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Profitability and determinants of output in catfish (*Clarias gariepinus*) production in South-East, Nigeria

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Abstract
This study investigated the profitability and determinants of output in catfish production in Southeast, Nigeria. The specific objectives were to estimate the costs and returns of catfish production, identify the determinants of output of catfish production, and identify the constraints faced by catfish farmers in the area. Multi-stage and snowballing sampling procedures were adopted in the selection of 384 respondents who participated in the study. The results showed that the gross margin, net income, return on investment, capital turn-over/benefit cost ratio and gross ratio were N452.64, N439.39, 34.4, 1.34 and 0.74 respectively (per kg of fish). In comparison, the total revenue showed a significant difference from the total cost at 1% level of probability indicating a significant profit level. The findings on the production function revealed that only quantity of fingerlings and quantity of fuel had significant impacts on the quantity of output, while the cost function showed that quantities of fingerlings, fuel, labour and feed had significant impacts on the total cost of production. Lastly, high cost of feed, high cost of fuel & poor electricity, insufficient finance/capital, and poor quality of feed ranked 1st to 4th among constraints militating against catfish production in the area.

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Keywords: Profitability, output, catfish production

Introduction

Fish production in Nigeria accounted for 55% of its apparent total fish consumption with the remaining 45% covered by its net import (i.e. import minus export) of fish (WorldFish, 2018) [24]. Nigeria remains a net importer of fish with over USD 811 million in annual imports of fish and fish products as estimated in 2018 (FAO, 2021). Furthermore, FAO, (2020) stated that aquaculture production in Nigeria is expected to grow by 4.5 times between 2020 and 2050. On the other hand, Phillips *et al*., (2020) stated that the growth will not meet the demand which is anticipated to grow by 4.0kg/person/year. Consequently, FAO, (2020) stated that low supply relative to demand hinders adequate access to and consumption of fish, thereby aggravating food and nutrition insecurity, with malnutrition still remaining a major concern in Nigeria. This demand and supply gap enumerated above, according to World Fish (2018), can only be bridged by sustainably increasing the growth rate of the sector and, it would not only increase production and consumption, but would also lead to higher youth employment, increased household income, improved nutrition and reduced child mortality.

However, despite the widening demand and supply gap reported above, catfish production in Nigeria, especially the Southeast zone of Nigeria has continued going southwards. This is evident in the increasing number of abandoned fish farms in the zone coupled with the influx of catfish in both fresh and dried forms into the zone from other parts of the country and beyond. As observed by the researcher; while the fresh ones were mostly supplied from the Southwest, most of the dried ones came from the North. This could be part of what informed Digun-Aweto and Oladele, (2017) [7] who reported a decline in aquaculture production in Nigeria, and increasing withdrawal of farmers from fish farming in favour of other agricultural ventures. The reason for this could be attributed to the decreasing profitability of catfish production, low quality of fish feeds and seeds, poor management of inputs leading to inefficiency. Although one could take these as general problems of catfish farms in Nigeria, the Southeast zone seemed to be the worst hit. Therefore, to close the demand and supply gap of fish and its products in Nigeria especially in the Southeast zone, it is necessary to focus on the broad objective of the study. Specifically, the objectives were to:

Objectives of the study

1. Estimate the costs and returns of catfish production in the area;
2. Identify the determinants of output of catfish production in the area;
3. Identify the constraints faced by catfish farmers in the study area.

Materials and Methods

Area of the study

This study was carried out in the South East zone of Nigeria. The zone is one of the six zones of Nigeria representing both a geographical and political zones of the country. The zone is bounded by the River Niger on the west, the riverine Niger Delta on the south, the flat North central region to the north, and Cross River State on the east. The zone is located at Latitudes $4^{o}30^{1}$ and $7^{o}30^{1}$ North of the equator and longitudes $6^{o}45^{1}$ and $8^{o}45^{1}$ East of the Greenwich Meridian with a total land area of ten million, nine hundred and fifty-two thousand, four hundred hectares (10,952,400 ha), (Ibeje and Ekeleme, 2020). The zone has a population of about thirty-six (36) million people (97.3% of who are of Igbo ethnicity and language), around 18% of the total population of the country. Aba and Enugu are the most populous cities in the zone as well as the tenth and fourteenth most populous cities in Nigeria. Other large South-eastern cities include (in order of population) Onitsha, Umuahia, Owerri, Nnewi Awka and Abakaliki (World Population Review, 2022).

