

## DETERMINANTS OF OUTPUT AND PROFITABILITY OF FISH FARMING IN OYO STATE, NIGERIA

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### ABSTRACT

The study examined the determinants of output and profitability of fish farming in Oyo State, Nigeria. A total of 160 respondents were selected using the sampling frame of the fish farmers available. Primary data were collected using a structured questionnaire. Both descriptive and inferential statistics were employed for the study. The mean age of respondents was 46 years. The majorities were male (65%), average years of educational attainment were 15 years of schooling, and the mean farm size of the fish farmers was 2.5 acres. The results revealed that rates of return on investment are more than 1 for fish production enterprises. This implies that for every naira invested in fish production, the farmer would realize ₦1.31 from the fish enterprise. This performance measure indicates that fish farming enterprise is viable and that the business is profitable. The determinants of output of fish farming in the study area are production system ( $P < 0.05$ ), number of fingerlings ( $P < 0.05$ ), quantity of feed ( $P < 0.05$ ), quantity of lime ( $P < 0.05$ ), quantity of fertilizer ( $P < 0.05$ ), educational level ( $P < 0.05$ ), income ( $P < 0.05$ ) and cooperative membership ( $P < 0.05$ ). The study concluded that various factors determine the output of African catfish (*Clarias garipinus*) farmers and that the business is profitable. The study recommends training, workshops, and seminars for African catfish farmers on how they could have easy access to land, feeds at affordable rates, and sources of funds at minimal interest rates.

**Keywords:** benefit cost ratio, fish production, pond systems, return on sales

### INTRODUCTION

Over the past three decades, aquaculture has experienced unprecedented growth and has emerged as the fastest-growing food-producing sector on the global scale (Bostock and Seixas, 2015). The significance of this development cannot be overstated. It is truly remarkable to witness how aquaculture has evolved into a crucial source of protein for people worldwide, accounting for over 30% of the fish consumed. Equally astounding is the fact that aquaculture has now surpassed wild-caught fisheries as the primary source of fish protein (Golden *et al.*, 2017). Global fisheries and aquaculture production in 2022 surged to 223.2 million tonnes, a 4.4 per cent increase from the year 2020. Fish production comprised 185.4 million tonnes of aquatic animals and 37.8 million tonnes of algae (FAO, 2024). Global aquaculture production reached an unprecedented 130.9 million tonnes, of which 94.4 million tonnes were aquatic animals, 51 per cent of the total aquatic animal production (FAO, 2024). This rapid expansion has presented challenges, particularly in terms of environmental impact, prompting calls for sustainable intensification to enhance the productivity and environmental sustainability of aquaculture (Waite *et al.*, 2014; Henriksson *et al.*, 2018).

The rapid expansion of the aquaculture industry has been made possible by the continuous growth of

aquaculture production areas (Oyinlola *et al.*, 2018), intensification of production systems, adoption of innovative technologies, and systematic enhancement of existing technologies that have brought about control over husbandry and production processes (Kumar and Engle, 2016; Henriksson *et al.*, 2018; Kumar *et al.*, 2018). Aquaculture presents significant opportunities for technical innovation to further enhance animal protein supply and resource efficiency (Waite *et al.*, 2014). Over the last five decades, advancements in production and breeding systems, feeds and nutrition technology, vaccines, species and strain selection, reproductive control, mechanical aeration, and water exchange, as well as non-technological innovations such as improved regulatory frameworks, market and certification standards, among others, have facilitated the growth of the aquaculture sector (Kumar and Engle, 2016). Recent research indicates that investments in new production systems, management practices, and products have substantially benefited producers and consumers (Kumar and Engle, 2016; Kumar *et al.*, 2018). Nonetheless, there is still a need for a more comprehensive understanding of technological change in aquaculture development in Africa. Despite Africa having the fastest-growing aquaculture industry with high biophysical potential, the sector still needs to make a significant

contribution to sustainable food supplies and economic development (Brummett *et al.*, 2008; Waite *et al.*, 2014).

