IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 10 Ser. II (October 2021), PP 01-09
www.iosrjournals.org

Determinants of Profit Efficiency Among Cat Fish Farmers In South Western Nigeria: Stochastic Profit Frontier Approach

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Abstract
In spite of her enormous potential in aquaculture and fish production, Nigeria is the fourth largest importer of fish in the world. Hence, the study investigated the determinants of profit efficiency among catfish farmers in South-western, Nigeria. A multistage sampling procedure was used to collect data from a sample of 208 farmers selected proportionately from the three senatorial districts in the state. The study used Descriptive statistics, Cobb-Douglas stochastic profit frontier function and inefficiency models to analyze the data in a single stage estimation procedure using version 15 of Stata computer software. Results showed that the estimated elasticity parameters of independent variables included in the stochastic profit function were all positively and statistically significant except the elasticity coefficient of variable involving the cost of water. The results further show that the estimated profit efficiency ranged from 0.77 to 0.98 with a mean of 0.95. This implies that, in the short run, there is scope for increasing profit from catfish production by 5 percent using the technology and techniques adopted by the "best practiced" catfish farmer. Analysis of factors influencing profit efficiency revealed that sex of the catfish farmer positively influenced profit efficiency while age and household size had negative influence on profit efficiency. The policy implication of these findings is that government and other relevant agencies including the technical partners should by policy option enhance the human capacity of the catfish farmers in the study area. More so, family planning and child spacing campaign should be advocated among the catfish farmers in the south-west, if the objective of improved profit efficiency is to be achieved.

Key words: *Profit efficiency, cobb-Douglas, multistage, factors and policy implication*

Date of Submission: 15-10-2021 Date of Acceptance: 30-10-2021

I. Introduction

Fish is an essential component of diet among the high and low income Nigerians with high nutritional value. It consists of adequate amino acid profile, vitamins and minerals (Akinrotimi *et al.,* 2007). In Nigeria, the fishery sub-sector is an important driver of the economy providing income and job opportunities for a good number of people most especially in the rural areas where agriculture is the major source of livelihood. The aggregate supply of domestic fish is traceable to three main sources namely artisanal, industry and aquaculture. However, available statistics from Federal department of Fisheries indicate that the growth in fish production is due to increased activities of aquaculture (Ozigbo *et al.,* 2014). The need for aquaculture became imperative in the face of persistent fall in supply from artisanal sources as a result of over-fishing, habitat destruction and pollution (Adedeji and Okocha, 2011).

Aquaculture is an underwater agricultural production of aquatic organisms and plants in fresh water, brackish and marine environment. A wide variety of aquatic organisms are produced through aquaculture. These include: fishes, crustaceans, molluscs, algae, and aquatic plants. Unlike captured fisheries where the wild stocks of fish are harvested, aquaculture requires deliberate human intervention at each stage of production cycles such as breeding, fertilizing, feeding, and management of water quality. This is to ensure that the harvestable yields exceed those from the natural environment alone. The most commonly cultured fish species in Nigeria are catfish, (*Clarias gariepinus*, the imported *C.lazera*, *Heterobrachus spp.,* and the imported *C. hollandica*) Tilapia, Osteoglossidea (Heterotis niloticus) and Common carp (Cyprinus carpio). However, Clariid have become the most farmed fish species in Nigeria and in other regions of the world because it is eaten by most tribes, resistant to harsh environmental conditions and has a market value of two to three times that of tilapia (Anitekhai, 2013; Issa *et al*., 2014). It can also be cultured in different culture systems such as ponds, cages, tanks, water re-circulatory system and whether through intensive or extensive fish culture system. For over two decades, African catfish has contributed about 90.8% by weight of fish produced from aquaculture in Nigeria (Anetekhai, 2013).

