Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS) 5(2): 223-231
 (ISSN: 2141-6990)
jeteraps.scholarlinkresearch.org

Evaluation of Technical Efficiency of Catfish Production in Oyo State: A Case Study of Ibadan Metropolis

Alawode O.O. and A.O. Jinad

Department of Agricultural Economics,
University of Ibadan, Nigeria

Corresponding Author: Alawode O. O

Abstract

The study evaluated the technical efficiency of catfish production using stochastic frontier production function analysis. Primary data were collected using structured questionnaire from eighty three farmers who were selected from all the local governments in Ibadan using simple random techniques. Frequency tables, percentages and means were used to present the socioeconomic profile of the respondents, and to determine the production types and production technologies used by catfish farmers in Ibadan. Results show that majority of the catfish farmers were male (75.9%), with a mean age of 44 years (±12.1), married (75.9%) with a household size of 4 persons on the average. Also, majority (70%) had tertiary education with a mean of about 9 years (±7.3) experience in catfish farming. Most of the catfish farmers (72.3%) preferred to raise catfish to table size and used static renewal technology (56.6%).Also, feed inputs and pond size had negative relationship with output while fingerling had positive relationship with output. Increase in the number of fingerling stocked in ponds will increase output of catfish. Also, about 65% of the catfish farmers had technical efficiency scores of 60% or less. Access to credit, education, culture system used, household size, and the years of experience in catfish farming were factors that contribute significantly and positively to technical efficiency of catfish farms. The mean cost efficiency was 37% and majority (85.7%) of the catfish farmers had cost efficiency score of 60% or less meaning that farmers were making substantial losses on net profit. Government should introduce training workshops especially for fresh school leavers in order to encourage greater participation in the sector. Also, extension visits should be increased in order to improve the experience and efficiency of catfish farmers.

Keywords: catfish farming, technical efficiency, cost efficiency, input use, Ibadan metropolis

INTRODUCTION

Aquaculture refers to the cultivation of aquatic organisms under controlled or semi-controlled conditions for economic and social benefits. Aquaculture has been the world's fastest growing food production system over the past decade (Fourier, 2006). The average growth rate for aquaculture has been 8.9% per year since 1970, compared to only 1.2% for capture fisheries and 2.8% for terrestrially farmed meat production over the same period (Brink, 2001). Catfish farming is a subset of aquaculture which involves the rearing of catfish under controlled conditions for economic and social benefits. According to Adewumi and Olaleye (2011), the favoured catfish for culture include *Clarias gariepinus, Heterobranchus bidorsalis, Clarias heterobranchus* hybrid (heteroclarias), with *C. gariepinus* and *H. bidorsalis* being the most cultured fish in Nigeria. *Clarias gariepinus* is regarded as an excellent aquaculture species because it grows fast and feeds on a variety of agricultural by-products, it is hardy and can tolerate extreme temperature, easy to produce in captivity with high annual production, good feed conversion rate and the ability to fetch high price as it can be sold live at the market.

Fish farming contributes significantly to the economy; creating employment opportunities in rural and urban areas, serving as a viable source of protein nutrients in Nigerian households and improving national food security. In 2009, fish accounted for 16.6 percent of the world population's intake of animal protein and 6.5 percent of all proteins consumed (FAO, 2012). Fish culture is an efficient means of animal protein production. It provides essential nutrition for over one billion people, including at least 50 percent of animal protein for about 400 million people from the poorest countries (The World Bank Group, 2011). Globally, fish provides about 3.0 billion people with almost 20 percent of their intake of animal protein, and 4.3 billion people with about 15 percent of such protein (FAO, 2012). Increasing demand for fish products has resulted in the growth of fish farms worldwide to meet a substantial part of the world's food requirement, of which China contributes a major portion (Olasunkanmi, 2012).

Nigeria is one of the countries in Sub-Saharan Africa with great potential to attain sustainable fish production via aquaculture considering extensive mangrove ecosystem available in the country (FAO, 2005). Nigeria is Africa's largest producer of catfish but the Netherlands, Hungary, Kenya, the Syrian Arab Republic, Brazil, Cameroon, Mali and South Africa also produce significant quantities (FAO, 2010). The Federal Government of Nigeria has disclosed that about 10million Nigerians are actively engaged in both the upstream and downstream areas of fisheries operations. According to figures revealed by the National Bureau of Statistics, the fisheries sector contributed 1.31% of total GDP in 2012 and this rose to 1.38% at the end of the third quarter of 2013. These figures represent 3.3% and 3.5% of agricultural GDP respectively.