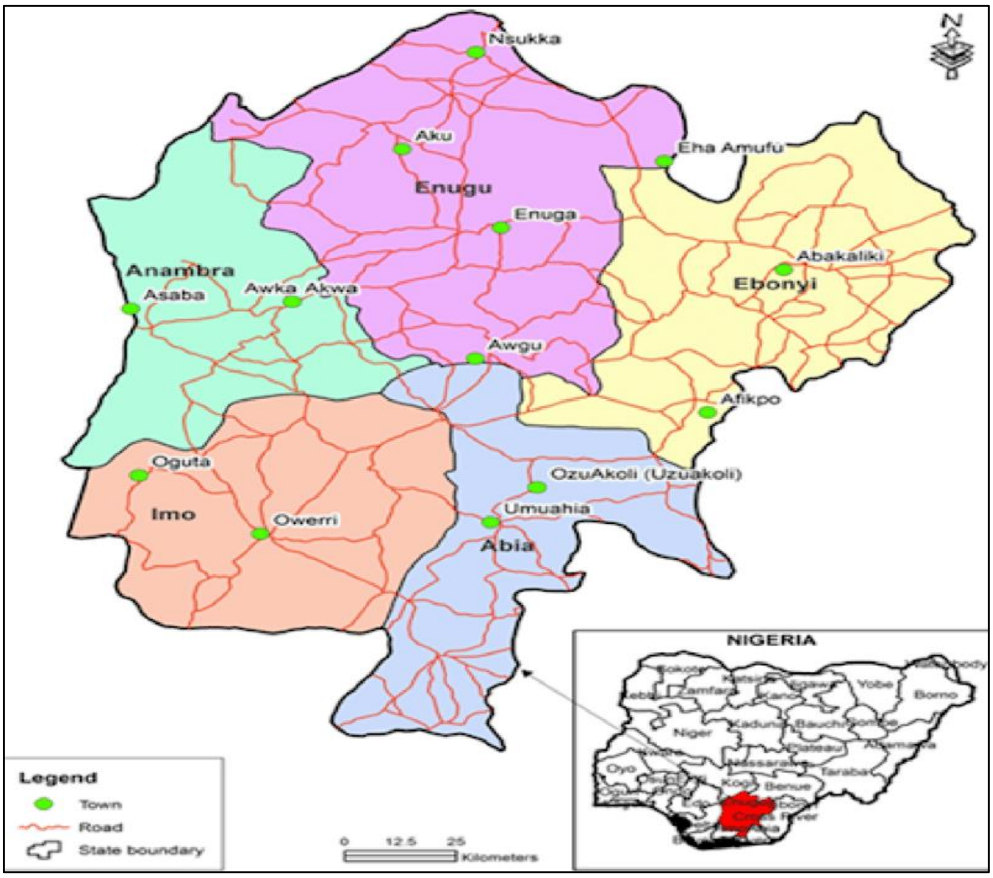

Fig 1: Map of Southeast, Nigeria

Sample size determination

The 'Cochran's' formula for infinite population was utilised in arriving at the sample size as the population of catfish farmers in the zone were unknown.

'Cochran's' formula for infinite or unknown population stated as follows:

$$n = \frac{Z^2 \times p(1-p)}{\epsilon^2} \qquad \text{(eqn. 1)}$$

$$n = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384$$

Where:
n = sample size
z = z score (based on 5% error margin)
p = population proportion (50%)
ϵ = margin of error (confidence interval, 95%).

Sampling procedure

Multi-stage sampling procedure was used for the study. In the first stage, Anambra, Imo and Abia States were randomly selected from the five states in the zone which included Enugu and Ebonyi States. Secondly, a total of nine (9) LGAs were randomly selected (3 from each state). The third stage was the purposive selection of thirty-six communities (four from each LGA) with significant history in catfish production. Lastly three hundred and eighty-four (384) respondents were randomly selected from the thirty-six communities.

Data collection

The study utilised questionnaire designed and structured to consist of opened and closed ended questions. This was made for uniform responses, and to enable the respondents contribute effectively with minimum restrictions and minimised bias. Six trained research assistants aided data collection which was done between October and November, 2023.

