Technical Efficiency of Fish Production in Earthen Ponds in Osun State, Nigeria

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Abstracts

This paper reports the assessment of the technical efficiency of fish production by fish farmers in Osun State, Nigeria. A simple random sampling technique was used to obtain quantitative and qualitative information about the critical factors impacting on the performance of the fish farmers. Seven variables (Pond size, fuel, percentage survival, feed, fixed cost, labour and operating cost) were used to estimate technical efficiency. Data was analysed using descriptive statistics and stochastic production frontier function. Findings showed that 79.3% of the respondents were male, 85.9% were married, 63 % had minimum of secondary education while 52.6% were above 50 years of age. Operating cost was significant at 10%. Age, education and marital status were the significant factors at 5% and 10%, respectively .Conducive environment with adequate credit facilities should be provided. All efforts to reduce the operating cost should be looked into. Also, educated youths should be assisted to go into fish farming as a profitable venture so as to compliment the effort of the ageing population that were the major actors in the sector in the sampled area.

Keywords: Earthen ponds, Fish production, Productivity, Technical efficiency.

Introduction

The ever increasing human population coupled with the limited availability of space for land-based food production system, urbanization and industrialization, has led to inconsistent supply of good quality food (Khan *et al*., 2011). The rapid increase in the human population of Nigeria has resulted in a huge increase in the demand for animal protein which is essentially better in quality than plant protein and contains all essential amino acids for body growth (Awoyemi and Ajiboye, 2011). The average protein intake in Nigeria which is about 19.38 g per caput consumption per day is far below FAO requirement of 75 g per caput consumption per day. The contribution of 7g from animal source is below recommended minimum of 35 g per caput consumption per day expected from animal products (Oladimeji *et al*., 2014). The per caput consumption per day of fish is higher than that of any other livestock products in Nigeria. It was estimated that the nation per caput consumption of fish per day which was 29.1 g, yielded 2.6 g of animal protein and represent 35.0% of the per caput consumption of livestock products and 30.8% of ingested animal protein (Oladimeji, 1999; Awoyemi and Ajiboye, 2011).

Aquaculture, one of the sub sectors of the Nigeria fishery industries started over 50 years ago (Olagunju *et al.,* 2007) but has not significantly contributed to domestic fish production. It is said to contribute between 0.5% and 1% to Nigeria's domestic fish production (Awoyemi and Ajiboye, 2011) and the possible creation of 30,000 jobs and generation of revenue valued at US$160 million per annum. Aquaculture is a food production system that shows the potential to provide the quality protein to ever increasing human population and to combat malnutrition. The awareness on the potential of aquaculture to contribute to domestic fish production has continued to increase in the country. The reason for this is that there is the need to meet the much needed fish for domestic production and export. Capture fisheries has shown signs of stagnation for more than a decade while, aquaculture is showing a vast scope of expansion (FAO, 2012). Aquaculture is economically more efficient and viable than land based animal farming systems because fishes are efficient converters of food to flesh and there is more production of fish biomass per unit area (Costa-Pierce *et al.,* 2012). In general, plant products are limiting in some essential amino acids. However, fish have well balanced amino acid and fatty acid profile especially polyunsaturated fatty acids which are present in good quantity. Fish flesh is highly digestible and considered as rich in several minerals and some vitamins. In addition, aquaculture practice generates employment and foreign exchange.

Aquaculture is believed to be the way of bridging the gap in the short fall between domestic fish production and domestic demand. Despite this perceived role there is a low level of fish production which is due to resource use constraints (feed supply, low managerial know-how, low capital e.t.c.) which have retarded the pace of development in the aquaculture sub-sector. A great deal of opportunity still abounds in aquaculture business (Okpeke and Akarue, 2015).

Taking this situation into consideration, the low level of production in Nigeria needs to rise beyond the level of subsistence to higher level of profitability through more efficient use of production resources. It is therefore expedient to examine the efficiency of fish farming in the study area to identify possible areas that require improvement. Analysis of productivity and technical efficiency of fish production in earthen ponds in Osun State was the focus of the study.