Despite the significant contribution of fisheries to the Nigerian economy, production is still inadequate to meet domestic demand and fulfil the potential for export. Also, demand on limited supply leads to high prices of fish and its products. In this regard, huge investments will be needed to boost production to desirable levels, especially from the private sector. Economic considerations in the selection of an appropriate aquaculture production system by the private sector include its potential for economic returns, its economic efficiency and ultimately, the farmer's access to operating capital (Hebicha et. al., 1994).According to Olasunkanmi (2012), Ugwumba (2011), Emokaro et. al. (2010), Oladejo (2010), Kareem and Williams (2008), catfish farming is a profitable business. However, increasing production costs demand that catfish farms should be run more efficiently, given the level of technology, in order to boost production.

It has been estimated that Nigeria has the potential to produce over 4 million metric tonnes annually (FGN, 2011). According to the Federal Government of Nigeria, current production stands at about 0.78 metric tonnes with an estimated domestic demand of about 2.66 metric tonnes leaving an estimated shortfall of about 1.8 metric tonnes. This shortfall is supplemented by imports of frozen fish from Europe, Latin America and Eastern countries. According to the Federal Government of Nigeria, the country spent over N100 billion on the importation of over 780,000 metric tonnes of frozen fish in 2010. The shortfall of fish supply in the country has led to a low annual per capita fish consumption rate of only 7.5 kilogrammes as against 15 kilogrammes per annum as recommended by the Food and Agriculture Organisation (FGN, 2011).

It is therefore crucial to increase domestic production in order to meet the shortfall between demand and supply, and to diversify the country's resources. However, the current challenges of rising costs of production require a focus on technically efficient production systems. Profit maximisation requires a firm to produce the maximum output given the level of inputs employed (that is, to be technically efficient), use the right mix of inputs in the light of the relative price of each input (that is, to be input allocative efficient) and produce the right mix of outputs given the set of prices (that is, to be output allocative efficient) (Kumbhaker and Lovell, 2000). The current shortfall in fish supply compared to local demand is putting pressure on the price of fish and its products. This can make fish unaffordable for many households in Nigeria and further decreasing the per capita fish consumption rate.

Catfish farming also plays a crucial role in driving the aquaculture sector in Nigeria by creating employment directly and indirectly to millions of people, helping to diversify the nation's resources, earn foreign exchange through potential export and help the country achieve the millennium development goals (MDGs). It also has the potential of contributing more to the gross domestic product (GDP) of the country. Evaluation of the technical efficiencyexposed the need for catfish farmers to adopt new technologies and achieve sustainable production. This study is also important in determining the extent to which catfish farmers can raise productivity through improved efficiency with existing resource base and available technologies.

OBJECTIVES OF THE STUDY

The general objective of this study is to determine the technical efficiency of catfish farms in Ibadan metropolis. The specific objectives are to:

i. to identify the production types and production technologies used in the catfish farms;

ii. to determine the technical efficiency of catfish farms;

iii. to determine the factors affecting technical efficiency of catfish farms; and

iv. to determine the cost efficiency of catfish farms.

STATEMENT OF HYPOTHESIS

The hypotheses are stated in the null form:

i. There are no technical inefficiency effects in catfish production.

ii. There are no cost inefficiency effects in catfish production.

METHODOLOGY

Study Area: This study was carried out in the metropolitan city of Ibadan which is the capital city of Oyo state, Nigeria. It is located on latitude 7^{o} 23'47"N and longitude 3^{o}55'0"E. It is the third largest metropolitan area, by population, in Nigeria after Lagos and Kano with a population of about 2,338,659 according to the 2006 Census. Ibadan is located in southwestern Nigeria in the southeastern part of Oyo state, about 128km inland north east of Lagos and 530km southwest of Abuja, the federal capital, and a prominent transit point between the coastal region and the areas to the north. The city's total area is about 3,080km^2 (Wikipedia, 2014).There are eleven local governments in Ibadan metropolitan area consisting of five urban and six semi-urban local governments. The urban local governments include Ibadan North, Ibadan Northeast, Ibadan Northwest, Ibadan Southeast, and Ibadan Southwest while Akinyele, Egbeda, Ido, Lagelu, Ona Ara, and Oluyole are the semi-urban local governments. With its strategic location on the operational railway line connecting Lagos to Kano, the city is a major center for trade in agricultural produce such as cassava, cocoa, cotton, timber, and palm oil. The main industries in the area include the processing of agricultural products like tobacco, flour milling, furniture making, and so on. The study area was chosen because of thriving aquaculture industry across all the local governments.

DATA COLLECTION

Primary data was used for the study. Data was collected from respondents with the aid of structured questionnaire. The catfish farmers were asked to provide quantitative data on quantities of output produced and inputs used, and the costs of production, as well as on the prices of inputs. Information was obtained on the socioeconomic characteristics such as age, sex, marital status, household size, and years of experience in catfish farming. Also, data were collected on the culture types, production types, and production technologies adopted by catfish farmers.

