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Technical efficiency of catfish production among smallholder farmers in Ikorodu local government, Lagos State

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Abstract

This study assessed the household farmers' technical efficiency in producing catfish in Ikorodu. 120 households were chosen using a multi-stage sampling procedure. Structured questionnaires were used to gather primary data, and logit regression models, descriptive statistics, gross margin analysis, and the stochastic frontier production function (SFA) were used to analyze the data. Majority of farmers were found to be well-educated, with 57.9% obtaining tertiary education, male (71.1%), and within the economically active age group (mean = 47 years). With a gross margin of ₦656,503.80, a rate of return on investment of 1.75, and an average total cost of ₦134,334.15, the business was extremely lucrative. According to the stochastic frontier results, labor, feed, and fingerlings have a major impact on output, but age and family size were mostly responsible for inefficiency impacts. Inefficiency accounted for 42% of output variation, indicating that the mean technical efficiency was moderate with potential for improvement. The results of logit regression showed that participation in catfish production was strongly influenced by gender, education, and the availability of a secondary occupation. Inadequate finance facilities, government policy barriers, poor road infrastructure, high feed costs, and restricted market access were among the main obstacles found. It is advised that government involvement be used to stabilize the input market and upgrade infrastructure, as well as capital-building initiatives to increase farmers' technical expertise and access to reasonably priced finance.

Nomenclature and units

GM	Gross margin (₦)
TR	Total Revenue
TVC	Total Variable Cost
Yi	The dependent variable
ά	The parameter to be estimated

1.0 Introduction

Aquaculture is one of the fastest-growing food production sector globally, accounting for over 52% of the fish consumed globally (FAO, 2022). With an annual production of over 1.2 million metric tonnes, Nigeria is the top producer of farmed catfish in sub-Saharan Africa; nonetheless, demand still exceeds supply Olaoye *et al.,* (2023). Over time, Nigerian aquaculture especifically, the production of catfish has expanded dramatically, boosting employment, income, and food security, particularly in rural regions Olasunkanmi, (2020);Adewumi and Olaleye, (2017) In Nigeria, aquaculture—specifically, the production of catfish expanded dramatically over time, generating jobs, income, and ensuring food security, particularly in rural areas Olasunkanmi, (2020); Ali and Byerlee,(2019). Producers and consumers alike prefer catfish, a mainstay of Nigerian diets, because of its high protein content, market demand, and capacity to adapt to local conditions Adewumi and Olaleye, (2020). Nigerian catfish production faces several obstacles despite its potential, including inefficient use of resources, high feed costs (approximately 70% of production costs), disease outbreaks, poor access to extension services and credit facilities, and problems with water quality Ekunwe and Emokaro, (2019); Sullumbe, (2024). The degree of sustainability and profitability of farmers is determined by how well they use the resources at their disposal Adeoye and Oke, (2019). According to Tsue *et al.* (2023), assessing the technical efficiency of catfish producers is therefore essential for locating production gaps and enhancing performance. Because of its high protein content, market demand, and capacity to adapt to local conditions, catfish is a staple in Nigerian diets and is preferred by both producers and consumers Adewumi and Olaleye, (2020). Accordingly, because of the area's closeness to urban markets and ideal climatic conditions for aquaculture, home farmers in Lagos State's Ikorodu Local Government Area now produce catfish as a significant source of income Olasunkanmi, (2020). Given the area's close proximity to metropolitan markets and ideal climatic conditions for aquaculture, household farmers in Lagos State's Ikorodu Local Government Area have turned to catfish production as a crucial source of income (Olasunkanmi, 2020).

