ECONOMICS OF CONCRETE POND CATFISH PRODUCTION IN OVIA NORTH EAST LOCAL GOVERNMENT AREA OF EDO STATE, NIGERIA

BY

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BENIN CITY

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CERTIFICATION

This is to certify that the research work on the Economics of concrete pond catfish production in ovia north east local government area of Edo State was carried out by Ogho Francisca Ogheneochuko with the Mat. No AGR2000030 under the supervision of the department of Agricultural Economics and Extension Services, Faculty of Agriculture, University of Benin, Edo State, Nigeria.

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Prof. J Egbodion **Date**
Project Supervisor

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Prof. J. Egbodion **Date**
Head of Department

DEDICATION

I wholeheartedly dedicate this research work to God Almighty, the source of wisdom, strength, and inspiration. His grace has guided me through every step of this journey. To Him be all the glory.

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With a heart full of gratitude, I give all thanks and glory to God Almighty, my source of wisdom, strength, and guidance. His grace has sustained me, His love has uplifted me, and His divine favor has made this journey possible. Through every challenge, He has been my refuge, and without His mercy, this research would not have been accomplished.

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constant support—emotionally, financially, and spiritually—has been invaluable, and I am forever grateful for her presence in my life.

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Above all, I return all the glory to God Almighty, who has been my guide, my strength, and my source of inspiration. To Him alone be all the praise!

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ABSTRACT

The catfish industry in Nigeria faces significant challenges including high production cost, low productivity, and limited profitability. Despite its potential, the industry has not fully explored the use of concrete pond for catfish production which could improve efficiency and reduce costs. This study investigated the socio-economic characteristics, profitability, and technical and allocative efficiency of concrete pond catfish production in the Ovia North East Local Government Area of Edo State, Nigeria, and identified key constraints faced by farmers. Data were collected from 113 concrete pond catfish farmers and analyzed using descriptive statistics, net profit analysis, and the Stochastic Frontier Analysis (SFA) model.

Socio-economic analysis revealed the enterprise is dominated by economically active males (62.83%) with a mean age of 44 years. A significant majority of farmers (69.91%) possess tertiary education, and 74.34% engage in full-time catfish farming. The cost and return analysis confirmed that concrete pond catfish production is highly profitable, yielding an average net profit of ₦599,386.39 and a strong Return on Investment (ROI) of 2.49 per production cycle, demonstrating high financial viability. The technical and allocative efficiency analysis showed that 95.28% of farmers operated at >90% efficiency, with a mean technical efficiency of 94.46%. However, the overall Returns to Scale (RTS) was -7.4534, indicating that the enterprise operates in an economically irrational region (Stage III) of production due to significant resource overuse. Technical efficiency was positively and significantly influenced by stock density and quantity of fingerlings, but negatively by fuel usage. Allocative efficiency was positively affected by the cost of fuel, feed, and fingerlings, but negatively by labor costs and depreciated fixed costs. Inefficiency models showed that increased age and pond size decreased allocative inefficiency, while increased experience, household size, and income increased technical and/or allocative inefficiency. The major constraint identified was the high cost of feed (Mean = 3.98), followed by disease outbreaks and theft.

The study concludes that while concrete pond catfish production is highly profitable, there is an urgent need to address resource overuse to move production into the rational efficiency stage. Recommendations include promoting optimal stocking density, investing in high-quality fingerlings, and providing targeted training to enhance feed and labor management, ultimately ensuring the long-term sustainability and profitability of the sector.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

The amount of protein the body needs in the diet will depend on the overall calorie needs. The daily recommended intake of protein for healthy adults is 10% to 35% of your total calorie needs (National library of medicine ,2021).

Fish happens to be the cheapest source of protein available to man (Imade and Ogieva 2022) and fish production is often viewed as one of the means of increasing food production in food deficient countries like Nigeria (imade, Ahmadu 2022). It is impossible to farm meat to meet the protein requirement of everyone in the world due to the large resource consumption for its production (Imade & Ahmadu, 2022). Catfish is a source of high-quality protein that can be produced more cheaply than any other animal protein for human consumption. It is highly recommended pregnant women, children and adults because of its high-level protein, digestibility and lack of cholesterols, and constitutes a preventive resource for heart attack or failure and stroke (Kareem, 2011).