SAMPLING PROCEDURE

A sampling frame of registered catfish farmers from across all the local governments was obtained from the Oyo State Department of Fisheries. These farmers are mostly members of the Catfish Farmers Association of Nigeria (CAFAN) and Aquaculture Farmers Association of Nigeria (AFAN) which are the two prominent catfish farmer groups in the state. Catfish farmers were selected by simple random sampling with the aid of the ballot method. A total of two hundred copies of questionnaire were given out for this study out of which one hundred were returned. Only eighty three had complete datasets that were used for analysis.

METHODS OF DATA ANALYSIS

Socioeconomic profile of the respondents was examined with the use of frequency tables, percentages and means. The technical efficiency of catfish farms and the inefficiency factors were estimated with a single step translog stochastic frontier production function. The model is specified as follows:

$$\ln (Y_i) = \beta_o + \beta_1 \ln (X_1) + \beta_2 \ln (X_2) + \beta_3 \ln (X_3) + \beta_4 \ln (X_4) + \beta_5 \ln (X_5) + \beta_6 \ln (X_1)^2 + \beta_7 \ln (X_2)^2 + \beta_8 \ln (X_3)^2 + \beta_9 \ln (X_4)^2 + \beta_{10} \ln (X_5)^2 + \beta_{11} \ln (X_1) \ln (X_2) + \beta_{12} \ln (X_1) \ln (X_3) + \beta_{13} \ln (X_1) \ln (X_4) + \beta_{14} \ln (X_1) \ln (X_5) + \beta_{15} \ln (X_2) \ln (X_3) + \beta_{16} \ln (X_2) \ln (X_4) + \beta_{17} \ln (X_2) \ln(X_5) + \beta_{18} \ln (X_3) \ln (X_4) + \beta_{19} \ln (X_3) \ln (X_5) + \beta_{20} \ln (X_4) \ln (X_5) + V_i - U_i \quad (1)$$

Where:

Y_i= catfish output (kg)

X_1 = number of catfish seeds stocked (fingerlings or juveniles)

X_2 = catfish feeds (kg)

X_3 = number of labour employed

X_4 = area of land (m^2)

X_5 = pond size (m^2)

βs = parameters to be estimated

V_i= random or stochastic disturbance term which captures the effect of weather, disease outbreak, and other factors outside the control of the catfish farmer. They are random variables which are assumed to be identically, independently and normally distributed with zero mean and a constant variance (σv^2).

U_i= farmer and farm specific characteristics related to production efficiency (technical inefficiency effects). It represents non-negative random variables which are assumed to account for technical inefficiency in production and cause the firm to operate below the stochastic production frontier. They are assumed to be normally distributed with zero mean and constant variance (σu^2). The model for the inefficiency variables (U_i) is stated as:

$$U_i = \delta_0 + \delta_1 Acc + \delta_2 pry + \delta_3 sec + \delta_4 ter + \delta_5 cult + \delta_6 hhs + \delta_7 exp + \delta_8 stat + \delta_9 flow + \delta_{10} mixed + \varepsilon i \quad (2)$$

where:

Acc = farmers' access to credit (dummy: personal contribution = 1; otherwise = 0)

pry = dummy for farmers' educational level (primary = 1; otherwise = 0)

sec = dummy for farmers' educational level (secondary = 1; otherwise = 0)

ter = dummy for farmers' educational level (tertiary = 1; otherwise = 0)

cult = culture type (dummy: monoculture = 1; polyculture = 0)

hhs = household size

exp = years of experience in catfish farming (in years)

stat = dummy for production technology (static renewal = 1; otherwise = 0)

flow = dummy for production technology (flow through = 1; otherwise = 0)

mixed = dummy for production technology (if farmers use both static renewal and flow through = 1; otherwise = 0)

δ_0, δ_i= parameters that were estimated

ε_i= random disturbance term

The technical efficiency of an individual farm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i*) given available technology, that is:

$$TE_i = Yi/Y^* = f(X_i; \beta_i) \exp (V_i - U_i) / f(X_i; \beta_i) \exp (V) \quad (3)$$

$$TE_i = \exp (-U_i) \quad (4)$$

So that, $0 \leq TE \leq 1$. If TE = 1, the farm is said to be technically efficient and its output is on the frontier. Otherwise, that is, if TE < 1, the farm is technically inefficient because it could have produced more outputs with the given level of inputs irrespective of input prices.

The estimates for all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained using the computer programme Frontier 4.1 (Coelli, 1994).