2.0: Materials and Method

2.1 Study Area

Lagos State is one of the 36 states of the Federal Republic of Nigeria and is home to an estimated 12.6 million inhabitants. The state is in the southwest of Nigeria and situated in the narrow coastal flood plain of the Bight of Benin, approximately between latitudes 6º 22'N and 6º 42'N, and between longitudes 2º 42'E and 3º 22'E (Figure 1). It runs approximately 180 kilometers along the Atlantic Ocean's Bight of Benin's Guinea Coast, it shares borders with the Republic of Benin in the west, the Atlantic Ocean in the south, and the Ogun State of Nigeria in the east and north. Ikeja, Badagry, Ikorodu, Lagos Island, and Epe are its five administrative divisions. These divisions are further divided into 20 Local Government Areas and 37 Local Council Development Areas, and together they cover an area of 3,577 km2 or 0.4% of the 923,773 km2 of Nigeria's entire geographical landmass. The wet season (June to November) and the dry season (December to May) are the two main seasons in the state (Britannica, 2023).

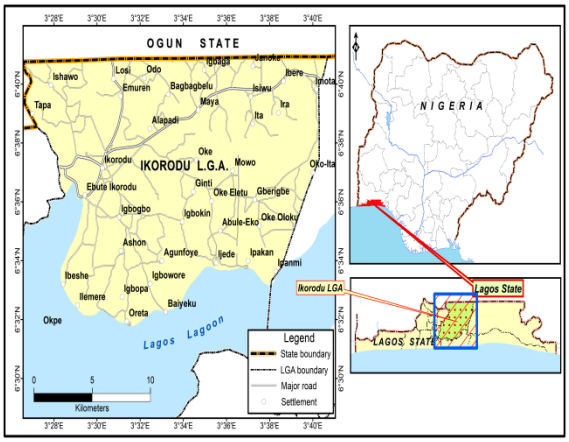

Figure 1: Map of the study area

2.2 Method of Data Collection

The Primary data were used for the study, obtained from the field survey through the administration of well-structured questionnaire.

2.3 Sampling Procedure and Size

This survey was conducted in Lagos State's Ikorodu local government area, and the respondents were chosen using a multi-stage sampling technique. Because of the presence of catfish farmers in the local government, the Ikorodu local government

region in Lagos state was specifically chosen for this study. Gberigbe, Itamaga, Ladegboye, Gbaga, and Mowo-kekere are the five farming settlements that were chosen for the first stage. The communities were specifically chosen since they are the hubs for farming operations including the production of catfish. The population of the communities for the year 1991 was obtained from the National Population Commission of Lagos State and from this; a projection of the 2024 population of each village was done using the projection formular adopted by Olawuyi *et al*., (2018). $P_n=P_oe^{rt}$

Where P_n=Final population, P_o=Initial population, e=exponential, r= Growth at 3.5%

R=common rate=3.5%,T=time of projection=(2024-1991) =33

A formula adopted by Suleiman *et al,*. (2017) was used to compute the appropriate sample size taking into consideration the population size of the household head of the selected communities. The formula minimizing sampling error and using formula is express as:

$N=N/1+ (e^2) N$

Where n= Sample size to be estimated

N= the definite population of the community

E= the significant level (0.005)

Table1: Sampling Size

Villages	1991 Population	2024 Projected Population	Sample size
1. Mowo Kekere	1,173	3718	25
2. Gberigbe	2,514	7969	53
3. Itamaga	329	1042	07
4. Gbaga	822	2606	17
5. Ladegboye	832	2637	18
Total		17972	120

2.4 Method of Data Analysis

Descriptive statistics, Stochastic Production Frontier (SPF), Budgetary analysis and Logit regression analysis were used to analyzed the data.

2.5 Model specifications

Gross margin was used to determine the cost and return analysis of catfish production.

The Gross margin equation is given as: GM = TR – TVC Gross ratio= TC/TR

Where:

GM =Gross margin (₦), TR = Total Revenue (₦),

TVC = Total variable cost i.e. cost incurred in catfish production e.g cost of purchase, transportation cost, etc.TC= Total cost incurred in the production

Production Efficiency Model

The stochastic frontier production function adapted to analyze the production efficiency of the fish farms.