Catfish production is a subset of aquaculture which involves the rearing of catfish under controlled conditions for economic and social benefits, and there are three major groups of activities that contribute to food production namely; agriculture, aquaculture and fisheries (FAO, 2015). Catfish has the potential to contribute to sustainable development and poverty reduction in Nigeria as a whole (Imade, Ahmadu 2022).

In effect, meeting the demand for fish using catfish production under different ponds system (concrete pond, earthen pond and plastics tank pond) offers a profitable and ecologically viable alternative to the oceans-as-deserts scenario we are currently facing (FAO, 2010).

Catfish majorly culture in Nigeria include Clarias gariepinus, Heterobranchus bidorsalis and Clarias heterobranchus hybrid (heteroclarias). Clarias gariepinus is regarded as an excellent aquaculture species because it grows fast and feeds on a variety of agricultural by-products, it is hardy and can tolerate extreme temperature, easy to produce in captivity with high annual production and good feed conversion rate (Ahmadu & Egbodion, 2017).

Fish production practice and management could be undertaken in earthen ponds, tanks, tarpaulin ponds, run-ways, glass tanks, acrylic tanks, plastic tanks, race-ways among others (FAO Fish Stat plus, 2012). The most prevalent fish-farming practice in Nigeria is pond culture. Other forms of culture include Cage, Pen, Burrow-pits, flow-through and water recirculation systems. Fish farming practices and methods, therefore, differ by farm size(Okoh.,2021)

1.2 Statement of Problem

The Nigerian vast aquatic medium comprising numerous water bodies like rivers, streams, lake reservoirs, flood plains, irrigation canals, and coastal swamps offer great potentials for aquaculture production in Nigeria (Imade, Egbodion 2021). The United Nation (UN) notedin its 2016 State of World Fisheries and Aquaculture report that nearly a third of wild stocks are overfished (FAO, 2016). Thus, there is need to annexed the potentials of catfish production to fill this gap. Catfish farmers need to be adequately equipped with the necessary production skills to be able to exploit the immense potentials of catfish production and sustaining efficiency under diverse production system.

Catfish also have good commercial values at markets and has more than three times the market value of tilapia (Ike and Chuks-Okonta, 2014). The majority of small-scale fish farmers grow and manage their fishes in tarpaulin ponds, tanks, earthen ponds, runways, concrete ponds, plastic tanks, race-ways among others (FAO, 2010). Catfish farming requires a large amount of capital to start up in order to make a satisfactory amount of profit (Adebayo and Daramola,2013). The demand for catfish has been on the rise among locals and the supply has fallen short. This unbalance between the demand and supply is putting an economic pressure on the price of catfish that could render the commodity unaffordable to many household consumers in Nigeria and further decrease the per capita fish consumption rate (FAO, 2010). In light of this, this study seeks to provide answers to the following research questions

1. What are the socioeconomic characteristics of catfish farmers using the concrete pond in Ovia North East Local government area Edo state, Nigeria?
2. What is the average productivity of concrete pond catfish farming in Ovia North East Local government area Edo state, Nigeria?
3. What is the average profitability of concrete pond catfish farming in Ovia North East Local government area Edo State Nigeria?
4. What are the major constraints faced by catfish farmers using the concrete pond in Ovia North East Local government area Edo State, Nigeria?

1.3 Objectives of Study

The main objective of this study is to determine the economics of concrete pond system for catfish production in Ovia north east local government area of Edo State.

The specific objectives are to:

1. examine the socioeconomic characteristics of catfish farmers using the concrete pond in Ovia North East Local government area Edo State Nigeria.

2. determine the cost, returns and profitability of concrete pond catfish farming in Ovia North East local government area Edo State Nigeria.
3. estimate the technical and allocative efficiency of concrete pond catfish farming in Ovia North East Local government area Edo State, Nigeria.
4. identify the constraints faced by catfish farmers using the concrete pond in Ovia North East Local government area Edo State Nigeria.

