ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

PRODUCTION EFFICIENCY OF CATFISH FARMERS IN OGUN STATE, NIGERIA

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ABSTRACT

Fish farming in Nigeria today tends to be on the increase, but there are some factors limiting its efficiency in the country. *The study investigated the production efficiency of fish farmers in Ogun State. The study was conducted with three hundred (300) catfish farmers sampled using multistage random sampling techniques.* Data were analyzed using descriptive and inferential statistics. Descriptive statistical tools such as frequency counts and percentages were used to describe the socio-economic characteristics of the fish farmers in the study area. Stochastic frontier model was used to measure the production efficiency; budgetary techniques were employed in computing the income accruing to fish production while Tobit regression model was used to estimate the effect of farm efficiency on the profitability of fish production in the study area. Socio-economic characteristics of the fish farmers revealed that majority (84%) of the respondents fall within 51 – 65 years of age, 86% were males, 80% were married and 53% have relatively large household size that ranges between 4 and 6 members. The rate of return on capital investment (RORCI) for the fish farmers was 157%, implying that for every ₦1 invested into culture fish, ₦ 1.57 was made as revenue; which is about 57 kobo realized as returns. The rate of return on capital invested (RORCI), otherwise called efficiency level was 0.57. The parameter estimates of the production function showed that labour ($p<0.01$), quantity of fingerlings ($p<0.10$), and depreciation cost of equipment ($p<0.05$) had significant influence on output of the fish farmers. Thus, an increase in the labour man-hours, quantity of fingerlings and depreciative cost of equipment will bring about increase in the productivity of the fish farmers. The study recommends that fish farmers in the study area should adapt cost effective measures in fish production to earn better returns among others.

Keywords: Efficiency, Production, Profitability, Ogun State

INTRODUCTION

Fish has been an important component of the human diet in many parts of the world. Fish catches increased rapidly over the past hundred years due to improved technology which provided more powerful fishing engines and equipment. This has led to overfishing and caused a worldwide decrease in wild stocks and the need to increase fish production by fish farming (Carballo *et al.*, 2003). Nigerians are high fish consumers and offer the largest market for fish and fisheries products in Africa. Fish farming has thus become an important venture in the quest for food security and eradication of malnutrition, especially among infants in the country (Awotide, 2012). Nigeria's current fish production stands at 0.8 million metric tons, with a deficit of 1.9 million metric tons of fish, as local demand for the protein stands at 2.7 million tons annually, with about 1.2 billion dollars' worth of fish being imported annually into the country (CBN, 2020).

Catfish farming in Nigeria today tends to be on the increase, but there are some factors limiting its efficiency in the country. Some of these factors include poor storage and processing techniques as well as lack of capital to start up fish production, among other factors. It is against this background that the study was embarked upon with a view to provide answers to the following research questions:

- What are the socio-economic characteristics of the fish farmers?
- Is fish farming profitable in Ogun State?
- Are the fish farmers efficient in the use of inputs?
- What are the effects of the farm efficiency on the profitability of fish production in Ogun State?

RESEARCH METHODOLOGY

The Study Area

The study was conducted in Ogun State, Nigeria. The State is a major economic hub. It has one of the largest concentrations of industries in the country and serves as the major corridor for transportation of goods, services and people between the nation's commercial centre Lagos, and the rest of the country, as well as the large West African markets. Its people are very industrious and are found in all walks of life. The State has abundant natural resources that include forest and water bodies as well as large quantities of mineral deposits, such as limestone, phosphate, granite stone, gypsum, bauxite, bitumen, feldspar, clay, glass sand, kaolin, quartz, tar sand, gemstones and crude oil are available in commercial quantities. The people of this area are involved in economic activities like trading, selling of livestock, fishing hunting, basket weaving as well as blacksmithing. There are different fish clusters within the state where small scale fish farmers come together for the production of their fishes in a given area.

Sampling Techniques

The sample consisted of three hundred (300) fish farmers which were chosen using multistage random sampling techniques. The first stage involved purposive selection of six (6) Local Government Areas with high numbers of fish farmers. In the second stage, five (5) towns were selected randomly from the six (6) Local Government Areas, making the total of thirty (30) towns. At the third and final stage, ten (10) fish farmers were selected randomly from each town and its adjoining villages, making three hundred (300) fish farmers from whom relevant information were obtained.