Statistics show that Nigeria imports over 900,000 metric tonnes of frozen fish valued at over $US 625 million annually (Ozigbo *et al.,* 2013). With the expected increase in Nigerian population which is estimated at annual growth rate of 2.83% per annum, Nigeria needs an average annual increase of 3.8% in fish production to keep up with demands of an ever-increasing population (FAO, 2014). Furthermore, the minimum requirement for the intake of protein by an average person is 65g per day. Out of this, 40% which is valued at 36g should come from animal sources (FAO, 2018). In Nigeria, the animal protein consumption is less than 8g per person per day, which is a far cry from the FAO minimum requirement (FAO, 2018).The foregoing suggests that fisheries sub-sector of Nigerian economy is currently facing the twin problems of foreign exchange loss due to massive importation of frozen fish and malnutrition arising from insufficient dietary intake of protein.

Several projects, programmes and policies have been instituted in the past by government at all levels in Nigeria as well as other relevant technical partners and development agencies towards the development and commercialization of cultured fish species in Nigeria. These include the establishment of demonstration farms in the West (Ibadan and Akure) and East (Umuna Okigwe and Opobo (1971-1981); establishment of four zonal seed production and training centers in the northern and southern part of the country, (1978-1980); extension of more fish seed centers to other part of the country by the federal/ state government; African Regional Aquaculture Centre (ARAC) at Aluu, PortHacourt; River Basin Development Authority, RBDA (1990); Growth Enhancement Support (2014); Establishment of Staple Crop Processing Zones and Nigeria Incentive Risk Sharing Agricultural Lending, NIRSAL (2015), these efforts were met with little success as Nigeria ranked the highest importer of frozen fish in Africa contributing about 2% to national Gross Domestic Product (Adedeji and Okocha, 2011; Atanda, 2012). This can be attributed to underutilization of abundant natural (lands, oceans, lakes, rivers and reservoirs) and human resources potentials.

Report shows that the aquaculture industry in Nigeria is restricted to inland freshwater with only a few species of aquaculture such as Clarias, tilapia and carps. With about 264 medium and large dams having a combined storage capacity of 33 billion cubic meters of water (Magdalene, 2013), Nigeria can compete favorably with the world leading aquaculture producers. George *et al.* (2010); Adewumi and Olaleye (2011) and Oyakhilomen, (2013) stated that lack of aquaculture extension services, poor technical know-how, inadequate supply of good quality seed, high cost of feed and lack of credit facilities at low interest rate are other problems confronting the fisheries sub-sector in Nigeria.

Numerous studies (Thompson and Mafimisebi, 2014; Okoror *et. al.,* 2017; Ebukiba and Anthony, 2019 and Oluwatayo and Adedeji, 2019) have been conducted in the past with specific focus on technical efficiency and profitability of catfish farmers in different microeconomic contexts of Nigeria. With the exception of few studies (Tsue *et al.,* 2012 and Sadiq *et l.,* 2016) conducted in North-central Nigeria, this study contributes to the literature by examining the determinants of profit efficiency among catfish farmers in south western state using a stochastic profit function approach. The Stochastic Profit Frontier approach has a desirable property of combining the concept of technical and allocative efficiency in the profit relationship (Rahman, 2003). Although, measurement of technical efficiency is important in determining the relative importance of the processes used in transforming a given set of inputs into the largest possible quantity of output, efficiency score obtained through this specification procedure does not give a detail and comprehensive information for an informed decision making. It has been argued that using a Stochastic Production Frontier approach to measure efficiency may not be appropriate when farmers face different uncertainties with respect to inputs and output prices in non-competitive markets. Therefore, the estimation of profit efficiency should incorporate farm specific prices and levels of fixed factors (Ali and Flinn, 1989). Computing farm level profit efficiency of catfish farmers with a view to analyzing its determinants will assist in identifying the gap in policy intervention in order to achieve self-sufficiency in domestic fish production.

Theoretical framework: Stochastic Profit Frontier

The popular Stochastic Frontier Approach specifies the relationship between output and input levels and decomposes the error term into two components namely a random error, and an inefficiency component. The random error which is assumed to follow a symmetric distribution is the conventional error term with zero mean and a constant variance. The inefficiency term is assumed to follow an asymmetric distribution and may be expressed as a half-normal, truncated normal, exponential or two-parameter gamma distribution. Furthermore, this approach recognizes three different functional relationships among inputs, outputs and non-factors. These include the cost, profit, or production functions.