1.4 Justification of Study

To solve the country's high demand for fish, Nigerians must turn to their underutilized inland water for improved fish production and aquaculture. One of the adopted strategy is the rearing of fast growing fish species which are resistant to diseases, one of such species in Nigeria is Catfish. Efforts to boost animal production and to bridge the gap between supply and demand are particularly directed at fish production which is traditionally regarded as cheap source of protein. Some of the programmes aimed at increasing fish production include (i) in-shore fisheries development project (ii) National Accelerated fish production project (NAFPP) and Canoe mechanization scheme (CMS); (iii) Special fisheries development project and (iv) processing and marketing project among others (FAO, 2020). The implementation ofthese projects brought about increase fish production initially but owing to policy shifts and unsustainable implement, fish production has declined steadily over the years. (Adeoye 2021)

The catfish industry in Nigeria faces significant challenges, including high production costs, low productivity, and limited profitability. Despite its potential, the industry has not fully explored the use of concrete system catfish production, which could improve efficiency and reduce costs. However, there is a lack of comprehensive research on the economics of concrete system catfish production in Nigeria, making it difficult to determine its viability and potential impact on the industry. This study aims to address this knowledge gap by investigating the economics of concrete system catfish production in Nigeria.

CHAPTER TWO

LITERATURE REVIEW

2.1 Concrete Pond System

Various types of pond culture systems were used for catfish production in the study area. 40.60% of the catfish farmers used concrete pond, followed byplastic/tarpaulin pond (36.75%) and earthen pond (22.65%). The concrete pond types were the most common used in the study area. This finding agrees with Imade and Ahmadu. (2022) who stated that majority of fish farmers in Edo State used concrete ponds for fish production. The use of concrete pond might be due to the convenience offered, in being easy to clean and manage, and the ease of harvesting and draining. 70.30% of the farmers stocked at juvenile stage. (Imade, Ahmadu 2022)

2.2 Constraint to catfish farming

Fish farming in Nigeria is constrained by many problems, principally: inadequate supply of quality fish seed, extension support, and intensive management strategies, lack of cost effective feed and poor infrastructure, limited opportunities for credit and the presence of technical inefficiency (Ogunremi *et al.*, 2022). Short supply of resources needed to meet up with the needs of the increased population has raised the cost of animal protein especially beyond the reach of the low-income groups. This has led to considerate increase in demand for fish to supplement animal protein because of its availability and accessibility to the common man (Ogunremi *et al*., 2022).

Flooding (3.93±0.34) was a very severe constraint to catfish farming likewise outbreak of diseases (2.75±0.59), poor quality of fish seed (2.38±0.83) and high cost of feed (2.32±0.72). The highest proportion of the catfish farmers identified flooding (99.2%), disease outbreak (82.5%), poor quality of fish seed (60.8%) and high cost of feed (40.8%) as severe constraints to fish farming. Findings also reveal that predators (2.96±0.81), poor marketing channel (2.95±0.98), poor quality of feed (2.94±0.85) and mortality (2.31±0.70) were not severe constraints in the study area. Predator (91.7%), poor quality of feed (70.0%) and poor marketing channel (61.7%) were considered as not severe constraint among highest proportion of the catfish farmers. The highest proportion of the catfish farmers identified flooding, disease outbreak, poor quality fish seeds and high cost of transportation as severe constraints to catfish farming. Also, predators, poor marketing channel, poor quality of feeds and mortality were considered as not severe among highest proportions of the catfish farmers. The findings are supported by Onuche *et al*. (2020) who reported scarcity of viable fingerlings and high cost of feed as serious constraints to catfish production in Kogi State. (Adeosun,2024)

The high initial capital outlay could serve as a disincentive for would-be catfish farmers who may be resource-poor, thus resulting to fewer people engaging in catfish production, this will lead to low fish supply (Emokaro, 2010).

The production constraints faced by catfish farmers in the study area. Out of the 16 constraints under consideration, 15 of them are rated serious with their mean scores greater than the bench mark of 2.5. They influence catfish productivity negatively. Top among the constraints are high cost of food, lack of capital and credit at affordable rates, and inadequate power supply respectively. Except for high spread of pest and disease that shows not serious, other constraints presented are greater than the bench mark of 2.5, meaning serious constraints. These results agreed with the findings of Saagulo *et al*. (2017) and Ahmadu, Boheje Odum and Osariemen (2021) that also reported these constraints are serious constraints in their respective study areas. (Imade, Ahmadu 2022).