Data Analysis

Gross margin: the gross margin was estimated as total revenue less total variable cost. Mathematically, it is stated as

$$GM = TR - TVC \quad \text{(eqn. 2)}$$

Net Revenue Analysis: the net revenue of the farmers was computed as:

Net Revenue = Total Revenue – Total Cost (eqn. 2)

Where: Total revenue (N) = amount generated from sales of the outputs (table sized catfish)

Total cost (N) = Total variable cost (costs of the inputs used) + Total fixed cost (depreciation of fixed assets).

Source: Ezeano and Ohaemesi (2019).

i. Profitability Ratios:

$$\text{Profitability index (P.I.)} = \frac{\text{Net Profit}}{\text{Total Cost}} \quad \text{(eqn. 3)}$$

a. $$\text{Return on investment (RoI)} = \frac{\text{Net Profit}}{\text{Total Cost}} \times \frac{100}{1} \quad \text{(eqn. 4)}$$

Source: Ezeano and Ohaemesi (2019).

b. $$\text{Benefit cost ratio (BCR)} = \frac{\text{Total Revenue}}{\text{Total Cost}} \quad \text{(eqn. 5)}$$

c. $$\text{Gross ratio} = \frac{\text{Total cost}}{\text{Total revenue}} \quad \text{(eqn. 6)}$$

d. $$\text{Fixed ratio} = \frac{\text{Total fixed cost}}{\text{Total revenue}} \quad \text{(eqn. 7)}$$

e. $$\text{Operating ratio} = \frac{\text{Total variable cost}}{\text{Total revenue}} \quad \text{(eqn. 8)}$$

Source: Olorunwa, (2018).

Objective 2 was achieved using maximum likelihood estimation

The Cob- Douglas stochastic frontier production function is specified in its explicit form as:

$$InY1 = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + V_i - U_i \quad \text{(eqn. 9)}$$

Where:

In =Logarithm to base e, Y = Output of catfish (kg), β_0 = Constant

$\beta_1 - \beta_6$ = Parameters estimated, X_1 = Fingerlings (Number), X_2 = Fish feed (kg)

X_3 = Labour (Man-days), X_4 = Drugs (litres), X_5 = Fuel (litres)

V_i = Random noise (white noise), U_i = Inefficiency effect which are non negative with half normal distribution.

It is assumed that inefficiency effects are independently distributed and Ui arises by truncation (at zero) of the normal distribution with mean Uij and variance δU^2.

The Cobb-Douglas stochastic frontier cost function is stated as follows:

$$lnC_i = \beta_0 + \beta 1lnX_1 + \beta 2lnX_2 + \beta 3lnX_3 + \beta 4lnX_4 + \beta 5lnX_5 + V_i + U_i \quad \text{(eqn. 10)}$$

Where:

lnC_i = Value of the catfish output for the ith farmer,

X_1 = Cost of fingerlings (₦), X_2 = Cost of fish feed (₦), X_3 = Cost of labour (₦)

X_4 = Cost of Drugs (₦), X_5 = Cost of Fuel (₦)

β = vector of the coefficients for the associated independent variables in the cost function,

U_i = one sided component, which captures deviation from frontier as a result of inefficiency of the firm,

V_i = effect of random stocks outside the catfish farmer's control, observation and measurement error and other stochastic (noise) error term.

Lastly, objective 3, constraints faced by the farmers, was achieved with descriptive statistics ranging from frequency, percentage and mean.

Results and Discussion

Costs and return (profitability) of catfish production

Total variable cost of Catfish Production

Total variable costs are considered normal cost or operating cost of a firm. They are expenses that vary or change in proportion to the activity of a business venture. It is the total expenses associated with the production of catfish from fingerlings to table size that vary in direct proportion to the quantity of catfish produced. For this study, total variable cost includes cost of fingerlings, feed, labour, drugs and chemicals used in washing and disinfecting the ponds to prevent breeding of pathogens.