The cost frontier for catfish farms is specified as:

$\ln (C_i/R_i) = \beta_0 + \beta_1 \ln (Y_i) + \beta_2 \ln (W_i/R_i)$ (5)

where:

C_i = cost of the ith farm

R_i = labour price

Y_i = output of the farm

W_i = capital price

β is a vector of unknown parameters

V_i is a vector of random variables which are assumed to be normally distributed with zero mean and constant variance and are independent of $U_i$which are non-negative random variables and are assumed to account for the cost of inefficiency in production. It defines how far the farm operates above the cost frontier. They are assumed to be normally distributed with zero mean and constant variance.The estimates of the stochastic cost function were also obtained using the FRONTIER 4.1 software.

LIMITATIONS TO THE STUDY

The limitations to this study include:

(i) Lack of proper record keeping on quantity of inputs and outputs, as well as prices by catfish farmers. Some information was therefore provided the farmers from memory.

(ii) Some farmers were also unwilling or reluctant to give information on output and income.

RESULTS AND DISCUSSION

Socioeconomic Profile of Respondents

Table 1 shows the summary of socioeconomic characteristics of the catfish farmers. Descriptive analyses of the socioeconomic characteristics revealed that majority of the catfish farmers were male (75.9%), with a mean age of 44 years (±12.1). Also, majority of the catfish farmers were married (75.9%) with a household size of 4 persons on the average. The catfish farmers attained one level of formal education or the other. However, the majority (70%) had tertiary education with a mean of about 9 years (±7.3) experience in catfish farming.

Table 1: Socioeconomic characteristics of respondents

Variable	Frequency	Percentage	Cumulative%
Sex			
Female	20	24.1	24.1
Male	63	75.9	100
Age category			
< 25	3.0	3.60	3.60
25 – 35	22	26.5	30.1
36 – 45	22	26.5	56.6
46 – 55	21	25.3	81.9
≥ 56	15	18.1	100
Marital status			
Single	18	21.7	21.7
Married	63	75.9	97.6
Widowed	2.0	2.40	100
Household size			
1 – 3	29	34.9	34.9
4 – 6	48	57.8	92.8
7 – 9	4.0	4.80	97.6
10 – 12	1.0	1.20	98.8
16 – 18	1.0	1.20	100
Farming experience			
< 8	45	54.2	54.2
8 – 15	28	33.7	88.0
16 – 20	4.0	4.80	92.8
≥ 21	6.0	7.20	100
Educational status			
Primary	6.0	7.20	7.20
Secondary	19	22.9	30.1
Tertiary	58	69.9	100
Total	**83**	**100.0**	

Source: Field survey (2013).

PRODUCTION TYPES AND TECHNOLOGIES

Production Types

From Table 2, 72.3% of the respondents were involved in grow out operations, that is, raising of catfish to table size, while 8.4% were involved in the sole production of fingerlings. Others combined feed production with fingerling production or grow out production. These made up 19.3% of the sampled farmers. Catfish farmers preferred grow out production because it is a profitable enterprise with high returns on investments (Olasunkanmi, 2012; Olagunju et. al., 2007).Fingerling production requires lower capital investment. However, fewer numbers of people were involved because it requires high technical knowledge and experience which these farmers did not have. There is also the issue of marketing; most fingerling producers complained of inadequate patronage for their products. This is because newcomers into the business have to build trust in the quality of the fingerlings and this takes time to accomplish.

Production Technologies

Table 2 shows that the majority of the catfish farmers (56.6%) used static renewal systems (earthen ponds) while 30.1% used flow through systems (tanks and troughs), and 13.3% used a combination of both systems. The static renewal systems are cheaper to construct and are also available for hire. This makes it possible for people who cannot afford the cost of purchasing land and borehole construction to engage in catfish farming. Also, earthen ponds provide a natural environment for the growing catfish to perform well in terms of yield. This finding agrees with Oladejo (2010) and Olagunju et. al. (2007). Concrete tanks, on the other hand, can be constructed within living environments of the farmers where adequate supervision can be given. Concrete tanks are becoming more popular among catfish farmers due to the urban nature of Ibadan. Others represent those who used a combination of static renewal systems and flow through systems on their farm for grow out operations. Some of them used flow through tanks for breeding operations and for raising fingerlings.

Culture System

Majority of the catfish farmers (89.2%) practiced monoculture, that is, the rearing of catfish alone without mixing it with another species of fish while 10.8% practiced polyculture, the rearing of catfish with another species of fish, mainly tilapia (Table 2).

Table 2: Production types and technologies used by catfish farmers

Production type/ technology	Frequency	Percentage	Cumulative percentage
Production type			
Grow out	60	72.3	72.3
Fingerlings	7.0	8.40	80.7
Others	16	19.3	100.0
Production technology	47	56.6	56.6
Static renewal			
Flow through	25	30.1	86.7
Others	11	13.3	100.0
Culture system			
Monoculture	74	89.2	89.2
Polyculture	9.0	10.8	100.0
Total	**83**	**100.0**	

Source: Field survey (2013).