Data Analysis

Socio-Economic characteristics of the fish farmers

The descriptive statistical tool comprised frequency counts, percentages, means and modes that were used to describe the socio - economic characteristics of the fish farmers in the study area.

Efficiencies of fish farms in the study area

The stochastic meta-frontier model is an extension of the meta-production function model. The Battese and Rao (2002) technique is used to measure technical efficiency ratios as well as technology gap ratios for firms in a group relative to the best practice in the industry. Similar to the stochastic frontier meta-production function, the stochastic meta-frontier function is expressed in equation 1. However, Battese and Rao (2002) explained that the meta-frontier function is an envelope of the stochastic frontiers of the different groups such that it is defined by all observations in the different groups in a way that is consistent with the specifications of a stochastic frontier model. Observations on individual firms in the different groups may be greater than the deterministic component of the stochastic frontier model, but deviations from the stochastic frontier outputs are due to inefficiency of the firms in the different groups. The stochastic frontiers for the different groups and that of the meta-frontier would generally be assumed to be of the same functional form (for example, Cobb-Douglas or Translog), but there are no problems of aggregation as with the relationship between firm and industry functions.

Stochastic frontier production function for analysis of the efficiencies and technical inefficiency of fish farmers

Stochastic frontier production function of the type proposed by Battese and Coelli (1995) was used to determine the efficiencies of the fish farmers. The model and its estimating form were used by Ogundari and Ojo (2007); Umoh (2006); It is specified in a linearized form as:

$\ln Y_i = \ln\beta_0 + \beta_j \Sigma \ln X_{ij} + V_i - U_i$ .... (1)

Where:

Y_i = Total fish output ith (Kg),

X_{is} are the inputs used in farm production,

X_1 = Pond size (m^2)

X_2 = Labour (Man-days)

X_3 = Quantity of fingerlings (number)

X_4 = Quantity of feed used (Kg)

X_5 = Depreciation cost of equipment (₦)

V_i and U_i represent error term and

β0 & βj are the vectors of parameters to be estimated.

Also the inefficiency model which was used by Bravo-Ureta and Pinheiro (1997) is specified as:

$U_i = \square_0 + \square_I \Sigma Z_{ij} + e_i$ ....

(2)

Where:

Ui =the inefficiency effect of the ith farm,

Z_{ij}= the vector of socio-economic factors,

e_i = the disturbance term,

Z_1= Age of the farmer (years);

Z_2= Gender (1 = Male; 0 = Female);

Z_3= Household size; (number of person)

Z_4= Educational level (Yrs);

Z_5= Experience in Farming (Yrs);
Z_6=Off-farm/non-farm activities (1 = If engaged in either or both; 0 = Otherwise);
Z_7= Number of Extension Contact (Number);
Z_8= Access to credit facility (1 = Access to credit; 0 = Otherwise);
Z_9 = Improved management practice (1 = Use of fertilizer and or pesticide; 0 = Otherwise) and
δo & δi are the parameters to be estimated.

The Technical Efficiency (TE) of individual farmer, as specified by Ogundari and Ojo (2007); Umoh (2006); is expressed as:

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{f(X_i, \beta)\exp V_i - U_i}{f(X_i, \beta)\exp V_i} = \exp(-U_i) = e^{-u_i} \quad \ldots\ldots (3)$$

The Allocative Efficiency (AE) of individual farmer as specified by Ogundari and Ojo (2007) is expressed as:

$$AE = \frac{C_i}{C_i^*} = \exp(-U_i) \quad \ldots\ldots (4)$$

The Economic efficiency (EE) estimated from the Farell (1957) formula specified as:

$$EE = TE \times AE \quad \ldots\ldots (5)$$

Profitability level and indices of fish production

The budgetary analysis was used to determine the profitability of the enterprise. The Net Farm Income is the difference between the total returns from production (total revenue) and the total costs of production. The total revenue refers to the gross income accruing to fish farms as a result of the sales of table-sized fish. This is obtained by multiplying the unit price of average table-sized fish by the quantity sold. The variable costs are those costs that vary with the level of output. In this study the relevant variable costs items are fish feed, fingerlings, labor, fuel, electricity, transportation, drugs among others. The fixed costs items under fish farming are Farm Structure, Machinery/ Equipment, Pumping Machine, land, Concrete /Earthen pond, Water Pump/ Borehole and other equipment.