Technical efficiency is specified as

$InQ = ß_0 + ß_1InX_1 + ß_2InX_2 + ß_3InX_3 + ß_4InX_4 + ßnInXn + vi- ui$

Where:

Q= Herd size (Number of fish per farm)

X_1= Initial number of fish (Number)

X_2= Quantity of feeds/ feed supplements (kg)

X_3= Labor input (man-days)

X_4= Chemical/drugs (litre)

vi= Random error

µi= Technical inefficiency

The inefficiency model µi is defined as

$µi= α_0 + α_1Z_1 + α_2Z_2 + α_3Z_3 + α_4Z_4 + α_5Z_5 + α_6Z_6 + α_7Z_7 + α_8Z_8$

Where: Z_1= Age of farmers (years)

Z_2= Educational level (years)

Z_3= Sex (1, if male; 0 if otherwise)

Z_4= Marital status (1, if married; 0, if otherwise)

Z_5= Household size (number)

Z_6= Membership of farmers association/cooperatives (1, if yes; 0, if otherwise)

Z_7= Rearing experience (years)

Z_8= Amount of credit obtained (₦) α is the parameter to be estimated.

α = the parameter to be estimated

Logistic model was used for the factors that influence the household engagement in catfish farming.

The Logit model was used which is written as follows:

$Y= a+b_1X_1+b_2X_2+ b_3X_3+ b_4X_4+b_5X_5……Xn$

Yi = is the dependent variable (catfish production).

X_1= Sex (1= female, 2= male)

X_2= age (in years)

X_3= Educational level (years of schooling)

X_4 =Family size (number of family members)

X_5= Monthly income (in naira)

X_6= Secondary occupation

X_7 = Years of experience

X_8 = Farm size (hectare)

3.0 Results and Discussion

3.1 Socioeconomic Characteristics of Fish Farmers in the Study

According to the findings in Table 1, a significant percentage of the fish farmers in the research area 43.8% were between the ages of 41 and 50. This suggests that the responders can be heavily active in the day-to-day operations of their fish farms because the fish farmers are within their economically productive age range. This outcome is consistent with a research on catfish farmers in Benue State, Nigeria, conducted by Tsue *et al., (*2023). Males made up the majority of the fish farmers (71.1%). This finding suggests that the research area's fish farming industry is a male-dominated one. This is consistent with the findings of Olaoye *et al.,* (2023) and Ajagbe and Ojo-Fakuade, (2019); who similarly found that 84.2% of fish farmers in a comparable research in Oyo State, Nigeria, claimed that fish farming was dominated by men. In a related study conducted in Osun State, Nigeria, Ajiboye, (2020) also found that 95.6% of the fish growers were men. Nonetheless, among small-scale fish producers, women's participation in fish farming was significant. The majority of the women were part-time fish farmers, which may explain this. The results showed that 57.9% had completed college. This indicates that the educated class, and particularly those with advanced degrees, control the fish farming industry. This is the case because successful fish farming necessitates a high level of technical and scientific expertise. According to Sullumbe (2024) and Olasunkanmi, (2020), education plays a significant role in determining the country's economic performance. The findings showed that a significant percentage of fish farmers (43.9%) lived in households with one to three people and four to six people, respectively. This indicates that fish farmers had comparatively big households, which means that family labor will typically contribute significantly to fish production. As a result, there will be less need for hired labor from fish farmers, particularly small-scale fish farmers. The outcome contradicted Ekunwe and Emokaro's (2019) findings. 56.1% of the fish farmers in the research region said that farming was their major activity, according to the farmers' results. This result supports that of Ideba *et al*. (2019), who found that in a research conducted in Calabar, Cross River State, Nigeria, a significant percentage (50%) of the fish growers were civil servants. The findings also showed that a significant percentage of fish farmers in the study region (83.3%) had less than five years of experience, with a mean of three years. This is in contrast to Benue State, where fish farmers have an average of five years of expertise Tsue *et al*., (2023). This finding suggests that fish farming is not a long-term farming activity for the farmers in the study area because they have comparatively little experience with it. As a result, they are more likely to encounter difficulties in fish production, which may affect their productivity and farm management choices. The findings showed that personal savings accounted for 43.3% of the respondents' sources of capital. The cooperative organization is the source of 21.9% of the funding. Naturally, since this criteria is the determining factor, catfish farmers were able to benefit from financial institutions and/or lending agencies by being members of associations. Cooperative members are more knowledgeable about farm planning and resource use, which helps them make better use of resources

