DETERMINANTS OF PRODUCTION AND TECHNICAL EFFICIENCY OF FISH IN ABIA STATE, NIGERIA: STOCHASTIC FRONTIER APPROACH

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ABSTRACT

The program frontier (version 4.1c) for stochastic production investigation was used for analysis to examine the factors that affect fish farming in Abia State as well as the determinants of technical efficiency of fish production. Data generated for the study were drawn across fish farmers in the three agricultural zones. Fifty respondents were used for the study. The research findings reveal that the number of fingerlings stocked and the pond size were the major determinants of fish production while the age of the farmers and their stock size determined majorly their technical efficiency of production. Although the fish farmers were reasonably technically efficient given a mean score of about 90 percent, there is yet a 10 percent chance of increasing the level of technical efficiency with the available technology at their disposal.

Keywords: **Technical efficiency, fish farming, stochastic frontier, Abia State**

INTRODUCTION

The increasing demand for animal protein has been said to be met through significant development in poultry and livestock farming. Relative to livestock and poultry however, fish farming is easier to develop because there is no scope for spatial expansion of grazing and feeding areas as may be expected in other livestock farming or enterprise. Therefore, animal protein from fish is in this respect is easier supply to the increasing population. Although it has been reported that about 79.85% of the annual fish demand in the country is supplied through importation of fish from outside the country (Onuoha, 2009), fish farming is a growing sub-sector in Abia State and seems to be gaining grounds with the passage of time. This is partly because as threat on health for the continued eating of red meat gains ground, fish remains the better alternative for supplementing the protein requirement for man's survival. Besides, fish production requires less cash investment compared to livestock enterprises and also can be produced using a land that is unsuitable for agriculture (Emokaro and Ekunwe, 2009).
According to Omonyinmi (1999), protein sources from fish are better than most of its rivals like beef etc, because besides its relatively cheaper rate, it contains an anticholesterol oxidant. Moreover, fish does not compete with man for other grains and vegetables as most livestock do and yet has more protein materials than most of its rivals (Ehirim and Onyeka, 2002). Fish provide throughout the tropics a cheaper source of first class protein for human consumption, which as a result, has led most countries to turn their attention to the development and exploitation of their fisheries resources as a means of providing their citizens with the much needed protein (Onuoha, 2009).

Advanced technology had been opined by researchers not to enhance output in most small scale agricultural production because a

lot of such technologies are exhausted without giving a proportionate increase in output (Quezada (1981). Optimum yield should be based therefore on full capacity utilization of resources through efficient use of existing technology and policies made bearing in mind this necessity of full capacity (Bravo-Ureta, 1993; Quezada, 1981). FMAWR (2008) has reported that the local fish supply in Nigeria is inadequate and partly responsible for the current daily low animal protein intake per head per day of 10g relative to the FAO recommended 36g.

In Abia State at present, many individuals are becoming interested in fish farming; and fishery experts are helping out in setting up small scale ponds for individuals at a cost either by use of the concrete type or plastics, and so, there are more fish farmers than was the situation a couple of years ago. Some of these fishery technologists or experts help set up the farms and assist the farmers to understand the enterprise and guide them to a point where they can stand on their own. In whichever way such farms are set up, the availability of water is necessary for proper take off. The growing operation of borehole by many farm families has made it possible in coping with the water needs of these farmers.

The need to examine, therefore, the factors that affect fish production among these fish farmers and the technical efficiency of their production would go a long way in guiding policy formulation and implementation in the State in particular and the Nigerian nation as a whole. This radical policy measure aimed at increasing fish production is what the study is aimed at accomplishing

METHODOLOGY

The study was carried out in Abia State which has an average population density of 364 persons per square kilometre with 63 percent (63%) involved in agricultural production and an average household of 6 persons per family (NPC Report, 1991; World Bank, 2000). Current Census statistics puts the State at a total population of 2,833,000 out of which 95% are said to be Christians (NPC, 2006). Fifty fish producers across the three agricultural zones of Abia State were randomly selected using a list obtained from the State Headquarters of the Abia State Agricultural Development Programme as the sampling frame. A total of 20, 15 and 15 respondents were selected from Aba, Umuahia and Ohafia Agricultural zones respectively. Aba zone had a higher concentration of fish farmers relative to the other two zones. This approach differs from earlier studies by researchers which focussed either on a Local Government or a particular agricultural zone or at best two out of the three.