Like the rest of Sub-Saharan Africa, aquaculture development is constrained by the lack of good quality seed and feed, low technical capacity, poor market and value addition, inadequate extension services and materials, poor management of culture systems, low capacity in disease diagnostics and bio-security, and increasing competition from cheaper imported fish products (Mwima *et al.*, 2012; Rothuis *et al.*, 2011; Kaminski *et al.*, 2017). Feed is often the most significant cost item in aquaculture, offering opportunities for cost savings associated with reduced quality and performance. Most aquaculture production systems use farm-made or supplementary feeds ranging from single ingredients (such as fish bran, wheat bran, and maize bran) to a mix of ingredients, cooked or raw, as moist and dry formulated feeds (Munguti *et al.*, 2017; Amankwah *et al.*, 2016). Larger aquaculture operators often depend on commercially manufactured feeds purchased from several small or medium-sized feed mills in the region. In most cases, switching to imported feed delivers consistent performance.

Specifically in Nigeria, the soaring cost of imported fish feeds have led many small-scale fish farmers to abandon fish farming. Also, some of the challenges facing fish production in Nigeria are type of pond system, technology adoption, inadequate research and information usage. Decline in capture fisheries in Nigeria has put pressure on aquaculture as an alternative to meet increase in fish demand (Ashley-Dejo, 2012). Apart from these, the culture medium affects the profitability of fish farming. There is need for improving aquaculture sector in Nigeria so that the sector could increase fish availability. It is therefore crucial to establish a more robust policy and legal framework for fish production pond system, seed certification and to implement mechanisms for monitoring compliance with fish seed production, supply, and quality to ensure high performance. Although new technologies and innovations are being developed to guarantee a consistent supply of high-quality farmed fish to the markets, there is a need for faster and more effective uptake to achieve the transformational change outlined in the 2030 Agenda for Sustainable Development. Several studies have highlighted various factors influencing aquaculture output and technology adoption (Dey *et al.*, 2010; Wetengere, 2011; Kumar *et al.*, 2018).

Also, artificial lake, reservoir, or dam known as an "earthen pond or traditional pond system" was built to retain some aspects of the natural aquatic

environment for the purpose of breeding fish of various species (Marywil, 2022a). Contrarily, a concrete fish tank is built without preserving the natural aquatic habitat using the proper proportions of cement, sand, and blocks (Marywil, 2022b). Fish in earthen pond grow more quickly than in concrete tanks because the natural aquatic environment is preserved. Concrete tanks are simpler to maintain for feeding, counting, sorting, managing predators, and harvesting even though earthen ponds often have higher stocking capacities (Nonye, 2022). Consequently, there is a growing literature on the determinants of output and profitability of fish farming, particularly within the context of various pond production systems. Thus, this study aimed to describe the socio-economic characteristics of African catfish farmers; identify the type of fish production systems engaged in by the farmers; cost, returns and profitability analysis of fish production in traditional and improved pond production system and the determinants of output in fish production in the study area.

## MATERIALS AND METHODS

### *Study Area*

The research was conducted in Oyo State, Nigeria, an inland State in Southwestern Nigeria with its capital at Ibadan (Nenge, 2019). Oyo State has an estimated population of over 5,591,589 million (NPC, 2006) and is situated in the rainforest vegetation belt of Nigeria within specific latitudes 8°00N and longitudes 4°00 E. It is bordered by Ogun State to the South, Kwara State to the North, the Republic of Benin to the West, and Osun State to the East. Oyo State experiences a typical tropical climate with high temperatures, relative humidity, and two rainfall peaks during the period from March to October. The mean temperatures are highest at the end of the Harmattan, averaging 28°C, and during the rainfall months, average temperature range between 24°C and 25°C. Rainfall patterns vary across the State, with the Southern part experiencing heavier rainfall compared to the Northern parts. The tropical climate is conducive for the growth of various crops such as yam, maize, cassava, millet, plantain, banana, and rice, as well as for fish farming. To enhance food production, the Oyo State government established the Oyo State Agricultural Development Programme (OYSADEP) to disseminate improved agricultural technologies, including fish production, to farmers. The State is divided into four Agricultural extension zones: Ibadan/Ibarapa, Ogbomoso, Oyo, and Saki (Figure 1).