Materials and Methods

Study area

Osun state (Figure 1) is in the South western part of Nigeria. It covers an area of 10,456 square kilometers and lies within the tropical rain forest region with thick deciduous vegetation in the Southern region and grass land towards the North. It lies between latitude 7^0 and 8^0 N and is bounded in the North by Kwara State, in the North-east by Kogi State, in the East by Ondo State and bounded in the South by Ogun State. The rainfall pattern of Osun state is wide and diverse ranging from 1125 mm in the derived savannah to 1475 mm in the rain forest belt. It has an estimated population of 3, 423, 535 (NPC 2006).

According to Osun State Agricultural Development Programme (ADP), the state is divided into three agricultural zones: Iwo, Oshogbo and Ilesha zones. Food crops grown in Osun State include maize (*Zea mays*), yam (*Dioscorea spp*.), cassava (*Manihot esculenta*), cocoyam (*Colocasia spp*.), rice (*Oryza sativa*) and vegetables. The permanent crops include cocoa (*Theobroma cacao*), kolanut (*Cola nitida*) and oil palm (*Elaeis guinensis*). These crops are usually mixed or intercropped (Sofoluwe *et al.,* 2011).

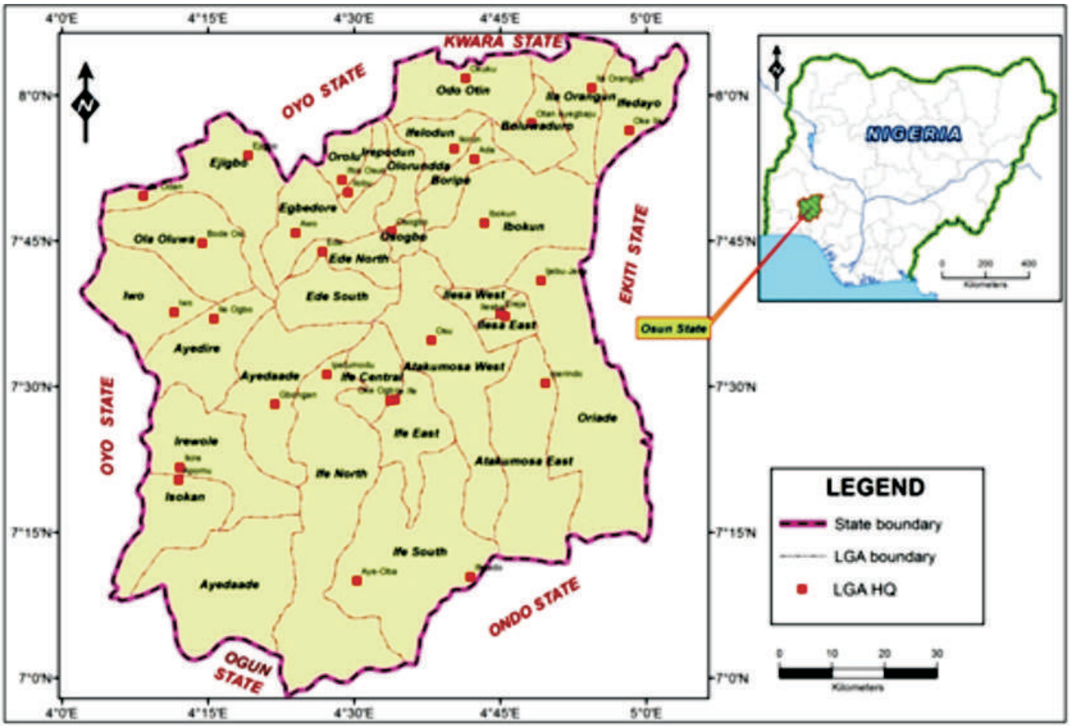

Figure 1: Map of Osun State as located in Nigeria
Source: Geography Department, University of Ibadan (2014)

Sampling Procedure

The study was based on primary data collected from 135 respondents selected from the three Osun State Agricultural Development Programme (ADPs) zones using a simple random sampling technique. Structured questionnaire was used to collect quantitative and qualitative information about socio demographic characteristics, micro-credit sources and use, production systems, occupational status, income and fish production data. Data were analysed using descriptive statistics and stochastic production frontier function.

