in line with studies carried out in other parts of Nigeria. Factors that could determine the technical efficiency of fish farms were examined and it was observed that farm size is statistically significant at 5 percent, which suggests that, large farms operate at a better efficiency level than small farms as indicated by the positive relationship between efficiency indices and farm size.

The inefficiency source model showed that only years of experience is the Significant Factor. Thus, it can therefore be concluded that years of experience contributed significantly to the explanation of inefficiency measure in aquaculture in Lagos State.

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