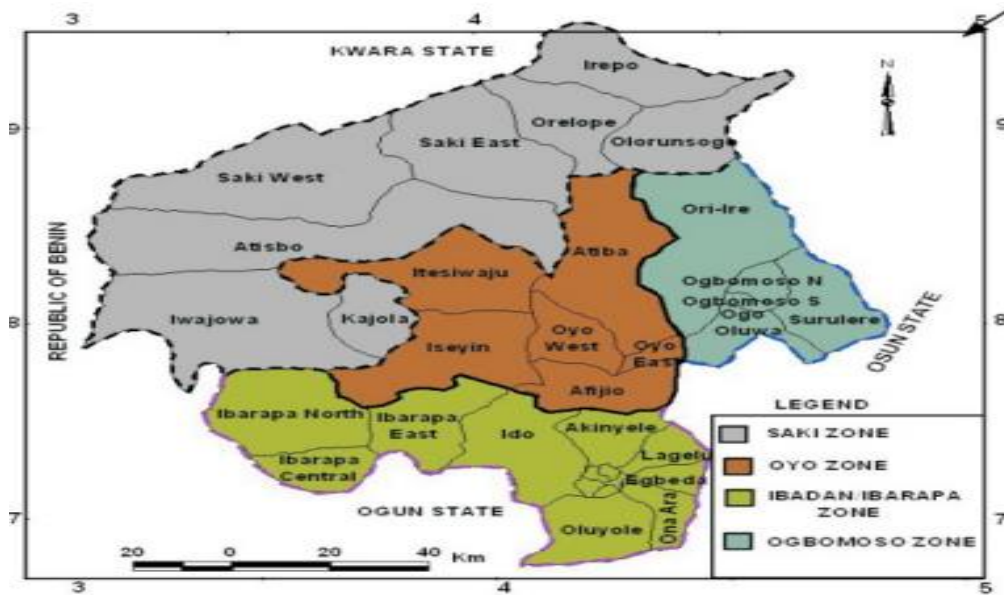


Figure 1: Map of Oyo State ADP showing zones and blocks  
Source: Ashley-Dejo, 2012.

**Sampling Procedure and Sample Size**

A multi-stage random sampling procedure was used to select African catfish farmers from the study area. The first stage involved a purposive selection of Oyo State in Southwest Nigeria due to increased aquacultural production in the study area based on pilot survey. The second stage involved the selection of four (4) Agricultural Development Programme (ADP) zones in Oyo States based on the predominance of catfish farmers in these zones. The third stage involved the purposive selection of two (2) extension blocks from each Agricultural Development Programme (ADP) based on the predominance of African catfish farmers in these extension blocks, making twelve (8) extension blocks in total. At the final stage, respondents were randomly selected from each cell (cells are different clusters of African catfish farmers within an extension block) proportionate to the population size of the cells. In all, 160 African catfish farmers were sampled in the study area.

**Sources of Data and Method of Collection**

The research data were obtained through primary sources, using a well-structured questionnaire from

the catfish farmers in the study area. The research instrument was pre-tested to ensure its validity and reliability. These catfish farmers included those who used traditional and modern pond production system in Oyo State. The questionnaires were administered to selected fish farmers in the study area for suitable information on socio-economic data, production data, and output data. Secondary data, on the other hand, were collected from relevant literature and textbooks to identified research gaps, chosen topic, objectives, selection of relevant dependent and independent variables.