Data were of primary origin aimed at investigating socio-economic characteristics of the fish farmers, their stocking capacity and efficiency of production. Thus, the age of farmers, household size, educational experience, number of fish stocked in their pond(s), various cost items necessary for production etc were among the various variables solicited for using questionnaire complemented with interview schedule. The stochastic frontier model which employs the maximum likelihood estimation was used for the analysis.

The stochastic frontier production function independently proposed by Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977) was used for the analysis. Research has proved that estimation by the stochastic frontier production function makes it possible to find out whether the deviation in technical efficiencies from the frontier output is due to farm specific factors or due to external random factors (Igwe, 2004; Onyenweaku *et al*,. 2005; Okoye, 2006).

The general implicit form of the model is stated below:

$Y = f(X_1, X_2, X_3, X_4, X_5, (V_i - U_i))... (1)$

Where

Y = Output of fish in kilogramme

X_1 = Number of fingerlings in number
X_2 = Size of Pond in meters squared
X_3 = Labour in hours
X_4 = Quantity of feed in kilograms
X_5 = Capital input in naira
Vi = Symmetric error term accounting for random variations in output due to factors beyond the farmer
Ui = Non-negativity random variable representing technical inefficiency in production relative to the stochastic frontier

$$\text{Exp}(-Ui) = b_0 + b_1 Z_1 + b_2 Z_2 + b_3 Z_3 + b_4 Z_4 + b_5 Z_5 + b_6 Z_6 + b_7 Z_7 + b_8 Z_8 + e \quad ... (2)$$

Where:
Z_1 = Stock size
Z_2 = Age of farmers
Z_3 = Education in years
Z_4 = Extension visits
Z_5 = Household size
Z_6 = Period of maturity
b_0 = Constant
b_1 b_8 = Parameters to be estimated
e = error term

The Cob Douglas form of the frontier model was used based on already established scientific view that it is the best for agricultural studies of this nature. In the context of the stochastic frontier equation above, the technical efficiency defined as the ratio of the observed output to the corresponding frontier output conditional on the levels of inputs used by the farmer is mathematically expressed as:

$$TE = Y_i / Y_i^* \quad ... (3)$$

$$= f(X_i;B) \exp(V_i - U_i) / f(X_i;B) \exp(V_i) \quad ... (4)$$

$$= \exp(-U_i) \quad ... (5)$$

Where Y_i = observed value of output and Y_i^* = the frontier output.

The frontier production function is estimated by the Maximum Likelihood Technique. Any farmer who is fully technically efficient will have the value of one. Thus farmers having value lying between zero and one are described as being technically inefficient.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of fish farmers in Abia State. It shows that about 44 percent of the farmers are either 42 years or less. The averages of various production and socio-economic factors of interest are shown in table 2. An average fish farmer in the study area has an educational status of about 3 and a household size of 6 and is about 47 years old. Fish farmers in Abia State are middle aged. The mean stock size of fish farmers is 4417 fingerlings. Table 3 shows the distribution of the stock across the sampled fish farmers in Abia State. About 64 percent of the sampled fish farmers have stocking capacity of about or less than 5000 fish.

Out of the five factors investigated based on *apriori* expectation to affect fish farming, only two were found to be significant in the study area. Number of fingerlings was highly significant (p=0.001) and positive in sign as expected. This is in line with research done in Oyo State among fish culturists by Ehirim and Onyeka (2002) except that they found a lower level of significance of fingerling variable. This means that as more fingerlings are purchased by fish producer, *ceteris paribus*, productivity of fish production increases. Higher output will be realized given the purchase of more fingerlings. This is true because the sizes of the fingerlings are about the same but not their output. Output expected of any farmer is a function of specie as well as period of maturity. The more time the fish stay the less feed it consumes but the bigger its size.

Pond size was also significant as well as positive in sign except that the level of significance was lower (p=0.05) relative to the number of fingerlings. This implies that for an increased productivity of fish farming in the study area, increase in the size of the ponds is necessary. This is necessary because in practice usually, the ponds are partitioned into various apartments to make for sorting otherwise because the fish grow at different rates, if sorting is not done, the excessively bigger fish would eat up the smaller ones leading to lower output in the long run. Thus, increase in the size of pond is a necessary condition for increased fish production in the study area.