Profit efficiency is a broader concept since it takes into account the effects of the choice of vector of production on both costs and revenues. Profit efficiency is defined as the ability of a farm to achieve the highest possible profit given the prices and levels of fixed factors of that farm, and profit inefficiency in this context is defined as loss in profit for not operating on the frontier (Ali and Flinn, 1989). Similar to Stochastic Production

Frontier model, the inefficiency effects can be expressed as a linear function of explanatory variable, reflecting farm-specific characteristics (Battese and Coelli, 1995). The advantage of this model is that, it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers using a single stage estimation procedure. According to Nmadu and Garba (2013), the standard stochastic profit function which is assumed to behave in a manner consistent with the stochastic frontier concept with a multiplicative disturbance term is expressed as:

$\pi_i = f(P_{ij}, Z_{kj}) \text{ Exp } e_i$ ………………………………………………………… (1)

Where π_i = normalized profit of the j_{th} farm measured in terms of Gross margin (GM) divided by the farm specific output prices,

$GM(\pi_i) = TR - TVC$ ………………………………………………………… (2)

TR= Total Revenue, TVC= Total variable cost

P_{ij} = Price of j_{th} variable input faced by the i_{th} farm divided by output price

Z_{ik} = Level of the K_{th} fixed factor on the i_{th} farm

e_i = Error term

$i = 1\ldots$ n is the number of farms in the sample.

$e_i = V_i - U_i$ ……………………………………………………………………......... (3)

V_i is the symmetric error term and it is assumed to be identically and independently distributed two-sided error term having normal N (0, σ²) distribution independent of the μi. It represents the effects of unobserved random errors, measurement errors, omitted explanatory variables and statistical noise. U_i is one-sided error term and it accounts for the effects of technical inefficiency of the i_{th} farm and it is assumed to be non-negative truncation of the half normal distribution N (μ, σ²μ). The profit efficiency of an individual farmer is defined as the ratio of predicted actual profit to the predicted maximum profit for the 'best practiced' catfish farmer represented as:

$\text{Profit Efficiency } (E\pi) = \frac{\pi}{\pi^{max}} = \frac{\exp[\pi\ (P_i Z)\exp(lnV)\exp(\ln U) - \theta}{\exp\ [\pi(P_i Z)\exp\ (lnV)\theta}$ ……………….......... (4)

Where π= predicted actual profit, πmax = predicted maximum profit. The maximum likelihood estimation technique can be used to estimate the profit function. The profit efficiency E (π) takes the value between 0 and 1. Therefore if iμ=0, that is lying on the frontier, the farmer has potential maximum profit given the price he faces and the level of fixed factors of production, while if μi>0, the farmer is inefficient and operates below the profit frontier as a result of inefficiency.

The inefficiency profit frontier model

The inefficiency effects specified in equation 3 is expressed as:

$\mu_i = \delta_0 + \sum \delta_i Z_{\delta i}$ ……………………………………………………………… (5)

Where Z_i = (1x m) vector of farm specific variables and it varies across the catfish farmers. δ = (m x 1) vector of unknown coefficients of the farm specific inefficiency variables. The μ is a non-negative one-sided error term representing the inefficiency of the farm. It represents the shortfall from maximum possible profit obtainable rom the stochastic frontier. The unknown parameters of stochastic frontier and inefficiency models were obtained simultaneously using a one-stage maximum likelihood estimation procedure. The variance parameter of the likelihood function is expressed as:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ ……………………………………………………………………… (6)

$\gamma = \frac{\sigma_u^2}{\sigma_v^2} + \sigma_v^2$ .... (7)

σ^2 represents the overall variance of the model. It measures the total variation of profit from the frontier and this is attributed to profit inefficiency (Battese and Corra, 1977). The parameter γ represents the share of inefficiency in the overall residual variance and its value lies between 0 and 1.