Table 1: Average Costs and Return for Catfish Production

Category	Value per kg (N)	Value per farmer	% of TC
Variable cost			
Fish seed/fingerlings	40.74	101,850.00	3.19
Fuel	93.50	233,750.00	7.32
Drugs and chemicals	5.42	13,550.00	0.42
Feeding	1,121.17	2,802,925.00	87.81
Labour	2.78	6,950.00	0.22
Total variable cost	1,263.61	3,159,025.00	98.96
Total fixed cost (depreciation)	13.25	33,125.00	1.04
Total cost	1,276.86	3,192,150.00	100.00
Total revenue	1,716.25	4,290,625.00	
Gross margin	452.64	1,131,600.00	
Net revenue/profit	439.39	1,098,475.00	
Z test result	6.00***		

Source: Computed from field survey, 2023

From table 1.0, it is shown that the farmers' stocking density ranged from 500 to 5,000 with an average stocking density of 2,500 fingerlings per farm. From the results of budgetary analysis as shown on table 1.0, it is shown that it costs a farmer N1, 263.61 (98.96% of total cost) to rear a fish to 1 kilogram. This is similar to the findings of Meliko, Ngoh and Okolie, (2021) [17] that the variable costs of all catfish production systems were more than 50% to total cost. Furthermore, it is revealed that cost of feed accounted for (87.81%) of the total cost, followed by fuel/water (7.32%), fingerlings (3.19%), drugs and chemicals (0.42%), and labour (0.22%). Amount spent on the feed input accounted for the largest proportion of the total cost. This could be because the farmers relied solely on purchasing bagged feeds at exorbitant prices due to little or no availability of alternative sources of fish feed. This is similar to the findings of Idris-Adeniyi, Busari, Badmus, and Adeniyi, (2018) who reported that feeding accounted 83.63% of the running cost of catfish production, and according to them, optimum output in fish production is highly dependent on standard feeding regime, implying garbage in; garbage out. In the descending order of percentage contribution, next is cost of fuel/water which accounted for 7.32%. This is reasonably high, and could be linked to the recent removal of subsidy from premium motor spirit (PMS) (otherwise called petrol) by the Federal government as most of the farmers relied on generators for either impounding water or flushing water from their ponds due to low availability of electricity.

This is followed by cost of fingerlings (3.19%) which can indirectly be linked to high cost of water and feed in raising the fish seeds from hatching stage (fries) to the fingerling, post fingerling or juvenile stage depending on the need of the farmer. Cost of drugs and chemicals was relatively low; contributing (0.42%) to total cost. This could be because disease occurrence was less frequent and only few of the farmers saw the need to use drugs and disinfectants. Labour was sourced from both family and hired source. Family labour was evaluated using the principle of opportunity cost and with the assumption that it served as a perfect substitute for hired labour. Therefore, the estimated cost for family labour equalled the prevailing wage rate of hired labour. From the table, the contribution of labour cost to total cost was low (0.22%). This could be due to high use of unskilled labour by many of the farmers.

Total fixed cost of catfish production

Total fixed cost refers to cost of production that does not vary with variations in the quantity of output produced by a firm in the short run. In this study, total fixed cost comprised of depreciations of the cost of pond construction, borehole, water pumps, generators, reservoir/water tanks, fishing equipment such as net, sieve, buckets, bowls, sorting tray, etc. accounting for 1.04% of the total cost. This is an indication that the farmers' operations were more traditional because they had little investment in infrastructures/modern technologies. This is a departure from Asa and Obinaju, (2014) [4] who reported that the costs and returns analysis showed that the fixed cost constituted 65.37% of the total cost of catfish production.

Average Costs and Returns of Catfish Production

The profitability of any business can be deduced from the relationship between cost of running the business and the returns accruing to it. Table 1.0 also shows the average costs and returns from producing and selling a kilogram of catfish in the study area. Total variable cost (TVC) was N1, 263.61, total fixed cost (TFC) was N 13.25 and the total cost (TC) amounted to N1, 276.86, while the total revenue (TR) generated from the sale of a kg of table sized catfish amounted to N 1, 716.25.

Gross margin

This is used to analyse the financial position of a firm at the end of a production cycle considering only the operating expenditure without putting into account, the depreciations from the fixed inputs.

Gross margin (GM) = TR – TVC
GM = N 1,716.25 – N 1, 263.61
GM = N 452.64.

Net farm income

Income is realized by catfish farmers from the sale of a harvested catfish at the end of a production cycle. Mathematically, it is calculated as total revenue less total cost. It is also calculated as gross margin less total fixed cost.

Net Farm Income (NFI) = TR – TC (GM – TFC).
NFI = N 1,263.61 – N 13.25
NFI = N 439.39.

The above result implies that N 439.39 is realised as profit from growing and selling 1kg of catfish in Southeast Nigeria. This amounts to N 1,098,475 per farmer in one production cycle. The z test result of 6.0 which was higher than the z tabulated value of 2.5 implies that the net farm income or profit of N 439.39 was significant at 1% probability level.