The budgetary techniques were employed in computing the income accruing to fish production. The arithmetical relations that were used in capturing profit made are presented below in a step-wise fashion:

The budgetary analysis is presented below:
NFI = GI – TFC
Where:
GI = TR - TVC
∏ = TR – TC
TR = P x Q
TC = TVC + TFC
NFI = Net Farm Income
GI = Gross Income
TVC = Total Variable Cost
∏ = Profit
P (Price of Output)
Q = Quantity of Output Sold

$$\text{Profitability Index or Return to Scale} = \frac{NI}{TR}$$

$$\text{Rate of Return on Investment (\%) RRI} = \frac{NI}{TC} \times 100$$

Rate of Return on Variable Cost (%) RRVC = $\frac{TR - TFC}{TVC}$ X 100

Operating Ratio $\frac{TVC}{TR}$

Average Net Income $\frac{NI}{T}$

Total Cost **(TC)** = Total Fixed Cost **(TFC)** + Total Variable Cost **(TVC)**...................... (1)
Gross Income **(GR)** = Total Farm Output **(TFO)** x Unit Price **(UP)**…………......... ...(2)
Gross Margin **(GM)** = GR – TVC …….. (3)
Net Farm Income **(NFI)** = GM – TFC……... (4)
PI = Profitability Index
t = Production Period in Weeks.

Total Fixed Cost: Depreciation expenses on land, equipment, generator, houses and machineries. To obtain the worth of each of the fixed cost items, the straight line method of depreciation was used and it assumes that the salvage value of the fixed items that were used in the business is zero.

Benefit-Cost Ratio: The variability of the fish enterprises was determined using the benefit -cost ratio (BCR) which is the division of total revenue by total cost. The BCR measures the ability of the business to upset the financial obligation and still remain standing.

Effect of farm efficiency on the profitability of fish production

The Tobit model: If a continuous random variable X has pdf f(x) and a is a constant, then

$$f(x / x > a) = \frac{f(x)}{\Pr ob(x > a)}$$

If x has a normal distribution with mean μ and standard deviation σ, then

$$\Pr ob(x > a) = 1 - \Phi\left(\frac{a - \mu}{\sigma}\right) = 1 - \Phi(\alpha)$$

Where α = (a-μ)/σ and φ(.) is the standard normal cdf. The density of the truncated normal distribution is then

$$f(x / x > a) = \frac{f(x)}{1 - \Phi(\alpha)} = \frac{(2\pi\sigma^2)^{-1/2} e^{-(x-\mu)2/(2\sigma^2)}}{1 - \Phi(\alpha)} = \frac{\frac{1}{\sigma}\phi\left(\frac{x - \mu}{\sigma}\right)}{1 - \Phi(\alpha)}$$

Where φ(.) is the standard normal pdf. The truncated standard normal distribution, with μ = 0 and σ= 1. Likewise, the discrete random variable is the truncated at Zero Poisson distribution,

$$\Pr ob\left|Y = y / y > 0\right| = \frac{(e^{-\lambda}\lambda^y)/y!}{\Pr ob[Y > 0]} = \frac{(e^{-\lambda}\lambda^y)/y!}{1 - \Pr ob[Y = 0]} = \frac{(e^{-\lambda}\lambda^y)/y!}{1 - e^{-\lambda}}, \lambda > 0, y = 1,...$$

Implicit form

$Y^*_{ij} = \beta'X + \varepsilon_i$ $\qquad \varepsilon_i \sim N(0,\sigma^2)$

$Y_{ij} = Y^*_{ij}$ $\qquad$ for $Y^*_{ij} > Y_i$

$Y_{ij} = Y_i$ $\qquad$ for $Y^*_{ij} \leq Y_j$

Y = the profitability index ($\frac{NI}{TR}$) as a proxy of farm profit (ratio in figure).

X_1 = the technical efficiency value for each fish farm (number).

X_2 = the economic efficiency value of each fish farm (number).

X_3 = fish farm income (naira)

X_4 = number of products for sale per farm (e.g, catfish, tilapia etc.)