**Data Analysis**

This study employed descriptive and inferential statistics. Descriptive statistical tools such as frequencies and percentages were used to analyze socio-economic characteristics of respondents and types of production systems. Budgetary techniques and profitability ratios were used to analyze profitability performance, and a linear regression model was used to analyze the determinants of African catfish production output. According to Oke *et al.* (2022), the equations for the different indices are provided below.

$$\text{Net fish farming income (NFFI)} = \text{Profit } (\pi) = \text{TR} - \text{TC} \dots\dots\dots (i)$$

$$\text{Gross Margin (GM)} = \text{TR} - \text{TVC} \dots\dots\dots (ii)$$

$$\text{Benefit-Cost Ratio (BCR)} = \text{TR/TC} \dots\dots\dots (iii)$$

$$\text{Return on Investment (ROI)} = \text{NFFI/TC} \dots\dots\dots (iv)$$

Where;

Total cost (TC) = Total Fixed Cost (TFC) + Total Variable Cost (TVC)

TR = Total Revenue (₦) = Output (Q) \* Price (P) = PQ

TVC = Total Variable Cost (₦)

TFC = Total Fixed Cost (₦). Thus, fish farming will be profitable provided NFFI and GM are positive, BCR >1, and ROI > 0.00 (Olaoye *et al.*, 2016). That is, fish farming is profitable if TR > TC.

*Linear Regression Model*

Linear regression model was used to analyze the determinants of catfish production output in the study area. The implicit model of the regression was specified as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9) \dots\dots\dots (v)$$

$$\text{Explicitly, it is given as: } Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \dots\dots\dots + \beta_9 X_9 + e_i \dots\dots\dots (vi)$$

Where:

- Y = The total fish output in kg
- X<sub>1</sub> = Production system (1 if improved system, 0 if otherwise)
- X<sub>2</sub> = Quantity of improved feed used in kg
- X<sub>3</sub> = Quantity of fertilizer used in kg
- X<sub>4</sub> = Quantity of lime used in kg
- X<sub>5</sub> = Labour in man-hour
- X<sub>6</sub> = Number of improved fingerlings stocked
- X<sub>7</sub> = Educational status (years of formal education)
- X<sub>8</sub> = Cooperative membership (1 if yes, 0 otherwise)
- X<sub>9</sub> = Household size (number of persons)
- β<sub>1</sub>... β<sub>9</sub> = Regression coefficients
- e<sub>i</sub> = Error term

Where:

- Y<sub>i</sub> is the dependent variable and X<sub>i</sub> (i=1 to 9) are independent variables,
- β are the parameters to be estimated,
- e<sub>i</sub> is the error term.

**RESULTS**

***Description of Socio-economic Characteristics Variables***

The findings of the socio-economic characteristic’s variables using the descriptive statistics along with the summary statistics are detailed in Table 1. The average age of the African catfish farmer was 46 years, and the majorities (69.4%) of the farmers were males. Additionally, most of the respondents (65%) were married, had 15 years of formal education, and with the mean farm size of the fish farmers was 2.5 acres. The average household size

was six persons per household, and had an average of seven years of fish farming experience. Moreover; the majority (60%) of the respondents had access to credit, such as bank loans, while approximately 40% relied on personal savings and friends for capital. Our study revealed that, on average, fish farmers had to travel nearly 5 kilometers to reach their fish farms. Furthermore, the land tenure system showed that the farmers owned about 45% of the fish farms, which is crucial in incentivizing investment and improvement of their own lands.

**Table 1: Description, measure and summary statistics of variables**

<b>Variab</b>	<b>Measure</b>	<b>Mean (SD)</b>
Age of the farmer	Years	46.0 (3.2)

Sex of the farmer	Dummy; 1 if respondent is a male and 0, otherwise	69.4 (0.12)
Marital status	Dummy; 1 if respondent is married and 0 otherwise	0.65(0.30)
Educational attainment	Years of schooling	15.7 (6.31)
Farm size	Acres	2.5 (2.0)
Household size	Number of persons living in the household	6.0 (1.2)
Access to credit	Dummy; 1 if respondent have access to credit, 0 if otherwise	0.60 (0.10)
Fish farming experience	Years of farming experiences	7.12 (3.0)
Distance from fish farm	Distance in kilometers	5.23 (2.41)
Fish farmers' association	Dummy; 1 if respondent belongs to association, otherwise 0	0.95 (0.22)
Tenure system	Dummy; 1 if respondent owned land, otherwise 0	45.23 (0.24)

Source: Field survey, 2024

**Types of Fish Production Systems Engaged in by Fish Farmers**

The findings regarding fish production systems and practices employed by the fish farmer are detailed in Table 2. The results indicate that the majority of respondents (56.3%) obtained fingerlings from commercial fish hatcheries. Furthermore, Table 2

reveals that most respondents had a fish culturing period of six to seven months (61.3%) and harvested their fish produce one to two times a year (40.6%-59.4%). Table 2 further revealed that majority (53.1%) of the respondents reared fish in the traditional pond system while only 46.9 percent of the respondents reared fish in improved pond system.