Profitability ratios for catfish production

1. Profitability index (P.I.) $= \dfrac{\text{Net Profit}}{\text{Total Cost}} = \dfrac{439.39}{1,276.86} = 0.344$

2. Return on investment $= \dfrac{\text{Net profit}}{\text{Total cost}} = \dfrac{439.39}{1,276.86} \text{ X } \dfrac{100}{1} = 34.412\%$

The above ratios show that for a naira invested in the production of catfish, about 34kobo was returned to the farmer as reward for management. This result is similar to that of Enwelu, Onuorah and Iyere-Freedom, (2023) [10] who recorded a return on investment of 28.77.

3. Benefit cost ratio (BCR) $= \dfrac{\text{Total revenue}}{\text{Total cost}} = \dfrac{1,716.25}{1,276.86} = 1.34$

This ratio implies that every ₦1 invested in catfish production yielded a cash flow of ₦1.34kobo. This is close to the findings of Ume, Ebeniro, Ochiaka and Uche, (2016) [21] and Ayanboye *et al.*, (2021) [5] that who both reported that catfish farming was found profitable with a benefit-cost ratio of 1.40 and 1.56 respectively.

4. Gross ratio $= \dfrac{\text{Total cost}}{\text{Total revenue}} = \dfrac{1,276.86}{1,716.25} = 0.744$

The implication of this is that 74% of the total revenue generated from the sales of the output in catfish production was used to pay off the entire costs incurred in the production. This is dissimilar with the findings of Ume, Ebeniro, Ochiaka and Uche, (2016) [21] who reported a gross ratio of 0.21.

5. Fixed ratio $= \dfrac{\text{Total fixed cost}}{\text{Total revenue}} = \dfrac{13.25}{1,716.25} = 0.008$

This ratio indicates that less than 1% of the total revenue could pay for the depreciation of the fixed assets used in the production.

6. Operating ratio $= \dfrac{\text{Total variable cost}}{\text{Total revenue}} = \dfrac{1,263.61}{1,716.25} = 0.74$

This shows that about 74% of the total revenue paid off the operating variable costs.
The above results showed that catfish production in the area was profitable, and conform to the reports of Onyekuru, Ihemezie and Chima, (2019), Aasa, Usman, Balogun and Yahaya, (2020) [1] and Enwelu, Onuorah and Iyere-Freedom, (2023) [10] who reported that catfish production was profitable.

Determinants of Output in catfish production

Table 2: Final maximum estimate of the production function

Covariates (Intercept)	Estimate 7.681	Std. error 0.632	Z-value 12.16***
Log Fingerling (No)	0.082	0.035	02.32**
Log Fuel (litre)	-0.086	0.045	-1.90*
Log Drug & disinfectants	-0.016	0.030	-0.55
Log Man/days	-0.012	0.053	-0.23
Log Feed (kg)	0.021	0.046	0.47
Sigma^2	0.252	0.023	11.11***
Gamma	0.895	0.020	45.48***
Log-likelihood		98.85378	

Source: field survey 2023

The coefficient of fingerlings had the desired positive effect on output, and is statistically significant at 5% probability. This implies that increases in the number of fingerlings stocked by the farmers increased the yield of catfish. Fingerlings are known to be one of the most critical inputs in fish production due to the fact that output depends on the quantity and quality of the fingerlings stocked. This result shows that it is an important factor in explaining changes in the output of the farmers. This finding was similar to that of Okoror, Izekor and Ijirigho (2017) [18], and Ume and Ochiaka (2016) [21] who found that quantity of fingerlings had positive and significant effect on the output of catfish production in Edo and Anambra States.

The coefficient of fuel for impounding and or flushing water from the pond was inversely related to output. This indicates that the more the farmer flushes and impounds water in the pond, the less the output. This is against popular opinion that frequent changing of water for the fish in the pond increases their performance and yield. This inverse relationship could be due to fish that are lost from the pond during the process of flushing the pond water in some farms due to poor handling. This finding was, significant at 10% probability level.

The coefficient of drugs and chemicals used in treating the fish and disinfecting the ponds respectively was also of inverse effect to output. This implies that as the quantity of drugs and chemicals used in production increased, output of catfish decreased. This is against expectation as drugs and output were supposed to relate positively. However, this may be as a result of inappropriate usage of the input. This could also be because farmers used drugs and disinfected their ponds only during disease outbreak when they must have lost some fish. However, only few of them disinfected their ponds with good disinfectants before stocking their ponds. This effect was also statistically insignificant.