X_5 = total value of all the products sold in the last session (naira)

X_6 = Total amount of money spend on production in last session (naira)

X_7 = Percentage change in price of the major input of the fish production farm (%), (price of the product at the end of the production session – price of the product at the beginning of the production season / price of the product at the beginning of the production season)

$= \frac{P1-P0}{P0} \times 100$

X_8 = age of the farmer (number)

X_9 = educational level of the farmer (number of year spent in school)

X_{10} = sex of the farmer (male = 1; 0 if otherwise).

X_{11} = household size (number)

X_{12} = size of the farm (number of fingerlings stocked)

X_{13} = amount of loan accessed in last production year (naira)

X_{14} = experience in fish farming (year)

X_{15} = presence of other occupation (yes = 1; 0 if otherwise)

X_{16} = management system practiced (1 = earthen pond, 0 if otherwise)

X_{17} = mortality rate (percentage)

X_{18} = presence of pilferage and externalities (yes = 1, 0 if otherwise).

Results and Discussion

Socio – Economic Characteristics of the Farmers

Fish production involves engagement of strong, agile, able-bodied and productive people, because most fish farming activities demand much strength. Also, the age of the household head is expected to have impact on the labour supply for food production. Thus, young farmers who are stronger are expected to be more productive than aged counterparts. Majority of the respondents fall within 50 – 65 years of age, with 30.0% specifically within 61-65 years. The result suggests that adult men/women are mostly engaged in fish farming activities. These groups of people are expected to be of high productivity as they would be capable enough to engage in tedious farming activities as their older counterparts would. The findings are consistent with those of Nmadu *et al.*, (2014).

Majority of the respondents (86.0%) were males, while 14.0% were females (Table 1). This could be due to the fact that females are often married to the males and so might not out-rightly own their lands. The females usually have a negligible portion compared to

Table 1: Socioeconomic characteristics of fish farmers

Socioeconomic characteristics	Frequency	Percentage
Age of farmers (Years)		
<=50	26	8.7
50 - 55	77	25.7
56 – 60	84	28.0
61 – 65	91	30.3
>65	22	7.3
Gender		
Male	258	86.0
Female	42	14.0
Marital Status		
Single	14	4.7
Married	240	80.0
Widow/Widower	46	15.3
Divorced	34	11.3
Educational Qualification		
Primary	58	19.3
Secondary	84	28.0
Tertiary	124	41.3
Household Size (Number)		
1 – 3	46	15.3
4 – 6	160	53.3
7 – 9	80	26.7
10 and Above	14	4.7
Occupational Experience (Years)		
1 - 5	52	17.3
6 - 10	116	38.7
11 - 15	70	23.3
16 - 20	14	4.7
21 and Above	48	16.0
Cooperative Membership		
Yes	112	37.3
No	188	62.7
Farm Size (Acres)		
Below 1	14	4.7
1 - 2	100	33.3
3 - 4	46	15.3
5 - 6	64	21.3
7 and above	76	25.3

Source: Field Survey, 2017

their male counterparts. This agrees with the finding of Olaleye (2000) that fish farming activities are being carried out mostly by males, while females are involved in light farm operation such as processing, harvesting and marketing.

Majority of the respondents (80.0%) were married, 15.3% were widow/widower, while 11.3% and 4.7% were divorced and singles, respectively. The high percentage of the married is a result of the fact that fish farming communities believe in marriage, and since fish farming occupation requires labour, their wives and family members would assist in their farm work.

Education is vital in eradicating ignorance and increases the fish farmers' exposure and ability to make use of new fish farming practices and innovation. Socio-economic results revealed that all the fish farmers had at least primary education.

The total household size of the respondents comprises the heads of the homes, the wives, children as well as all other dependents resident in the house. Household size and its composition are important factors to consider in analyses of fish farmers, most especially as it determines the availability of labour to fish farmer's economic pursuits. Results of the findings on the household size showed that larger percentage (53.3%) have relatively large household sizes that range between 4 and 6 members (Table 1). By implication, as the household size increases, it is expected that family labour should increase, thereby reducing the cost of hired labour and increasing income generated. The households in the sample tended to be a bit larger than the recommended national average, five members on average compared to the average of four recommended by Alabi and Haruna (2005).