Table 2: Distribution of fish farmer respondents according to fish pond production systems

Production systems	Frequency	Percentage
<i>Source of Fingerlings</i>		
Own Fish Farm	70	43.7
Fish Hatchery	90	56.3
<i>Production Cycle (months)</i>		
4-5	60	37.5
6-7	98	61.3
>7	2	1.2
<i>Harvesting period/ year</i>		
Once/year	65	40.6
Twice/year	95	59.4
<i>Pond production systems</i>		
Improved pond system	75	46.9
Traditional pond system	85	53.1

Source: Field survey, 2024

**Gross margin and profitability analysis of traditional and improved catfish production pond systems**

Table 3 presents the average costs and returns per pond from the various pond production systems. The findings shows that the cost of feeds accounted for the largest proportion (68.6% and 77.4%) for traditional pond system (₦ 521,654.78/1100 fingerlings/6 months) and improved pond system (₦1,584,422.4/980 fingerlings/6 months) farmers due to high cost of feed. The result revealed that farmers using improved pond system incurred more money on feed when compare with the farmers using traditional pond system. This is followed by cost of fingerlings (15.4% and 25.2%) for the two pond production systems. Findings equally shows that large (15.4%) amount of money was spent by respondent using traditional pond system in the

study area for the purchase of fingerlings, while farmers using improved pond system, the cost of fingerlings were the largest (25.2%). From Table 3, it is observed that an average total variable cost (TVC) of ₦760, 179.11 and ₦2, 046,780.30 per pond were incurred by the farmers, while mean revenue per pond of ₦950, 632.41 and ₦2, 743, 802.57 were realized with an average gross margin per pond of ₦190, 453.30 and ₦ 697, 022.27 for the traditional and improved pond production systems. The t-test of mean result shows that there is a significant difference (P > 0.01) between the gross margin per pond size from the different pond production systems at the 1% level of significance (Table 4).

The results revealed that rates of return on investment are greater than 1 for fish production enterprises irrespective of their pond typology,

whether traditional or improved. This implies that on every one naira invested in fish production, the fish farmer would make a return of ₦1.14 and ₦1.20 from the different pond production systems. The mean return on sales per pond is 0.12 and 0.13, which implies that on every one naira earned from

sales, the fish farmer would have 12kobo and 13kobo respectively for traditional and improved pond production systems. These measures of performance indicate that fish farming enterprise in the study area is viable and the business is profitable.

**Table 3:** Gross margin and profitability analysis of traditional and improved fish pond production system

Items	Traditional (Mean Amount, ₦)	Improved (Mean Amount, ₦)
Variable cost	₦	₦
Fingerlings	191,828.95	315,423.77
Feed	521,654.78	1,584,422.4
Labour	30,844.62	73,909.89
Medication	1,510.63	3,410.29
Fuel	985.28	25,885.3
Electricity	908.25	5,598.04
Transport	3,766.04	5,680.88
Fertilizer	1,196.2	13,389.7
Lime	-	5,726.67
Maintenance	6,276.32	8,274.51
Miscellaneous	1,208.04	5,058.85
<b>Total Variable Cost (TVC)</b>	<b>760, 179.11</b>	<b>2, 046,780.30</b>
Total Fixed Costs (TFC)	75, 502.4	308, 502.59
Total Cost (TC)	835, 681.51	2, 355, 282.89
Total Revenue (TR)	950, 632.41	2, 743, 802.57
Gross Margin (GM) = TR-TVC	190, 453.30	697, 022.27
Profit = GM – TFC	114, 950.90	338, 519.68
BCR = TR / TC	1.14	1.21
ROS = NFFI/R	0.12	0.13