Model Specification

The stochastic frontier production model, as described by Battese and Coelli, 1995 was used

$$Yi = F(Xi\beta) + \varepsilon i$$

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

The farm efficiency model of the fish farms is defined as follows:

$$Yi = \beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + Vi - \mu i$$

Where i = the number of respondent farms i = 1, 2 …

Y = Output of fish harvested (Kg), X_1 = Pond size (m^2), X_2 = cost of fuel (Naira) X_3 = Percentage survival (%), X_4 = Feed (kg), X_5 = Operating cost (Naira), X_6 = Fixed cost (Naira) X_7 = labour (man days)

Vi = Stochastic error term and Ui= Estimate of technical inefficiency. Bo = constant term; βi to β5 variances of V (σv^2), μ (σu^2) and gamma (Y) are unknown scalar parameters to be estimated using the program FRONTIER 4.1 (Coelli 1994). gamma is calculated as $Y = \sigma u^2 / \sigma v^2$

Inefficiency model

The inefficiency model is stated as

$$Qi = \alpha_o + \alpha_1 \beta_1 + \alpha_2 \beta_2 + \alpha_3 \beta_3 + \alpha_4 \beta_4 + \alpha_5 \beta_5 + \alpha_6 \beta_6 + \alpha_7 \beta_7 + \alpha_8 \beta_8 + \mu$$

β_1=Age of farmers (years), β_2= Sex, β_3= Years of formal education, β_4=Years of experience, β_5=Household size, β_6 = access to micro-credit, β_7 = marital status, β_8 = number of wives were the parameters estimated through ordinary least square method as described by Battese and Coelli, 1995.

Results

Socio- economic analysis

Findings from this study revealed that 52.6% of the respondents were above 50 years of age. The mean age was 44.1±7.48 years. Most of the respondents were married (85.9%), were males (79.3%) with a high level of formal education (63%) Table 1. Most of the farmers (74.8%) had been producing fish for over 5 years, while 59.3% of the fish farmers were not full time fish farmers, with an average pond size of 0.182 hectares. About 94.89% of the farmers produced catfish (*Clarias gariepinus)* only, while others produced catfish mixed with *Tilapia* sp., and 70% of the fish farmers employ hired labour. The major source of their capital was the cooperative society (79.3%).

Table 1: Socio-economic characteristics of fish farmers in Osun State, Nigeria

Characteristics	Frequency	Percentage
Gender		
Male	107	79.3
Female	28	20.7
Marital Status		
Married	116	85.9
Single	10	7.4
Divorced/widow	9	6.7
Age Group		
< 31 years	4	3.0
31- 50	60	44.4
> 50 years	71	52.6
Educational Status		
No formal Education	8	5.9
Primary	42	31.1
Secondary	26	19.3
Tertiary	59	43.7
Household size		
<6	68	50.4
6-10	51	37.8
>10	16	11.8
Years of Experience		
< 6	34	25.2
6-10	64	47.4
11-15	29	21.5
>15 years	8	5.9
Source of Micro-credit		
None	10	7.4
Bank Loan	8	5.9
Cooperative Societies	107	79.3
Government Assisted	10	7.4
Occupational Status		
Full time fish farmer	55	40.7
Others	80	59.3
Size of Pond		
< 0.2 ha	88	65.2
> 0.2 ha	47	34.8
Source of Labour		
Family	41	30.4
Hired	94	69.6
Type of Fish Cultivated		
Catfish only	128	94.8
Catfish and Tilapia	7	5.2

Technical Efficiency

The parameters of the stochastic production frontier are presented in Table 2. Six out of seven coefficients associated with inputs variables (X_1) are estimated to be positive with only operating cost significance at 10%. It means that the operating cost in the production frontier had a significant influence on fish production in Osun State. The positive estimated coefficients implies that for every 10% percent increase in these variables, the gross output (kg) of fish will increase by 0.63575. Pond size and feed consumed on the other hand had negative values. This means that a 10% increase in the values of their coefficients (0.63575) will decrease the value of the output of the fish farmers by the value of coefficients. In other words, in Osun State, there exists great potential for increasing fish farming through improvements in technical efficiency.

Table 2: Estimates of parameters of stochastic frontier models of technical efficiency of fish farms in Osun State Nigeria

Variables	Co-efficient	t-ratio
Constant	0.68326274E+01	0.11647528E+02
Pond size	-0.66816E-02	-0.38055E+00
Fuel	0.23741E+00	0.41094E+01
Percentage Survival	0.007991E+00	0.1569E+00
Feed	- 0.37480E+00	-0.22556E+01
Operating cost	0.63575E+00	7.1436E+00***
Fixed cost	0.009035E+00	0.6039E+00
Labour	0.37767E+00	0.58729E+01

***= Significant at 10%

The inefficiency sources model as shown in Table 3 shows that age, education and marital status were the significant factor (at 5% and 10%, respectively).