A large proportion of the respondents (38.7%) had between 6 and 10 years of occupational experience (Table 1); showing that most of the fish farmers were averagely old in the enterprise and this level of experience can also determine the level of knowledge on management practices. The older they get in the enterprise, the more they get to know and understand the management practices of fish farming. This agrees with Omotosho and Fagbenro (2004) that experience matters in adoption of recommended packages of innovations and modern farm techniques.

Cooperative membership could influence access to finance for farm or non-farm business or businesses. Improved finance for farm and/non-farm business by the respondents could improve their livelihoods. Majority (37.3%) of the fish farmers were members of cooperative societies while 62.7% were non-members of cooperative societies (Table 1). Membership of cooperative societies assists in solving members' problems. The finding agrees with the submission of Hamid and Chiaman (2010), but contradicts the findings of Nmadu *et. al.,* (2014) who showed that the majority of the farmers did not join cooperative societies due to cultural and religious beliefs. This may not be unconnected with the fact that the majority of the respondents are small and medium scale farmers. It is becoming more difficult for this category of farmers to access loan from financial institutions.

Farm size is necessary to know whether the fish farmers are either small scale, medium scale or large scale fish farmers. With respect to farm size, findings showed that 33.3% of the fish farmers had farm land ranging from 1 – 2 Acres. This compares favourably with the findings of Obasi (2007). The implication of this farm size is that as population increases, farm size reduces due to partitioning in the inheritance process or due to land reform process. This will invariably lead to more intensive land use systems.

Profitability level and indices of fish production

The cost of feed accounted for the largest proportion (33.0%) of the total cost of fish production (Table 2). Adequate feeding of the fingerlings/juvenile is an important step to better performance of fish farming which also depends not only on how well the fish are fed but also on the quality. This explains why feeding took the bulk of the total variable cost. The cost of fingerlings accounts for 22.2% while the cost of hired labour accounted for 26.9% of the total cost of production (Table 2). This shows that a large amount of money is spent by fish farmers in the study area for the purchase of feeds, hired labour and fingerlings. Concrete/Earthen pond construction and pumping machine costs account for 6.0% and 3.2% of the total cost, respectively. The fixed cost of production consists of cost of fixed assets such as Concrete /Earthen pond construction, Farm Structure, Land Purchase, Machinery/Equipment and Pumping Machine which accounted for 11.9% of total production cost. The respondents that claimed that majority of the fixed inputs such as Farm Structure, Machinery/Equipment, Pumping Machine, land, Concrete /Earthen pond, Water Pump/Borehole had been in existence for some years and are only maintained by the fish farmers, hence, the cost of the fixed inputs were low.

The rate of return on capital investment (RORCI) for the fish farmers was 157%. This implies that for every ₦1 invested into culture fish, ₦ 1.57 was made as revenue. About 57 kobo was realized as returns. The rate of return on capital invested (RORCI), otherwise called efficiency level was 0.57. This suggests both viability and profitability of fish farm enterprise in the study areas, as this value is higher than current lending rate of between 6 and 25% charged by both Co-operative societies and Commercial Banks in the study area.

It can be concluded by way of comparison that fish farming appears to be viable and profitable in the study area. This is consistent with the findings of Ashaolu *et al.* (2006); Awotide and Adejobi (2007) from their studies on technical efficiencies.

Efficiencies of fish farms

The variance parameters, sigma-square (σ^2) and gamma (γ) were estimated at 0.845 ($p< 0.01$) and 0.997 ($p<0.01$), respectively (Table 3). The sigma-square attests to the goodness of fit and correctness of the distributional form assumed for the composite error term while the gamma indicates the systematic influences that are unexplained by the production function and the dominant sources of random errors. This implies that about 84.5% of the variation in output of fish farmers is due to the differences in their technical inefficiency. Thus, inefficiency effects were present and contribute significantly to the efficiency of the fish farmers.

The parameter estimates of the production function showed that labour on mandays ($p<0.01$), quantity of fingerlings ($p<0.10$), and depreciation cost of equipment ($p<0.05$) had significant influence on output of the fish farmers. Thus, an increase in the labour on man-hours, quantity of fingerlings and depreciation cost of equipment will bring about increase in the productivity of the fish farmers.