TECHNICAL EFFICIENCY OF CATFISH FARMS

Production variables in catfish farming

The mean output produced by catfish farmers was 5,996kg (±16,376.6), employing 2 labour units on the average with an average pond size of 409m^2 (±470.81). The mean number of fingerling stocked was 6,837 units (±21267.17) with an average feed usage of 4,221kg (±18203.81), and ₦26,218.00 on average was expended on land per production season. The average price of the output (catfish) is ₦443.75 per kilogramme, feed costs ₦645.35 per kilogramme while labour costs ₦13,680 per unit. Also, it costs ₦74,166 on the average to construct a pond.

Distribution of Technical Efficiency Scores

The distribution of technical efficiency scores of the catfish farms is shown in Table 4. Results show that 21.7% of the farms recorded technical efficiency scores within the range of 51 – 60 percent and 71 – 80 percent respectively. The table also shows that about 65% of the catfish farmers had technical efficiency score of 60% or less. The mean efficiency score for the catfish farms was 52.9% and it ranged from 11.3% to 83.7%. Hence, on the average, catfish farmers in the study area incurred output loss of about 47% due to technical inefficiency. In other words, there exist 47% potential for increasing output by the catfish farms. There is therefore room for improvement in catfish production in the study area given the available resources and available technology.

Table 3: Summary statistics of variables used in translog stochastic production function analysis

Variable	Mean	Standard deviation	Minimum	Maximum
Output	5,996	16,377	350	120,000
Fingerling	6,837	21,267	245	150,000
Feed	4,221	18,204	3.50	140,000
Labour	2.066	1.5880	1.00	12.000
Land	26,218.04	19,249	10,000	120,000
Pond size	409.32	470.81	20.00	1,860

Source: Field survey (2013).

Table 4: Distribution of technical efficiency scores of catfish farms

Technical efficiency range (%)	Frequency	Percentage	Cumulative percentage
11 – 20	3.0	3.60	3.60
21 – 30	4.0	4.80	8.40
31 – 40	14	16.9	25.3
41 – 50	15	18.1	43.4
51 – 60	18	21.7	65.1
61 – 70	10	12.0	77.1
71 – 80	18	21.7	98.8
81 – 90	1.0	1.20	100.0
91 – 100	0.0	0.0	
Total	**83**	**100.0**	
Mean	**52.9**	**Minimum**	**11.3**
Maximum	**83.7**	**Range**	**72.4**

Source: Field survey (2013).

Hypothesis Testing

The maximum likelihood estimates (MLE) of equation 1 are given in Table 5. In order to check whether technical inefficiency effects are absent, the log likelihood test was used. The log-likelihood parameter in the half-normal model is given by:

$\lambda = \sigma_u^2/\sigma_v^2$.
If the value of λ is equal to 0, there are no technical inefficiency effects and all deviations from frontier are due to noise (Aigner et. al., 1977). The estimated value of $\lambda\hat{}$ = 143.2 and it is significantly different from 0 and the null hypothesis that that there are no inefficiency effects is rejected at 1 % significance level.

In terms of the t statistic; $t = \lambda\hat{} /se\ \lambda\hat{} = 0.5/0.132 = 3.79$ which exceeds the critical value of $t_{0.01}$=2.54) implying that there exists inefficiency effects among catfish farmers in the study area. The gamma (γ) measures total variations in output from the frontier attributable to technical efficiency. The estimated value of γ is 0.77, which means that 77 % of the total variation in output is due to technical inefficiency.

DETERMINANTS OF TECHNICAL EFFICIENCY AMONG CATFISH FARMERS

Input Use on Catfish Farms

The estimated coefficients in Table 5 show the relative change in output (Y) due to a percentage change in explanatory variable. These estimates show relative importance of various inputs in catfish production. Except labour, all the estimated coefficients were significant at 1% level of significance. This is because over-use reduces the productivity of labour. Also, feed inputs and pond size are negatively signed, that is, a unit increase in feed input and pond size lead to a decrease in output respectively. This is in contrast with *a priori* expectations. However, the explanation for this is that these inputs are being over-utilized in the production process. Catfish farmers will therefore have to reduce the quantities of these inputs used in production in order to achieve higher profitability.