Table 1: Distribution of respondents according to socio-economic characteristics

Socio economic characteristics	Frequency	Percentage
Age group		
Below 30 years	5	4.4
31-40 years	22	19.3
41-50 years	50	43.9
51-60 years	34	29.8
Above 60 years	3	2.6
Sex		
Female	33	28.9
Male	81	71.1
Educational level		
No formal education	12	10.5
Primary education	2	1.8
Secondary education	34	29.8

Tertiary education	66	57.9
Household size		
1-3	50	43.9
4-6	50	43.9
7-9	8	7.0
10-12	6	5.3
Primary occupation		
Accounting	8	7.0
civil servant	2	1.8
Farming	64	56.1
Marketing	2	1.8
Medicine	3	2.6
Plumbering	12	10.5
Teaching	20	17.5
Trading	3	2.6
Years of fishing experience		
Below 5 years	95	83.3
6-10 years	18	15.8
11-15 years	1	.9
Source of capital		
Personal saving	49	43.0
Loan from bank	29	25.4
Cooperative society	25	21.9
Family or friends	11	9.6
Total	114	100.0

Source: Author computation, 2024

3.2 Profitability Analysis of Catfish Farming

The average cost (both fixed and variable) and yield statistics produced by each of the tested fish farmers for each cropping season were used to estimate the costs and returns of fish farming. The variable cost accounted for the biggest percentage (75.97%) of the overall cost of fish farming in the research area, according to the cost and return analysis in Table 2. This indicates that the majority of the money spent by fish farmers in the research area went toward buying fingerlings and fish feed. The cost of land (rent depreciation), water pump, concrete tanks, earthen pond, deep well, generator, building/shed, drag net, wheelbarrow, etc., made up 24.03% of the total cost of production. Additionally, the results indicate that an average total cost (TC) of ₦134334.1481 was incurred, while total revenue (TR) of ₦769128.5407 was realized. For every ₦1.00 invested, the respondents gained ₦1.75 kobo, with a gross margin (GM) of ₦656503.8000 and a net farm income (NFI) of ₦634794.3926. This result agreed with the findings of Ajagbe and Ojo-Fakuade, (2019); Aasa *et al.,* (2020) Alawode and Oluwatayo, (2019); Edet *et al*., (2018) when they noted that Fish farming is a profitable business.

Table2: Costs and returns of catfish farming in the study area.

Inputs	Mean
Feed cost	33177.77
Labour cost	1278.52
Fingerlin cost	12510.48
Fertilizer cost	70953.496
Transportation cost	4791.85
Drugs cost	2191.11
Chemical cost	2221.48
Total Variable Cost	112624.74
Land cost	8154.81
Pond cost	1240.74
Cutlass cost	1137.78
Hoe cost	1679.03
Basket	597.78
Shovel and spade	1059.26
Scale cost	4907.41
Headpan	762.96
Wheel barrow	2169.63
Total Fixed Cost	21709.41
Total cost	134334.15
Total revenue	769128.54
Gross margin	656503.80
Net income	634794.39
Profitability Index	0.75
Rate of return on investment	1.75

Source: Field survey, 2025.