**Source:** Field Survey, 2024. ROS = Return on sales; BCR = Benefit Cost ratio

**Table 4:** T-test mean values of the gross margins in the two production pond systems

Production pond systems	N	Mean	Std. dev.	Minimum	Maximum	t-value
Traditional system	85	190,453.30	17, 950.85	120,253.11	257,790.23	0.000
Improved system	75	697, 022.27	157,762.12	250,245.20	960,895.45	

*Source:* Field survey, 2024

**Determinants of output among African catfish farmers**

The findings from the linear regression analysis regarding the determinants of output among catfish farmers in the study area are summarized in Table 5. The coefficient of multiple correlations (R) is 0.852 (85.2%), indicating a strong direct relationship between the explanatory variables and the fish farmers' output. The R-squared value (R<sup>2</sup>) is 0.751, signifying that 75.1 percent of the variability in the outputs of the respondents is collectively explained by variations in the specified independent variables in the model. The adjusted R-squared value is 0.691 (69.1%). The obtained F-value (15.12) demonstrates that the overall equation is statistically significant at the 1 percent level. Specifically, the coefficient of the pond production systems (0.4130) is positively and significantly related at 1 percent level, indicating that an increased in the use of improved pond production system would lead to a 0.4130 unit increase in African catfish output at the 0.01 significance level. The coefficient of the number of

fingerlings stocked by the farmers is also positively and significantly related at the 1 percent level, suggesting that an increase in the number of fingerlings stocked would result in a 0.068 unit increase in output at the 0.01 significance level. Furthermore, the quantity of feed shows a positive and significant coefficient at the 1 percent level, while the quantity of lime used demonstrates a negative and significant coefficient at the 1 percent level, indicating a decrease in output by 1.243 units at the 0.01 significance level with an increase in the quantity of lime used. However, the coefficient of the quantity of fertilizer used is positive and statistically significant at the 5 percent level, suggesting that an increase in the quantity of fertilizer used as per recommended rates would lead to a 10.021 unit increase in fish output at the 0.05 significance level.

The coefficient of education demonstrated a positive correlation with output, suggesting that well-educated farmers are likely to be more innovative and proficient in maintaining fish farm records.

Additionally, the coefficient for income was positively significant at the 5 percent level, indicating that an increase in fish farmers' income would result in a 0.03 unit increase in catfish output at the 0.05 significance level. The coefficient for cooperative membership also proved to be positive and statistically significant at a 5 percent level, signifying that increased participation in cooperatives would lead to a substantial 2.60 unit

increase in catfish output at the 0.05 significance level. Moreover, the coefficient for household size was positively significant at the 5 percent level, suggesting that an increase in the fish farmers' household size, which contributes to family labour, would result in a significant 4.1902 unit increase in output of African catfish production at the 0.05 significance level.

Table 5: Linear regression estimates of factors influencing fish farm output

Variables	Coefficients	Standard error	-t Stat	p-value
Constant	1503.85	187.13	8.0363	0.000*
Production pond system (1 if improved pond system, 0 if traditional)	0.4130	0.054	7.6481	0.000***
Fingerlings (No./kg/acre)	0.0689	0.0204	3.3774	0.006***
Feed (kg/acre)	6.4010	1.4412	4.4414	0.000*
Lime (kg/acre)	-1.2431	0.3242	3.8343	0.008*
Fertilizer (kg/acre)	10.0205	4.1433	2.4184	0.021**
Labour (man-hour)	1.6572	0.4135	4.0077	0.000*
Educational status (years of formal education)	0.8132	0.2043	3.9804	0.009*
Income	0.0030	0.0010	2.9032	0.006**
Cooperative membership (1 if yes, 0 otherwise)	2.6010	1.2113	2.1472	0.045**
Household size (number of persons)	4.1902	2.0014	2.0936	0.042**

Source: Field survey, 2024. Level of significant: \*\*\* signifies 1%, \*\* signifies 5%, \* signifies 10%. Multiple R = 0.8520, R<sup>2</sup> = 0.7510, Adjusted R<sup>2</sup> = 0.6910, F = 15.12