The estimated coefficient for fingerling indicates that for a unit change in fingerling, output increases by 0.497 on the average. The estimated coefficient for feed was negative and significant at the 1% level. This means that a unit change caused a decrease in output by 0.518, on the average. The coefficient for land shows that for a unit increase in land, output will increase by 0.103. This is because increase in land will enable catfish farmers to expand the size of their ponds. The estimated coefficient for pond size is however negative, meaning that a unit increase in pond size will decrease output by 0.103 on the average. This is because larger pond sizes might be difficult to manage especially with the additional cost implications that will arise. Output can be increased by increasing the number of fingerlings being raised in the ponds using the existing labour.

The estimated coefficients of the square of the inputs show the marginal effects of these inputs on output. If the estimate is negative, it means that the input has a decreasing marginal effect on output. Therefore, land and pond size have a decreasing marginal effect on output, that is, a unit change in any of these inputs caused an increase in output but at a decreasing rate. Fingerling and feed contributes to output at an increasing rate respectively.

The estimated coefficients of the interactions of fingerling with feed, labour, and land were all negative and significant at 1% level. This means that when these inputs are used with fingerling respectively, they contribute to output at a decreasing rate. The interaction of fingerling with pond size is however positively signed, meaning that the use of both inputs together contribute to output at an increasing rate. Also, the interactions of feed with labour and pond size are positive and significant at the 1% level. This implies that a unit increase in both inputs increases output at an increasing rate. The interaction of feed with land is negative and significant at the 1% level. Therefore, a unit increase in both feed and land has a decreasing marginal effect on output. Pond size in combination with labour and land has a decreasing marginal effect on output respectively.

Factors Affecting Technical Efficiency of Catfish Farms

Table 5 shows the maximum likelihood estimates of the translog stochastic frontier production function (equation 1). The hypothesis that there are no inefficiencies was rejected at the 1% level of significance. Positive or negative signs on the coefficients indicate that increase in the variable increases or decreases inefficiency respectively.

I. **Access to credit:** Timely access to adequate amounts of credit is expected to raise catfish farmers' efficiency as it will enable them to purchase quality feeds and other inputs to improve the yield of the farm. The estimated coefficient was negative and significant at 1% level of significance. This implies that increased access to credit led to a decrease in inefficiency of catfish farms.
II. **Level of education:** Educational attainment of the catfish farmers is expected to reduce inefficiency on the farms. This is because it is easier for educated farmers to adopt new technology and properly prepare records in order to make informed managerial decisions. Only the estimated coefficient for primary education was significant at 1% level while the estimated coefficients for the other two categories were not significant. It was however positive, while others were negative meaning that the lower the level of education, the lower the level of technical efficiency of the catfish farm.
III. **Culture system:** The estimated coefficient for culture system was negative and significant at 1% level. The negative sign on the estimated coefficient for culture system shows that the use

of polyculture reduced efficiency by 2.71 on the average. This is because monoculture allows for intensive feeding and reduces variation in fish size after harvest. Monoculture also enables farmers to respond quickly to meet market targets.

IV. **Household size:** The estimated coefficient for household size was negative and significant at 1% level of significance. This implies that larger household size reduces inefficiency. This is so because large household sizes are a source of cheap labour on the farm. This agrees with the report of Ugwumba (2011) which found a negative relationship between household size and catfish farm inefficiency.

V. **Years of experience in catfish farming:** The estimated coefficient for catfish farming experience was negative and significant at the 1% level. This means that the more experienced the catfish farmer, the more the output he is able to produce from the given inputs. This finding is similar to that reported by Kaliba and Engle (2004) that experienced catfish farmers were more efficient than new farmers

Table 5: Maximum likelihood estimates of translog production function

Variables of stochastic frontier model	Parameter	Coefficient	Standard error	t – ratio
Constant		8.49	0.765	11.1***
Ln Fingerling	β_1	0.497	0.094	5.29***
Ln Feed	β_2	-0.518	0.093	-5.50***
Ln Labour	β_3	-0.185	0.097	-1.90
Ln Land	β_4	0.103	0.093	1.11
Ln Pond size	B_5	-0.103	0.030	-3.43***
Ln (fingerling)^2	β_6	0.625	0.073	8.50***
Ln (feed)^2	β_7	0.325	0.074	4.40***
Ln (labour)^2	β_8	0.874	0.795	1.18
Ln (land)^2	β_9	-0.436	0.073	-5.96***
Ln(pond size)^2	β_{10}	-0.268	0.692	-3.87***
Ln (fingerling) ln (feed)	β_{11}	-0.679	0.089	-7.65***
Ln (fingerling) ln (labour)	β_{12}	-0.535	0.088	-6.01***
ln (fingerling) ln (land)	β_{13}	-0.650	0.090	-7.32***
Ln (fingerling) ln (pond size)	β_{14}	0.452	0.088	5.13***
Ln (feed) ln (labour)	β_{15}	0.535	0.088	6.02***
Ln (feed) ln (land)	β_{16}	-0.502	0.089	-5.60***
Ln (feed) ln (pond size)	β_{17}	0.363	0.088	4.11***
Ln (labour) ln (land)	β_{18}	0.137	0.089	1.55
Ln (labour) Ln (pond size)	β_{19}	-0.261	0.088	-3.05***
Ln (land) ln (pond size)	β_{20}	-0.388	0.088	-4.41***
Inefficiency effects				
Constant		-0.245	0.223	-1.12
Access to credit	δ_1	-0.808	0.101	-8.02***
Primary education	δ_2	0.377	0.102	3.68***
Secondary education	δ_3	-0.333	0.222	-1.54
Tertiary education	δ_4	0.878	0.094	0.93
Culture system	δ_5	-0.297	0.110	-2.71***
Household size	δ_6	-0.277	0.107	-2.58***
Years of experience	δ_7	-0.117	0.038	-3.07***
Static renewal	δ_8	-0.186	0.520	-1.24
Flow through	δ_9	0.150	0.171	0.88
Mixed systems	δ_{10}	-0.58	0.480	-1.24
Sigma squared		0.50	0.132	3.79***
Gamma		0.77	0.856	0.90
Log likelihood function		-143.21		
Likelihood ratio test		25.2		