3.3 Stochastic frontier production function analysis of catfish production

The coefficient estimates of fingerlings, fish feed, and fuel were positive and statistically significant at the 1% to 5% probability levels, according to the estimates of the parameters of the stochastic production frontier of the elasticity of output with respect to the different inputs in catfish production (Table 3). This suggests that raising these factors (fingerlings, fish feed, and labor) with positive coefficients will raise catfish production output. At the 1% level of probability, the $\sigma 2$ (0.68) and γ (0.42) were substantially distinct from zero. When compared to zero at 1%, the sigma squared (0.68) was substantially different. This shows that the distribution form anticipated for the composite error term fits well and is accurate. The amount of output variation brought on by the farmers' technological inefficiencies is indicated by the gamma estimate, which was 0.42. This indicates that technological inefficiency accounted for 42% of the variation in fish farmers' output.

Determinants of technical efficiency

Finding the sources of efficiencies among fish farmers in the research area is made easier by the prevalence of technical inefficiency. Table 3 displays the results of the model's estimation and consideration of socioeconomic variables. At the 1% level of significance, the theory that the fish farmers had no technical efficiency effects was disproved. When the variable is increased, efficiency either rises or falls, as shown by positive or negative signs on the coefficients.

The estimated coefficient for age (Z1) was negative and statistically significant at 1% level of probability. This suggests that older farmers are generally more productive when it comes to producing catfish. This supports the findings of Ikpozia *et al*., (2021), who discovered that technical efficiency rises with age. It is thought that as people mature and acquire more resources, their experience grows, increasing their efficiency. Household size (Z5) had a negative coefficient estimate that was statistically significant at the 5% level. This suggests that farmers with relatively large households are generally more efficient in producing catfish, which in turn lowers technical inefficiency.

Table 3: Maximum likelihood estimates of stochastic frontier production function of catfish farming in the study area

Variables	Coefficients	Standard Error	T-ratio
Constant	11.5763***	3.9502	2.9306
Fingerlings (Number)	4.1301***	1.6818	2.4558
Fish Feed (kg)	0.2054**	0.0972	2.1132
Labour (Man-days)	0.0963	0.0691	1.3936
Chemical (litre)	0.0417	0.0223	1.4700
Inefficiency variables			
Constant	0.2650	0.1941	1.3653
Age (Z1)	-0.0109***	0.0041	-2.6585
Education (Z2)	-0.0167	0.0123	-1.3577
Sex (Z3)	-0.0134	0.0141	-0.9504
Marital status (Z4)	-0.0573	0.0428	-1.3388
Household size (Z5)	-0.2166**	0.1024	-2.1152
Rearing experience (Z6)	0.1623	0.1581	1.0266
Variance parameters			
Sigma-squared ($\sigma 2$)	0.6804***	0.1082	6.2884
Gamma (γ)	0.4231**	0.2108	2.0071
log likelihood	104.6646		
Number of observations (n) = 114			

Source: Field survey, 2025. Note: 1% Significance level= ***, 5% Significance level= ** and 10% Significance level= *

3.4 Determinants of engagement in catfish production

The logit egression model was used to estimate factors that influence engagement in catfish production in the study area. The estimated coefficients of the model, along with the t-values are presented in Table 4. Gender of the respondents with male being a reference factor had an estimated coefficient of 4.964 and this implies that male gender was positively related to engagement in the fish farming in the study area than their female counterpart and statistically significant in line with *a priori* expectation at 10% probability level.

Educational level had an estimated coefficient of 0.814 and this implies that the educational level of the fish farmers was positively related to their engagement in fish farming in the study area and statistically significant in line with *a priori* expectation at 5% probability level. Therefore, the more educated the fish farmers, the more their engagement in fish farming as this will enhance the profit this is because the more educated the fish farmers, the better will be their managerial ability in handling the operations of their fish farms and also education enhances their ability to acquire technical knowledge with respect to adoption of technologies geared towards increasing their efficiency. Therefore, the educational level of the fish farmers can be exploited as an important policy variable towards enhancing the profit of fish farms in the study area. Availability of secondary occupation had an estimated coefficient of 0.001 and this implies that the presence of secondary occupation was positively related to engagement in fish farming in the study area and statistically significant in line with *a priori* expectation at 5% probability level. This implies that the more the number of the availability of secondary occupation the more the probability of engagement in fish farming in the study area.