II. Material and Methods

Study Area: The study was carried out in Ondo State, Nigeria. It is one of the six states in South-west, Nigeria. The state is bounded in the West by Osun and Ogun States and in the North by Ekiti and Kogi States. Ondo State also shares boundaries with Edo and Delta States in the East and in the South by the Atlantic Ocean. Ondo state has a land area of about 15,500 square kilometres with a total population of about 3.4 million inhabitants (National Population Commission, 2006). Ondo State has eighteen local government areas and three distinct ecological zones namely the mangrove forest to the south, the rain forest in the middle and the guinea savannah to the north. The state is known for the production of both permanent and arable crops as well as fisheries from both artisanal and aquaculture sub-sectors. Ondo State has about 180 km coastline which is the longest in the Nigeria. The major occupation of these riverine or coastline ethnic groups is fishing either at the artisanal or motorized levels while the secondary occupations include lumbering and production of local gins (Mafimisebi, 1995 and Fagbenro *et al.*, 2004).

Sample size and sampling procedure: Multistage sampling technique was used to select respondents for this study. The first stage involved purposive selection of Ondo state from the six states in the south western, Nigeria. This is because Ondo is the highest producer of catfish in the region (Mafimisebi and Okumadewa, 2006). Ondo state is divided into three administrative zones of senatorial districts comprising Ondo North, Ondo south and Ondo Central Senatorial district with each zone consisting of six local government areas. The second stage involved random selection of two local government areas in each of the three senatorial districts making a total of six local government areas. The third stage involved a random selection of three communities from each of the selected local government areas making a total of eighteen communities in all the three senatorial districts. The last stage was a random selection of two hundred and eight catfish farmers in all the selected eighteen communities proportionate to the size of communities.

Data collection: Primary data was used for this study collected from the respondents through structured questionnaire with oral interview. Data on quantity of fixed and variable inputs used, fixed and variable cost of production, operational costs such as transportation and fuelling were also collected. Also, data on yield (in kg) of catfish harvested, selling price per unit kilogramme of catfish harvested. Data on household socio-economic characteristics as well as catfish farm specific variables were also collected from the respondents. These include the age, gender, household size, marital status, level of formal education, farming experience and frequency of contact with extension agents.

Methods of Data Analysis

The study used different analytical techniques in order to achieve the study objectives. These include descriptive statistics, cobb-Douglas stochastic profit frontier model and the inefficiency model. The descriptive statistics which was used to analyze the socio-economic characteristics of the respondents include the frequency distribution, mean and standard deviation.

Cobb-Douglas Stochastic Profit Frontier Model: Following Coelli (1996) and as further adopted by Ogundari *et al*. (2006), Tsue, (2012) and Sadiq *et al*. (2015), the stochastic Profit Frontier function with behavioral inefficiency component was used to estimate all parameters together in a one-step maximum likelihood estimation procedure. The Cobb-Douglas functional form in its explicit form was specified for catfish farmers in the study area as follows:

$$\ln \pi = \beta_o + \beta_1 \ln Z_i + \beta_2 \ln P_{1i} + \beta_3 \ln P_{2i} + \beta_4 \ln P_{3i} + \beta_5 \ln P_{4i} + \beta_6 \ln P_{5i} + \beta_7 \ln P_{6i} + V_i - \mu_i \ \dots \ (8)$$

Where $\ln \pi$ = normalized profit function computed as the total revenue less variable cost divided by output price,

Z_i = total area of pond under catfish production (m^2),
P_{1i} = Normalized cost of fertilizer (₦)
P_{2i} = Normalized cost of feed (₦)
P_{3i} =Normalized cost of fingerlings (₦)
P_{4i} = Normalized cost of labor (₦)
P_{5i} = Normalized cost of transportation (₦)
P_{6i} = Normalized cost of water used (₦)
β_0-β_7 = Unknown parameters to be estimated.
V_i= Random error which is assumed to be identically and independently distributed as N $(0,\sigma^2)$.
μ_i= Non negative profit inefficiency effects and is assumed to be half normal and independently distributed ofV_i.
$i = 1\dots$ n. n= 150