Table 2: Average cost and return of fish production

Variables	Total Expenditure (₦)	%	Mean	Std. Deviation
Fingerlings	40,656,500	22.2	271,043.33	324,029.53
Feed (Kg)	60,497,500	33.0	403,316.66	171,801.54
Hired labour	49,276,000	26.9	328,506.66	405,990.55
Family labour	50,000	0.0	333.33	1,801.07
Fuel	949,750	0.5	6,331.67	4,277.76
Electricity	1,057,000	0.6	7,046.67	14,190.61
Transportation	1,231,000	0.7	8,206.67	17,088.91
Drugs	29,600	0.0	1,013.33	2,036.53
Pesticides	3,375,000	1.8	197.33	614.36
Lime	1,904,000	1.0	22,500.00	23,384.65
Cutlass/Hoe	25,400	0.0	12,693.33	11,796.90
Pond	1,015,000	0.6	6,766.67	33,675.99
Basket	642,700	0.4	4,284.67	2,873.36
Shovel and Spade	21,150	0.0	141.00	886.47
Water Pump/Borehole Construction	741,000	0.4	4,940.00	19,605.24
Concrete /Earthen pond construction	11,040,000	6.0	73,600.00	173,527.58
Farm Structure	1,035,000	0.6	6,900.00	31,546.65
Land Purchase	212,600	0.2	14,173.33	56,141.21
Machinery/Equipment	3,440,000	1.9	22,933.33	88,882.29
Pumping Machine	5,900,000	3.2	39,333.33	19,769.36
TVC	159,026,350	86.8	104,856.51	606,362.53
TFC	24,072,850	13.2	189,603.06	28,916.53
TC	1,830,992,200	100	124,546.58	760,705.53
GR	7,755,436,654		516,646.55	271,996.77
GM	7,596,410,304		411,796.00	861,696.44
NI	7,572,337,454		4.96	3.80
ROI	0.24			
ROIC	0.57			

Source: Field Survey, 2017

The contribution of farmers' personal characteristics: age of the farmer, gender, household size, educational level, experience in farming, off-farm/non-farm activities, number of extension contact, access to credit facility, and improved management practice to fish farm inefficiency was also examined. The sign of the coefficients of these variables has important policy implications as positive sign implies negative effect on efficiency while negative sign signifies a positive effect on efficiency. The coefficients of age, educational level and number of extension contact were positively and significantly related to technical inefficiency (TE gap) but contributed negatively to technical efficiency

Table 3: Stochastic Frontier Production Maximum likelihood of Estimate for Fish Farmers

Efficiency Variable	OLS Estimates		MLE Estimates	
	Coefficient	t-ratio	Coefficient	t-ratio
Pond size	-6.216	1.045	-3.715	-0.983
Labour on man-day	0.769***	13.750	0.999***	23.780
Quantity of fingerlings	1.213	0.754	1.936*	1.605
Quantity of feed used	-51.781	-0.633	-8.500	-1.470
Cost of Depreciative equipment	0.129**	2.526	7.649**	2.086
Inefficiency Variables				
Age of the farmer	-	-	4.307**	2.580
Gender	-	-	-0.243	-1.096
Household size	-	-	0.202	0.850
Educational level	-	-	3.641*	1.648
Experience in Farming	-	-	-5.012	-0.999
Off-farm/non-farm activities	-	-	96.015***	0.170
Number of Extension Contact	-	-	2.523**	2.162
Access to credit facility	-	-	-35.041	-0.797
Improved management practice	-	-	21.036	0.904
Diagnostic Statistics				
sigma-squared (σ^2)			0.845***	14.530
Gamma (γ)			0.997***	13.771
log likelihood function		-12.886		

***,**,* indicates significant at 1%, 5% and 10% respectively

Source: Field Survey, 2017

(Table 3). Thus, as age increases, farmers tend to be less productive. The contribution of age variable to technical inefficiency conformed to a priori expectation that as the fish farmers grew older, their TE would drop. This finding however, negated the findings of Esobhawan (2006) that age was a positive contributor to technical efficiency.

The contribution of education variable to technical inefficiency negated a priori expectation which could, however, be due to lack of technical education on aquaculture production. The positive contribution of access to extension agents to technical inefficiency was the result of the majority of them (52.0%) not having access to extension agents.