Source: Field survey (2013).
***Represents 1% level of significance.

Cost Efficiency of Catfish Farms

Table 6 shows estimates of the Cobb Douglas cost function. The estimated coefficients had a priori signs and were significant at 1% level. Both labour and the capital price – labour price ratio contribute positively and significantly to the cost of production of the catfish farm. A unit increase in output on the average increases cost by 7.09. Also, a unit increase in the capital price – labour price ratio will on the average increase cost by 1.76.

Hypothesis Testing

From Table 6, the log likelihood test was used to check whether cost inefficiency effects are absent. The estimated value of $\lambda\hat{}$ = 130.4 and it is significantly different from 0. Therefore, the null hypothesis that there are no cost inefficiency effects is rejected at 1% significance level.

In terms of the t statistic; ($t = \lambda\hat{} / se\ \lambda\hat{} = 0.524/0.1089 = 4.81$ which exceeds the critical value of $t_{0.01} = 2.54$) implying there exists inefficiency effects among catfish farmers in the study area. The estimated value of γ is 0.96, which means that 96 % of the total variation in output is due to cost inefficiency.

Table 6: Estimates of Cobb Douglas Cost function

Variable	Coefficient	Standard error	t statistic
Constant	1.91	0.691	2.77***
β_1	7.09	0.910	7.79***
β_2	1.76	0.755	2.33***
Sigma squared	0.52	0.109	4.81***
Gamma	0.96	0.037	26.3***
Log likelihood	-130.4		

Source: Field survey (2013).
*** Represents 1% level of significance.

Distribution of Cost Efficiency Scores
Table 7 presents the cost efficiency of 77 catfish farms in Ibadan metropolis. It shows that cost efficiency scores vary widely among catfish farms, with an average of 37%. From the results, 79.3% of the farms had efficiency scores of 50% and below. Hence, on average, cost efficiency of catfish farms can be improved by about 63% with existing resources. This result compares with Kaliba and Engle (2004) which reported mean cost efficiency scores of 33%. The persistent rise in the price of inputs may be forcing catfish farmers to opt for less efficient choices in their decision making. This is because catfish farmers who cannot afford the costly imported feeds supplement their feed with local materials such as rice grains, brewery wastes, chicken offals, and so on, and this lowers overall cost efficiency of production.

Table 7: Distribution of cost efficiency scores

Efficiency score	Frequency	Percentage	Cumulative
0.10 – 0.20	38	49.4	49.4
0.21 – 0.30	11	14.3	63.7
0.31 – 0.40	7	9.0	72.7
0.41 – 0.50	5	6.5	79.3
0.51 – 0.60	5	6.5	85.7
0.61 – 0.70	2	2.6	88.3
0.71 – 0.80	3	3.9	92.2
0.81 – 0.90	2	2.6	94.8
0.91 – 1.00	4	5.2	100.0
Total	**77**	**100.0**	
Mean	0.37		
Minimum	0.11		
Maximum	0.97		
Range	0.86		

Source: Field survey (2013).

CONCLUSIONS AND RECOMMENDATIONS
It was concluded thatcatfish farming is a viable and attractive farming enterprise for highly educated people. Most catfish farmers avoid operating hatcheries but prefer grow out production. Also, catfish farmers prefer the use of static renewal systems because it is less costly to construct and maintain. However, flow through technology is becoming more popular with catfish farmers, especially in the urban areas. This is because it can be constructed within living premises and thus allows for closer monitoring of the tanks.Also, labour and feed inputs are being overused in catfish production process.