The Inefficiency Model: Given that μ_i are the profit inefficiency effects, the inefficiency model is thus defined as:

$$\mu_i = \alpha + \beta_1 Z_i + \beta_2 Z_{2i} + \beta_3 Z_{3i} + \beta_4 Z_{4i} + \beta_5 Z_{5i} + \beta_6 Z_{6i} + \beta_7 Z_{7i} \ \dots\dots\dots\dots\dots\dots \ (9)$$

Where μ_i = Profit inefficiency of the i_{th} farmer
β_i = Age of the respondent (years)
β_2= Gender of the respondent (1= married, 0 otherwise)
β_3= Household size
β_4= Formal education (years)
β_5= Primary occupation of the respondent (1= farming, 0 otherwise)
β_6= Farming experience (years)
β_7= Contact with extension agent (1=yes, 0 otherwise)
$\alpha_o, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ = Coefficient of unknown parameters

The maximum likelihood estimates of the parameters in the Cobb-Douglas stochastic frontier profit model as well as those of the profit inefficiency model were obtained in a single stage estimation procedure using a statistical programme of Stata 15. Single stage estimation procedure was adopted in order to produce consistent estimates of maximum likelihood. In other words, estimating a Cobb-Douglas stochastic frontier profit inefficiency models using a two-stage estimation technique requires that the dependent variable (i.e. technical efficiency / inefficiency) in the second stage of estimation is normally distributed (Amemiya, 1984; Rahji, 2019). The unknown parameters of the models and the variance parameters were simultaneously estimated. The value of the variance, associated with the distribution of the inefficiency effects, Ui. If Ui in the stochastic frontiers are not present or alternatively, if the variance parameter γ associated with the distribution of Ui has value of zero, then $\sigma^2{}_u$in the frontier model is zero and the models reduce to the traditional response model.

III. Results and Discussion

Distribution of respondents by socio-economic characteristics

Table 1 shows the socio-economic characteristics of catfish farmers in the study area. The results of the data from the table revealed that majority of the catfish farmers in the study area were male (78.85%) with at most ten years of farming experience (63.94%) and were found within the age range of active labour force (79.81%). The mean age of the catfish farmers was about 47years while the mean years of farming experience was 10 years. Furthermore, there is a high level of literacy in the study area as 98.07% of the respondents completed at least primary level of education. The mean year of formal education was 12. The high literacy level among the catfish farmers in the study area implies that the respondents were likely to be receptive to improved production technologies and thus able to improve their technical efficiency.

Table 1: Socio-Economic Characteristics of Catfish Farmers

Variable	Frequency	Percentage
Sex		
Male	164	78.85
Female	44	21.15
Age		
0-40	81	38.94
40-60	85	40.87
>60	42	20.19
Mean	46.85	(14.51)
Educational level		
No formal	4	1.92
Primary	39	18.75
Secondary	56	26.92
Tertiary	109	52.40
Household size		
1-5	86	41.35
6-10	120	57.69
>10	2	0.96
Mean	5	(1.45)
Farming Experience		
0-10	133	63.94
10-20	69	33.17
>20	6	2.88
Mean	9	(4.90)
Primary Occupation		
Farming	133	63.94
Others	75	36.06

Source: Author's computation from field survey, 2020. Values in parenthesis are standard deviation.

About half of the respondents (41.35) had 1-5 members of household, 57.69% had 6-10 members while the lowest (2.88%) percentage of the respondents had above 10 members of household. The mean size of the household in the study area was 5 members. This implies that majority of the respondents were likely to have a portion of their disposable income saved for future investment or for smoothening the household consumption in the lean period. The primary occupation of the respondents in the study area was predominantly farming (63.94%). This implies that farming constitutes the major source of income and livelihood for majority of the respondents in the study area.

Summary Statistics of the Variables in Stochastic Profit Frontier

The result from table 2 revealed that the mean yield of 3686.46kg of catfish per farm was recorded over the sampled farms with a standard deviation of 2779.42kg per farm. The large variability recorded as measured by the standard deviation could be attributed to marked variation in the number and size of the fish ponds. Also, an average of ₦665 per kg of catfish was recorded in the sampled farms as price of the output. The result further revealed that a mean gross margin of ₦2, 064,138 per farm with a standard deviation of ₦1, 858,981. The analysis of variable costs showed that feed constitutes the largest proportion contributing about 70% to total variable cost. This finding is consistent with Sodiq *et al.* (2015).