Table 3: Technical inefficiency parameters of fish farms in Osun State, Nigeria

Variables	Coefficient	t ratio
Age	0.11548992E+01	0.16509702E+01**
Sex	- 0.15459926E+01	-0.14686914E+01
Education	-0.46515250E+01	-0.28023716E+01***
Years of experience	-0.95146938E+00	-0.12534195E+01
Household size	0.0010499E+00	0.05650E+00
Micro credit	0.45090983E+01	-0.22938440E+01
Marital status	0.56345746E+01	0.19828115E+01***
No. of wives	0.56345746E+01	-0.15966509E+01
Sigma Squared	0.93331713E+01	0.25338055E+01
Gamma	0.99413675E+00	0.32478562E+03

Log Likelihood function =-0.16073768E+03
= Significant at 5%; *= Significant at 10%

Discussion

The descriptive statistics on the demographic features obtained in this study is similar to the findings of Crentsil and Essilfie (2014) in their study on smallholder farmers in Ghana. Olayiwola (2013) in his study in Ijebu Ode and Omitoyin and Sanda (2013) in their study on poverty and micro-credit use in Osun State all reporting a much higher percentage of men in fish production, mostly married with a high level of education and smallholding pond sizes.

The result of the estimates of parameters of stochastic frontier models showed that six out of seven coefficients associated with inputs variables (X_1) were estimated to be positive with only operating cost significant at 10%. Thus, the operating cost in the production frontier had a significant influence on fish production in Osun State. The study of Akenbor and Ike (2015) in Edo state found that labour and operating cost were over utilized, while Abdullahi and Mohamed (2016) in Malaysia also found that production cost was over utilized.

The results obtained from the inefficiency sources model showed that age, education and marital status were the significant factor at 5% and 10%, respectively. It can therefore be concluded that these factors contributed significantly to the explanatory of inefficiency measures in fish production systems in Osun State, Nigeria. The positive age coefficient indicated that the older farmers were more inefficient than the younger ones. This may be due to the aggressive drive of the younger ones, their ability to take risk and doggedness in pursuing a business goal. The older farmers may also be conservative and thus refrain from adopting new or improved technology. They may also have invested in a particular technology which makes it difficult to change to new or improved technology and therefore are less technically efficient. The negative estimate of level of education and its significance at 10% indicated that fish farmers with high level of education tend to be efficient. This may be connected to their ability to acquire technical knowledge with respect to adoption of new technology, read and follow instructions more readily and carefully. High educational level does not contribute to the explanation of inefficiency measured in aquaculture. Marital status was also significant at 10%, suggesting that married people were able to utilize resources more efficiently than others. This may be due to the fact that married people were able to take on higher risk as their partners may help in absorbing some shocks serving as buffers. Married people are also viewed culturally as more responsible and may be able to access some inputs e.g. Micro-credit more readily. Though micro-credit was not significant, it is a parameter to look at as the coefficient was high. The obtained results and interpretation is in line with the findings of Battese and Coelli (1995), Ajibefun *et al.* (1996), Onu *et al.* (2000), Adeogun *et al.* (2007), Kareem *et al.* (2008), William *et.al*. (2012), and Itam *et al.* (2014) which is also similar to the findings of Crentsil and Essilfie (2014) in "measurement of technical efficiency of small holder fish production in Ghana: A Stochastic frontier approach analysis" which reported that feed, fingerlings and labour influenced technical efficiency positively and significantly while formal education, marital status, membership of fish farmer groups and contact with extension services negatively influenced inefficiency. Also, Akenbor and Ike (2015) in comparative analysis of technical efficiency of catfish farming in Edo State, Nigeria and Abdullahi *et al*., (2016) in Comparative analysis of technical efficiency for different production culture systems and species of freshwater aquaculture in Peninsular Malaysia had similar results.

Conclusion

The results obtained from the study area indicated that the fish farmers are operating below the production frontier, thus, there is room for improvement. The farmers must adjust their input utilization so as to reduce their operating cost thereby increasing their turn over.

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