It was observed that technical efficiency indices were low, ranging between11.3 and 83.7 with a mean efficiency score of 52.9.The study also found that farmers' cost efficiency scores were low, also ranging from 0.11 to 0.97 with a mean of 0.37, and that farmers' access to credit, level of education, culture system used, years of experience in catfish farming, and household size were factors which contributed significantly to catfish farming.

Participation in catfish farmingcan be encouraged by the government by introducing training workshops on catfish production through its extension agencies, especially for fresh school leavers, as an alternative to non-existent white collar jobs. Also, extension agents should increase visits or contacts with this category of catfish farmers because of their inexperience.

The catfish seed industry also needs to be standardized and regulated. Government needs to establish an agency to certify the quality of catfish seeds. This will go a long way in helping newly established hatcheries to secure market for their products as potential customers will have little fear in certified fingerlings.

REFERENCES
Adewumi, A.A. and V.F. Olaleye, (2011): "Catfish culture in Nigeria: Progress, prospects and problems", African Journal of Agricultural Research, Vol. 6(6): 1281 – 1285

Aigner D.J, C.A.K. Lovell, and P. Schmidt, (1977): "Formulation and estimation of stochastic frontier production function models". Journal of Econometrics, Vol. 6 (1), pp. 21 – 37

Brink, D. (2001), "Aquaculture production in South Africa: proceedings of the Animal feed Manufacturers Association. Pretoria, pp 57 – 65

Coelli T.J. (1994): "A guide to Frontier version 4.1: A computer program for stochastic frontier production and cost function estimation, mimeo, Department of Econometrics, University of New England, Armidale, pp 32 – 36.

Emokaro, C.O., P.A Ekunwe, and A. Achille (2010): "Profitability and Viability of catfish farming in Kogi State, Nigeria", Research Journal of Agriculture and Biological Sciences, 6(3): 215-219

FAO (2005): "Report of the FAO-World Fish Centre, workshop on small – scale aquaculture in sub-Saharan Africa: Revisiting the Aquaculture Target Group Paradigm, FAO, Rome Publication, ftp:// ftp.fao.org/docrep/ fao/008/a0038e/a0038e00.pdf.

FAO (2010): The state of world fisheries and aquaculture, Rome, pp 88

FAO (2012): The state of world fisheries and aquaculture, Rome, pp 209

FGN (2011): National stakeholders' workshop on development of aquaculture value chain under the agricultural transformation agenda. www.w3.org/1999/xhtml.

Fourie, J.J. (2006): "A practical investigation into catfish (Clarias gariepinus) farming in the Vaalharts Irrigation Scheme", Department of Zoology and Entomology, University of the Free State, Faculty of Natural and Agricultural Sciences

Hebicha, H.A., A.R. Gamal, and B.W. Green (1994): "Economic analysis of different Tilapia pond culture systems in Egypt", 12th Annual Technical Report 1994, PD/A CRSP Office of International Research and Development, Oregon State University, OR,USA, pp 181 – 189

Kaliba, A.R. and C.R. Engle (2004): "Cost efficiency of catfish farms in Chicot County, Arkansas: The impact of extension services", Cooperative State Research Education and Extension Services, U.S. Department of Agriculture, pp 25

Kareem, R.O. and S.B. Williams (2008): A techno economic analysis of aquaculture business in Ogun State, Nigeria, Chinese Journal of Oceanology and Limnology, Vol. 27, No.2, pp 415 – 420.

Kumbhaker, S.C. and C.A.K. Lovell (2000): Stochastic frontier analysis, Cambridge, Cambridge University Press.

Oladejo, A.J. (2010): "Economic analysis of small scale catfish farming in Ido Local Government Area of Oyo State", Nigeria. Agricultural Journal, Vol. 5 (6), pp: 318 – 321

Olagunju, F.I., I.A. Adesiyan, and A.A. Ezekiel (2007): "Economic viability of catfish production in Oyo State, Nigeria", J. Hum. Ecol., Vol. 21(2): 121-124

Olasunkanmi, J.B. (2012): "Economic Analysis of Fish Farming in Osun State, South –Western Nigeria", Proceedings of The International Institute of Fisheries Economics and Trade, Tanzania, pp1 – 10

The World Bank Group (WBG) (2011): The Global Program on Fisheries: Strategic Vision for Fisheries and Aquaculture, Agricultural and Rural Development Department, the World Bank Group, Washington DC.

Ugwumba, C.O.A. (2011): "Analysis of catfish farming system and its impact on net farm income in Anambra State, Nigeria", Journal of Agricultural And Biological Science, Vol. 6(2), pp 5

Wikipedia (2014): Ibadan City, http://en.m.wikipedia.org/wiki/ibadan.