The coefficient of labour also had inverse effect on output. This could stem from engaging labourers with little or no knowledge of catfish production to work in the farm without proper supervision. This effect was also statistically insignificant. This report disagrees with the findings of Abasiekong, Ogban, and Idiong (2021) [2] who reported that labour had significant positive effect on the output of catfish production.

The coefficient of feed has the expected positive relation with output, implying that increases in the quantity of feed fed to the fish increased their yield. This is in line with the expectation that feed has the most significant contribution in catfish production; and its variation directly affects the yield of catfish. This result suggests that optimum levels of feed utilization under the current scale of fish production in the area was yet to be reached, implying that further additions to the variable will move the production close to the optimum level. The coefficient was, though, insignificant. This result agrees with the findings of Abasiekong, Ogban, and Idiong, (2021) [2], who reported that quantity of feed had positive effect on the output of catfish production in mobile, concrete and earthen pond systems.

These findings were similar to the results of Unekwu, Adah and Salami (2017) [22] that feed and fingerlings related positively and significantly with catfish output; and that of Usman *et al*., (2023) [23], that fuel and antibiotics had no statistical significance with output.

The variances of the model presented in table 4.3 implies conformity to the expectation of the model as sigma-square (δ2) and gamma (γ) were both positive and significant at 1% levels of probability. This indicates a good fit and the correctness of the specified distribution assumption of the composite error term. Therefore, the stochastic frontier function estimated by using the Maximum Likelihood Estimation procedure is adequate for the data. The magnitude of the variance ratio (gamma statistics) of 0.895 (close to 1) shows that only 10.5 % (100 – 89.5) variations in output was due to the presence of the inefficiency factors in the model; implying low inefficiency.

Table 3: Final maximum estimate of the cost function

Covariates	Estimate	Std. error	Z-value
(Intercept)	13.550	0.199	68.00***
Log fingerlings	0.073	0.009	8.12** *
Log fuel	0.065	0.008	8.63***
Log drugs & disinfectants	0.004	0.007	0.57
Log labour	-0.012	0.011	-9.06***
Log feed	0.070	0.003	21.93***
Log output	-0.021	0.023	-0.91
Sigma^2	0.331	0.021	16.01***
Gamma	1.000	0.000	14.50***
Log-likelihood		-58.2814	

Source: field survey 2023

From table 3.0, it is shown that the coefficient of fingerlings has the expected positive effect on output. This is an indication that increases in the number of fingerlings stocked in the pond lead to an increase in the cost of production. This is in line with a priori expectation because fingerlings are a very crucial input as they are the seeds upon which production is built and output depended. Cost of fingerlings was statistically significant at 1% alpha level indicating the importance of fish seeds in catfish farming. The coefficient of fuel, as expected, is positively signed. This is an indication that increases in the cost of fuel increased production cost.

This could be due to the high dependence of the farmers on the fuel for impounding and or flushing water from the ponds as petrol is now very costly as a result of the subsidy removal by the Nigerian government. This result is also statistically significant at 1% alpha level.

Table 3.0 also shows that, the coefficient of drugs and disinfectants also, as expected, related positively with production cost. This implies that a unit increase in the quantity of drugs and disinfectants increased production cost by 0.004. This positive effect is expected because of the importance of drugs in improving the wellbeing of the fish, and disinfectants in preventing the buildup of pathogenic organisms in the ponds especially the mobile and concrete ponds. This coefficient was, however, insignificant because, as revealed by the study, many of the farmers used drugs less often while earthen pond farmers didn't use disinfectants. The coefficient of labour has inverse effect on the cost of production. This implies that as the number of family labour employed in the farm operation increased, cost of production decreased. This could be because since the hired labourers employed by farmers in the area were mostly unskilled, family labour could easily be a replacement thereby reducing cost. This result was significant at 1% probability level. The coefficient of feed is positively related to cost of production. This is in conformity to the expectation that, feed is a very important input which, if other inputs are kept constant, determines the yield of the fish. This result is also significant at 1% probability.

These results agreed with the findings of Kadurumba, Emma-Ajah, Njoku, and Okezie, (2021) [16], that costs of labour and fingerlings significantly influenced management and production of catfish. It, however, disagreed with them that cost of drugs was significant.