Table 2: Summary Statistics of variables included in the Stochastic Frontier Profit function

Variables	Mean	Standard deviation	Minimum	Maximum
Catfish output(kg/farm)	3686.46	2779.42	500	8685
Output price (per unit kg)	665	26.62	650	720
Gross margin per farm (₦)	2,064,138	1,858,981	594000	6,013,700
Cost of feed(₦)	295,409.6	257,692.5	26,500	800,000
Cost of fingerlings (₦)	57,706.29	23929.87	24000	139000
Cost of labour (₦)	4531.25	1523.64	2000	8000
Cost of water (₦)	4519.23	1542.35	2000	8000
Cost of medication (₦)	9125	2411.97	4000	18500
Number of ponds	5.50	3.20	1	12

Source: Author's computation from field survey, 2020.

Maximum Likelihood Estimates of Stochastic Profit Frontier Function

Table 3 presents the maximum likelihood estimates (MLE) of the parameters of the Stochastic Profit Frontier model. The dependent variable was restricted normalized profit from the catfish output produced. The estimated Sigma-Squared (σ^2) was 0.389 and statistically significant at 1% probability level indicating the correctness and good fit of the specified distributional assumption of the composite error term. Furthermore, the estimated value of gamma (γ=0.95) which is the ratio of the variation of farm specific profit inefficiency to the total variance of the profit implying that the one-sided random inefficiency component strongly dominates the error components. This shows that about 95% of the variation in the actual profit among catfish farms was due to the differences in production practices rather than random variability.

With the exception of the estimated partial elasticity of cost of water used in catfish farms, all the estimated elasticity parameters of variables in the Stochastic Frontier Profit model were positively and statistically significant. The significant negative relationship between the cost of water used in cat fish production and the gross profit shows that an increase in cost of water for cat fish production decreases the gross profit of catfish output. This could be attributed to the overutilization of water in the catfish aquaculture. The result from table 3 also indicated that the quantity of catfish harvested was the most important variable determining the profit level of catfish farms in the study area. Furthermore, cost of feeds, cost of fingerlings, size of ponds, cost of hired labour and cost of medications were all positively and significantly influenced the profit level of cat fish farmers in the study area.

Determinants of Profit Efficiency

The result of the inefficiency model was presented in table 4. The signs and significance of the estimated coefficients have important implication in explaining the determinant of profit efficiency among catfish farmers in the study area. A coefficient with negative signs implies that the variable had an increasing effect on profit efficiency (decreasing effects on profit inefficiency) while a positive coefficient implies decreasing effect on profit efficiency (increasing effect on profit inefficiency). The results of the estimated inefficiency model revealed that the coefficients of age, gender and household size were negative and statistically significant at 5% levels. This implies that the variables had negative effects on profit efficiency. These findings are in line with *a priori* expectation except the coefficient of gender of the respondent.

The positive and significance relationship between the estimated coefficient of gender of the cat fish farmers and profit inefficiency implies that profit efficiency had a decreasing effect on male respondents. The possible reason is that the female respondents, unlike their male counterparts were less likely to share part of their scarce productive resources with other income generating activities. They tend to operate at full employment of their productive resources and were thus able to achieve higher profit efficiency than their male counterparts. This finding is consistent with Okoror *et al.* (2017).