Table 4: Logit regression analysis of determinants of engagement in catfish production in the study area

Variables	Coefficients	Standard Error	T-value
Constant	-9.852	3.807	-2.59
Sex	4.964	1.074	4.62***

Age	0.036	0.045	0.81
Educational level	0.814	0.420	1.94**
Family size	-0.011	0.194	-0.06
Monthly income	-1.600	0.000	-1.64
Secondary occupation	0.001	0,000	2,10**
Years of experience	0,045	0.179	0.25
Farm size	0.655	0.682	0.96

Source: Field survey, 2025. Note: 1% Significance level= ***, 5% Significance level= ** and 10% Significance level= *

3.5 Constraints to catfish farming in the study area

The results of the analysis in table 5 showed the constraints being encountered by fish farmers in the study area. Some of the constraints are inadequate credit facilities, government policy, high cost of transportation, high cost of labour, market competition, bad road, low demand, and high cost of inputs. Inadequate farm land, others are high cost of feed and market access problem

Table 5: Constraints to catfish farming in the study area

Constraints to fish farming	Frequency	Percentage
Inadequate credit facilities		
Strongly agreed	32	28.1
Agreed	44	38.6
Undecided	20	17.5
Disagreed	18	15.8
Government policy		
Strongly agreed	57	50.0
Agreed	49	43.0
Undecided	8	7.0
High cost of transportation		
Strongly agreed	36	31.6
Agreed	57	50.0
Undecided	19	16.7
Disagreed	2	1.8
High cost of labour		
Strongly agreed	25	21.9
Agreed	63	55.3
Undecided	17	14.9
Disagreed	9	7.9
Market competition		
Strongly agreed	26	22.8
Agreed	46	40.4
Undecided	31	27.2
Disagreed	11	9.6
Bad road		
Strongly agreed	42	36.8
Agreed	48	42.1
Undecided	17	14.9
Disagreed	7	6.1
Low demand		
Strongly agreed	29	25.4
Agreed	56	49.1
Undecided	18	15.8
Disagreed	11	9.6

Source: ***Field survey,2025***

Conclusion

Based on the findings of the study, it can be concluded that fish farming is profitable at various scales of production and can be a major source of income for both full and part-time fish farmers in view of the wide demand-supply gap for fish in the study area and Nigeria at large. This implies that vast opportunities exist in fish farming for employment especially for the teeming unemployed youths in the study area. Given the current level of technology at the disposal of the fish farmers, they have a scope of improving on their current level of technical efficiency through efficient utilization of their available resources. The catfish farmers in the study area were facing some challenges in their production, Some of the challenges are inadequate credit facilities, government policy, high cost of transportation, high cost of labour, market competition, bad road, low demand, and high cost of inputs. Inadequate farm land, others are high cost of feed and market access problem .These challenges can be solved by; i. Catfish farmers should enhance their technical expertise in catfish production by participating in seminars and workshops, particularly focusing on the efficient utilization of resources in the production process

ii. The government ought to promote financial institutions to extend loans to active and registered catfish farmers at reasonable interest rates, accompanied by appropriate oversight.

iii. To manufacture high-quality and reasonably priced catfish feed and drastically lower farmers' production costs, it is also necessary to find locally accessible and reasonably priced fish feed ingredients or raw materials to substitute the pricey fish meal.

Declaration of conflict of interest

The authors have collectively contributed to the conceptualization, design, and execution of this journal. They have worked on drafting and critically revising the article to include significant intellectual content. This manuscript has not been previously submitted or reviewed by any other journal or

publishing platform. Additionally, the authors do not have any affiliation with any organization that has a direct or indirect financial stake in the subject matter discussed in this manuscript

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