Table 1: Socio-economic Characteristics of Fish Farmers in Abia State

Variable	Range	Frequency	Percentage
Age			
	25-30	5	10
	31-36	3	6
	37-42	14	28
	43-48	8	16
	49-54	10	20
	55-60	3	6
	61-66	2	4
	67-72	4	8
	73-78	1	2
	Total	**50**	**100**
Education			
	1-2	8	16
	3-4	41	82
	5-6	1	2
	Total	**50**	**100**
Household size			
	1-3	3	6
	4-6	25	50
	7-9	18	36
	10-12	4	8
	Total	**50**	**100**

Source: Field Survey, 2010

Table 2: Means of Production and Efficiency Factors

Variables	Mean
Quantity	3349.37
No of Fingerlings	4417
Size of Ponds	396.62 m^2
Labour	89.51 hours
Quantity of feeds	158.55 kg
Capital input	46, 587.24
Age	46.58 years
Education	3.16 years
Extension contacts	2.78
Household size	6.32
Period of maturity	21.58 weeks

Source: Field Survey, 2010

Table 3: Frequency of Stock Capacity of Pond of Fish Farmers in Abia State, Nigeria

Range	Frequency	Percentage
1500 2300	5	10
2301 3200	8	16
3201 4100	9	18
4101 5000	10	20
5001 5900	9	18
5901 6800	3	6
6801 7700	3	6
7701 8600	1	2
8601 9500	1	2
9501 10000	1	2
Total	**50**	**100**

Source: Field Survey, 20010

Table 4: Determinants of Fish Production and Technical Efficiency

Variables	Coefficients	T-values
Production Factors		
Constant	0.964	0.853
No of Fingerlings (X_1)	0.680	4.897***
Size of Pond (X_2)	0.200	4.631***
Labour (X_3)	0.045	0.247
Quantity of Feed (X_4)	-0.073	0.949
Capital Input (X_5)	-0.001	1.264
Efficiency Factors		
Constant	-1.306	-1.377
Stock size (Z_1)	0.987	1.650*
Age (Z_2)	-0.037	2.252**
Education (Z_3)	-0.313	1.119
Extension visits (Z_4)	-0.025	0.748
Household size (Z_5)	0.092	1.108
Period of maturity (Z_6)	-0.173	1.333
Diagnostic Statistics		
Sigma-squared	0.0864	2.479**
Gamma	0.699	5.441***
Log likelihood function	13.317	
n	50	

Source: Field Survey, 2010

On factors that determine technical efficiency of production among fish farmers, stock size and age were the major ones established in the study area. Whereas the stock size was positively related with technical efficiency at 10%, age was negatively related with technical efficiency at 5% level. The implication of this for the age variable therefore is that younger farmers were more technically efficient in their production than the older farmers. Fish farming is easy to embark upon given availability of take off capital and could generate income for the operators within few months. Young men are thus more responsive to venture into what gives them quick money relative to the older men. Policy emphasis that would stimulate youth's involvement in fish farming in the area would help reduce unemployment as well increase the standard of living of the State thereby strengthening food security in the State reasonably.

Table 5: Frequency Distribution of Technical Efficiency of Fish Farming in Abia State

Range	Frequency	Percentage
0.38 0.58	1	2
0.59 0.79	4	8
0.80 1.00	45	90
Total	**50**	**100**

N/B: Mean technical efficiency = 90%
Source: Field Survey, 2010 Result of Frontier 4.1 Computer Print out

CONCLUSION

A study on fifty fish farmers sampled across the three agricultural zones in Abia State revealed that an average farmer stocked about 4417 fingerlings in the 2010 survey. Data generated on the sampled farmers when analyzed to measure the determinants of fish farming in Abia State and the technical efficiency of its farming showed that number of fingerlings and pond size were the major determinants of fish farming while age and stock size determined the technical efficiency of fish production among fish farmers in Abia State.

The implication is that given the available technology, only the age of the fish farmers and the size of their ponds would affect the technical efficiency of the sampled fish farmers in the study area and thus, in order to improve on the mean efficiency of 90 percent as found by the study, government policies must factor in these two variables for meaningful increase in fish productivity to be achieved. The study used the stochastic production frontier which employs the maximum likelihood estimation. Given the findings of the study, government policy that would precisely encourage youth participation in fish farming would help increase the technical efficiency of fish farming in Abia State given that technical efficiency decreases with increasing age.

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