Table 3: Result of the Estimated Stochastic Frontier Profit Function for Catfish Farmers in Ondo State

Variables	Coefficient	Standard error	Z-value
Catfish output	1.0430	0.0093	112.58***
Cost of feeds	0.0400	0.0114	3.52***
Cost of fingerlings	0.1995	0.0219	9.11***
Size of ponds	0.1370	0.0194	7.07***
Cost of hired labour	0.1383	0.0255	5.42***
Cost of medications	0.3331	0.0450	7.41***

Cost of water	-0.0556	0.0391	-1.42*
Constant	6.6344	0.0609	108.97***
Age	0.3170	0.1357	2.34**
Educational level	-0.1707	0.6446	-0.26
Sex	2.5065	1.3247	1.89**
Household size	1.3562	0.8023	1.69**
Family experience	0.0040	0.1526	0.03
Primary occupation	-3.4393	2.6110	-1.32
Constant	14.2511	6.7346	2.12***
Variance parameters			
Sigma (σ_v)	0.1343	0.0075	17.93***
Sigma (σ_μ)	0.6092	0.1010	6.03***
Sigma^2 (σ^2)	0.3891		
Lambda (λ)	4.5355		
Gamma (γ)	0.9537		
Log likelihood	73.9399		

Source: Author's computation from field survey, 2020. ***, ** and * indicate the levels of significance at 1%, 5% and 10% respectively.

Furthermore, the positive and significant ($p<0.05$) relationship between the coefficient of household size and profit inefficiency implies that there is a reduction in profit efficiency as the household size increases. This finding is consistent with Ettah and Kuye, (2017). As expected, the estimated coefficient of age of the respondents was positively correlated with profit inefficiency and significant at 5%. This implies that the loss in profit due to profit inefficiency increases with age. This is because as the cat fish farmer gets older, his ability - in terms of physical and mental alertness - to promptly respond to the emerging needs required for enhanced profit decreases. This finding corroborates Abu *et al*. (2012) and Ettah and Kuye, (2017) but contrary to Tsue *et al*. (2012).

Descriptive statistics of profit efficiency scores

The distribution of profit efficiency scores as shown in table 4 revealed that majority of the cat fish farmers operated at close to the profit frontier level with 64.42% of them had profit efficiency scores found between 0.95 to 0.99, followed by 28.85% with efficiency score found between 0.90 to 0.94. This implies that the loss in profit due to inefficiency by these categories of fish farmers, given the prices and fixed factor endowment were 3% and 8% respectively. Furthermore, about 2% of the cat fish farmers in the study area had profit efficiency scores below 0.85. On the average, the cat fish farmers operated at profit efficiency level of 0.95.This implies that the loss in profit due to technical, allocative and managerial inefficiency was just 5%. In other words, about 5% of the profit is lost to inefficiency of management, given the prices of inputs and outputs used as well as the level of fixed factor endowment. The foregoing suggests that, in the short run, the farmers have the scope for increasing profit from their production by 5% through the adoption of innovations and technologies adopted by the best-practiced cat fish farmer in the study area.

Table 4: Descriptive statistics of the profit efficiency scores

Efficiency range	Frequency	Percentage
≤0.79	1	0.48
0.80-0.84	3	1.44
0.85-0.89	10	4.81
0.90-0.94	60	28.85
0.95-0.99	134	64.42
Minimum	0.77	
Maximum	0.98	
Mean	0.95 (0.03)	

Source: Field survey, 2018. The values in parenthesis are standard deviation.

IV. Conclusion

The study used the functional specification of Stochastic Cobb-Doglas profit frontier to determine profit efficiency among cat fish farmers in Ondo state, south-western Nigeria. Farm level survey data were obtained from 208 fish farmers in the study area using multi-stage sampling procedure. The results of the study revealed that majority of the fish farmers were male, within the age range of productive labour force and were highly educated as above 90% had formal education. The analysis of stochastic profit frontier model revealed that there were marginal variations in profit efficiency levels as majority of the fish farmers operated at close to profit frontier with a mean efficiency score of 0.95 implying that the best practice production technologies were adopted in the study area. Nevertheless, the existing variation in the profit efficiency scores can be attributed to the low price of output resulting from imperfect competition in the input markets. The result of the determinants of profit efficiency revealed that the moderately-sized households, headed by the relatively-young and female catfish farmers were more profit efficient, compered to their counterparts headed by relatively older and male farmers with large household size. The policy implication of these findings is that the inefficiency in cat fish production can be significantly reduced with a sustained awareness campaign on child spacing and family planning. Furthermore, the relatively young and female members in the study area should be encouraged to participate in cat fish production.

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