The parameter estimates of the stochastic frontier cost function for catfish farmers in the study area are as presented in table 3.0. The variance parameter estimates for both sigma-squared (δ2) and gamma (γ) were positive and significant at 1% levels of probability. The gamma (γ) coefficient of 1.000 means that there was no cost inefficiency effects in catfish farming in the area.

Constraints faced by catfish farmers

There are challenges that militate against every agricultural production. These challenges end up affecting the yield of the production. Catfish production is not left out in this as these constraints have, over the years, negatively affected the output of fish production in Nigeria resulting in inability of the farmers to meet the demand for fish which resulted to over reliance on the importation of fish and fish products. These constraints are presented in table 4.0 and ranked according to their magnitude. From table 4.0, it is shown that among all the constraints faced by the farmers, high cost of feed ranked highest (100%) as all the farmers concurred that it was a problem. Feed is one of the major inputs in catfish production upon which output depends greatly. Although fish feed has always been high, but it became overbearingly costly in recent times. This can be attributed to low availability of raw materials/ingredients required for its production due to the high rate of insecurity (especially the farmers herders crisis) ravaging the country. This result conforms to the reports of Ogenyi (2015), and Enwelu, Onuorah and Iyere-Freedom (2023) [10] that high cost of feed was a very important problem in catfish production.

Table 4: Distribution of constraints experienced by the respondents

Constraints	Frequency	%	Rank
High cost of feed	384	100.0	1st
High cost of fuel & poor electricity	334	87.0	2nd
Insufficient finance/capital	286	74.4	3rd
Poor quality of feed	204	53.0	4th
Low access to medication	156	40.5	5th
High cost of fish seed	135	35.2	6th
High cost of medication	119	31.0	7th
Theft	60	15.6	8th
Low access to good water	44	11.5	9th
Prevalence of diseases and high mortality rate	46	12.0	10th

Source: Field survey, 2023

High cost of fuel and poor electricity was a problem (ranked 2nd) agreed by 87% of the farmers. Apart from farmers who used earthen ponds, there seems to be no alternative means of accessing fresh clean water other than through the use of electricity. However, farmers in the study area still struggle with poor electricity supply which made use of fuel for generators inevitable. Catfish farming is a capital intensive agricultural venture to embark upon. This is because, it requires huge resources for pond construction, digging and equipping of boreholes or wells for water supply, purchase of feed, and other cost demanding inputs. Insufficient finance/capital is ranked 3rd among the farmers as it affected over 74% of them. This lack of capital explained why catfish farming in the area was largely traditional as the farmers lacked the resources to acquire technologies that would improve their efficiency level. This finding is also in line with the findings of Enwelu, Onuorah and Iyere-Freedom (2023) [10] that catfish farmers faced problem of insufficient capital.

Table 4.0 also revealed that 53% of the farmers complained about dwindling quality of feeds in the market, making the constraint rank 4th. This could be linked to low availability of raw materials available in the market causing some feed producers to supplement the unavailable raw materials with available inferior ones. This could also be linked to high cost of quality feeds which were beyond the reach of some farmers. This could have caused them to go for the substandard and less expensive ones.

The rest of the constraints ranking 5th to 10th were of little magnitude as majority of the farmers did not complain about them.

Conclusion

In conclusion, the gross margin, net income, return on investment, capital turn-over/benefit cost ratio and gross ratio were N452.64, N439.39, 34.4, 1.34 and 0.74 respectively (per kg of fish). In comparison, the total revenue showed a significant difference from the total cost at 1% level of probability indicating a significant profit level.

The findings on the production function revealed that only quantity of fingerlings and quantity of fuel had significant impacts on the quantity of output, while the cost function showed that quantities of fingerlings, fuel, labour and feed had significant impacts on the total cost of production.

Lastly, high cost of feed, high cost of fuel & poor electricity, insufficient finance/capital, and poor quality of feed ranked 1st to 4th among constraints militating against catfish production in the area.

Recommendations

Based on the findings of this study, the following were, therefore, recommended:

a. Since catfish production was a profitable venture, youths, with their vibrancy are encouraged to increase their participation in the enterprise to harness the huge profit potentials.
b. Farmers are encouraged to increase their scale of operation so as to minimise cost, and benefit from economies of scale.
c. As many of the constraints seem to be beyond the farmers' control, policy makers and government at all levels should consider loans, grants and or subsidies to help ameliorate and cushion the effects of the constraints.

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