**DISCUSSION**

The average age of African catfish farmers was found to be 46 years, which is consistent with the findings of Okwu *et al.* (2011) who reported that most fish farmers are young and active, indicating that most fish farmers are in their economically active years. The majority of the fish farmers were male, suggesting that fish farming enterprises are male-dominated in the study area, supporting the observations of Okwu *et al.* (2011) who reported that most fish farmers are males. Approximately 65% of the respondents were married, indicating that most fish farmers have responsibilities that drive them to seek innovations for increasing their income and improving their standard of living. The mean farm size of the fish farmers was 2.5 acres, signifying that the average fish farmer is categorized as a smallholder according to Nigeria's official definition (less than 5 acres). This finding aligns with the study by Mgbenka and Mbah (2016), which reported that most fish farmers are smallholders. Moreover, the findings revealed that rates of return on investment are greater than 1 for fish production enterprises irrespective of their pond typology, whether traditional or improved. This implies that on every one naira invested in fish production the farmer would make a return of ₦1.14 and ₦1.21 from the different production systems. This measure of performance indicates that fish farming enterprise in the study area is viable and the business is profitable. This result agrees with the findings of

Oluseye and Damilola (2019) who reported that fish farming enterprise is viable and the business of fish farming was profitable.

The coefficient of pond production system was found to be positive and statistically significant at 1 percent level. This indicates that fish farmers using improved production pond system are more likely to achieve higher fish output compared to those using traditional system. This is consistent with the expectation, as they are more affected by predators, low standard feeding regimes, poor breeds of fingerlings, lack of inlet and outlet devices, and irregular changes of water. The coefficient of the number of fingerlings stocked by the fish farmers was also positive and statistically significant at the 1 percent level, aligning with the findings of Salau *et al.* (2014), who found out that quantity of fingerlings stocked, was significant. Furthermore, the quantity of feed had a positive coefficient and was significant at the 1 percent level, indicating that the output of fishes is influenced by the quantity of feed given to them, consistent with the findings of Adikwu and Yusuf (1997) and Tsue and Lawal (2012).

Moreover, the coefficient of the quantity of fertilizer used was positive and statistically significant at the 5 percent level, this is in agreement with the findings of Musaba and Namanwe (2020) that fertilizing fish ponds, even with chicken manure, increases fish production. Labour used also had a positive relationship with output and was significant at the 1

percent level, suggesting that an increase in the use of labour by the fish farmers in fish production increases the output by 1.6572 units at the 0.01 level of significance. Educational level similarly had a positive coefficient and relationship with output, implying that fish farmers with higher education levels can be more creative, innovative, and proficient in record-keeping, consistent with the findings of Olasunkanmi *et al.* (2012) and Lawal and Idega (2004) who reported that most education influenced adoption of new technologies in fish farming. The coefficient of cooperative membership was positive and statistically significant at the 5 percent level, indicating that cooperative membership accelerates the adoption of improved pond production system and thereby results in higher fish output, consistent with the findings of Wabbi (2002) and Salau *et al.* (2014), who reported that cooperative societies promote level of adoption of improved production system.

## CONCLUSION

The research examined several key factors that significantly influence farmers' output in African catfish production. These factors include the quantity of lime and fertilizer used, labour, the number of fingerlings stocked and cooperative membership. The study revealed that African catfish production is profitable and viable. Nevertheless, with improved pond production system, fish farming has the potential to become even more profitable and feasible in the study area. The study therefore recommended that there is need to expand and strengthen educational programs aimed at training African catfish farmers in fish farming and management practices especially in improved pond system. Additionally, farmers should be incentivized to join cooperative societies, providing them with access to training, workshops, seminars, land, funding sources at minimal interest rates and affordable fish feeds.

**AUTHORS CONTRIBUTION:** Oni T.S. designed the study; Adeoye, R. L. experimented and collected the data. Oni T.S. analyzed the data and interpretations. Adeoye, R. L. wrote the draft of the manuscript. All authors approved the manuscript for submission.

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