Production efficiency estimates of fish farmers

The technical efficiency of the fish farmers is fairly distributed, with 24.7% having efficiency within the bracket of 0.33 and 0.98% (Table 4). This gives a mean technical efficiency of 0.78%, implying there is room for improvement in technical efficiency by 22% with the present technology. The allocative efficiency estimates ranged between 0.23 and 0.93%, with a mean efficiency of 0.65%. This implies there is room for improvement

Table 4: Distribution of Production Efficiency Estimates of Fish Farmers

Variables	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
Below 0.50	8	5.3	21	14.0	24	16.0
0.50 – .60	9	6.0	27	18.0	26	17.3
0.61 – 0.70	37	24.7	48	32.0	51	34.0
0.71 – 0.80	33	22.0	38	25.3	17	11.3
0.81 – ≤0.90	15	10.0	8	5.3	32	21.3
≥0.90	48	32.0	8	5.3	0	0.0
Mean	0.78		0.65		0.63	
Minimum	0.33		0.23		0.11	
Maximum	0.98		0.93		0.91	

Source: Field Survey, 2017

by 35%. The economic efficiency estimates of the fish farmers ranged between 0.11 and 0.91%, with a mean efficiency of 0.63%. The implication is that the fish farmers averagely produce output at a minimum cost. In addition, the mean economic efficiency of the fish farmers shows there is room for improvement by 37% (Table 4).

Effects of Farm Efficiency on the Profitability of Fish Product

Profitability of fish products is significantly determined by the technical efficiency value for each fish farm.T his implied that an increase in the technical efficiency value for each fish farm, number of products for sale per farm, total amount of money spends on production in last session, household size, size of the farm, amount of loan accessed in last production year, experience in fish farming, presence of other occupation will bring about increase in the profitability of fish products (Table 5). Also, the study showed that the coefficient of variables age of the farmer, sex of the farmer and presence of pilferage and externalities were negatively significant to the profitability of fish product in the study area. This implies that increase in the age of the farmer, sex of the farmer and presence of pilferage and externalities will reduce the profitability of fish products in the study area (Table 5).

Recommendations

The study recommends the following:

i. Fish farmers in the study area should adapt cost- effective measures in fish production to earn better returns.
ii. Fish farming in the area is male dominated. Females need to be encouraged to participate in fish farming in the area as a means of augmenting their income and improve their standard of living.
iii. Youths and young adults should be encouraged by policy makers and government through the provision of incentives to engage in fish production because they are still economically active in this age as it increases the profitability.

Table 5: Effect of Farm Efficiency on the Profitability of Fish Product

Efficiency Variable	Ordinary Least Square		Maximum Likelihood Estimate	
	Coefficient	t-value	Coefficient	t-value
(Constant)	0.264	0.919	-1.233	-0.915
The technical efficiency value for each fish farm	0.575***	2.854	0.272***	2.855
The economic efficiency value of each fish farm	0.474	0.700	0.236	0.734
Fish farm income	0.195	0.404	0.761	0.339
Number of products for sale per farm	-0.311***	3.290	-1.446***	3.250
Total value of all the products sold in the last session	0.403	1.075	0.205	1.145
Total amount of money spend on production in last session	-0.551**	1.970	-0.264**	1.992
Percentage change in price of the major input of the fish production farm	-0.148	-0.193	-0.816	-0.223
Age of the farmer	0.110***	2.782	0.544***	-2.785
Educational level of the farmer	-0.165	-0.062	0.162	0.012
Sex of the farmer	0.609*	1.793	0.285*	-1.789
Household size	0.909	1.379	0.474	1.501
Size of the farm	0.191**	2.172	0.374***	3.080
Amount of loan accessed in last production year	0.372**	2.574	0.508**	2.609
Experience in fish farming	0.992	1.240	0.117*	1.669
Presence of other occupation	0.582***	5.685	0.974***	5.074
Management system practiced	0.912	1.033	0.204	1.180
Mortality rate	-0.199	-0.286	0.276	0.029
Presence of pilferage and externalities	-0.104***	-4.007	-0.138***	-3.875
Log likelihood function		-134.8716		
Chi- square		34.13073		

***, **, * = significant at 1%, 5%, 10% respectively.

Source: Field Survey, 2017

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(Manuscript received: April 7, 2025; accepted: July 11, 2025).