The respondents indicated the high cost of feeds (mean scale of 2.9) as the most serious constraint to catfish production in the study area. The cost of importation of most commercial feeds into the country and problems associated with importation and distribution could be the main reasons for the hike in feed prices. The second serious problem was the problem of lack of sufficient capital (2.78). Catfish farming is capital intensive and thus requires big capital investment for making more profit. Another serious constraint was poor extension service (2.69).

This could be a result of the poor motivation given to the extension agents by the government. (Umaru, Okoh, Isihu 2021).

Poor road network with a mean of 2.44 was ranked 1st suggesting that farmers face difficulties in transporting their products to the market due to poor road conditions. Inadequate capital for investments highlights the financial constraints farmers face to access a new technology, and this was ranked 2nd with a mean of 2.40, while the high cost of feed and input which increase production cost and reduce profit margin is ranked 3rd with a mean of 2.31. These challenges were regarded as the major challenges associated with catfish production in the study area. However, price fluctuation and inadequate processing facilities make it difficult for catfish farmers to plan and invest in catfish production, thereby limiting their ability to preserve and add value to fish products, and these were ranked 4th with a mean of 2.24. The result further revealed that poor customer attitudes (2.02), suggesting a reduced demand for fish products, and the problem of market location (1.78), particularly for small-scale fish farmers, were ranked 6th and 7th respectively, indicating that price fluctuation, inadequate processing facilities, poor customers attitudes, and problems of market location were seen as minor challenges associated with catfish production in the study area. (Akoh, Achalenge, Oloniyo 2025)

Ridiculous pricing of food-size catfish was another problem of concern confronting catfish farmers. After spending so much money raising catfish to marketable size, the price at which a kilogramme of catfish is being sold is abysmally low. For instance, the cost of producing a kilogramme of food-size catfish in the study was ₦ 952.30, while the average selling price per kilogramme was 938.96, resulting in a loss of about 13.34 per kilogramme. This suggests that farmers were unable to recoup all of the capital invested into the production of catfish, which is one of the reasons why many farms are closing down. Other problems facing catfish farmers in the study area were poor-quality species of fish seed (26.9%), poor-quality feed (19.3%), stealing of fish (17.54%), inadequate technical knowledge in catfish production (13.45%), inadequate electricity (5.26%), and weed invasion (3.51%). (Abbas, Ebukiba, Otitoju, Iduseri, Agbonika, Adole, Gamba, Olutumise & Haruna 2023)

There have been reports of increasing withdrawal of farmers from fish farming in favor of other agricultural ventures. Some of the reasons attributed to this include poor quality of fish feed and seed and reduced profitability of fish farming (PIND, 2017; Digun-Aweto and Oladele, 2017).

2.3 Production

At present, most fish farmers operate small-scale farms ranging from homestead concrete ponds (25 - 40 meters) to small earthen ponds (0.02 - 0.2 hectares). The industry produced over 85,000 tonnes of fish in 2007 (FDF, 2008). FAO (2005b, 2006b) pointed out that Nigeria with extensive mangrove ecosystem and over 14 million hectares of inland water surface out of which 1.7 million are available and suitable for fish farming, should not have any major challenge in achieving sufficient and sustainable fish output to meet domestic demand.

Utilising premium commercial feeds can greatly improve the production and health of fish. According to Adewale *et al*. (2018), commercial feeds outperform locally prepared feeds in terms of growth performance and general fish health.

28.3% of farms used a borehole, 64.2% of farmers obtained their water from deep wells. Water with a generally good quality can be reliably obtained by drilling deep wells and boreholes, which is crucial for catfish growth and health. Having constant access to clean water is essential to keeping pond conditions at their ideal. According to Ezenwa *et al*. (2018), deep well and borehole water quality is typically less polluted and better regulated than surface water sources. (Adeosun,2024).

The average feed quantity of catfish production in the study area was 0.78kg per cycle for a kg of catfish produced. Edo-South fertilizer quantity (0.28kg per cycle per kg fish) was the highest while Edo-North had the least fertilizer quantity (0.18kg per cycle per kg fish). The results in also recorded that the average number of catfish produced was 4153.43, the weight of a catfish was 1.17kg and the output quantity produced was 4859.51kg per cycle per average of 584.17m2 pond sizes of the catfish farmers in the study area. The prices per kg of mature catfish in Edo-South, Edo-Central and Edo-North were respectively NGN 760.22, NGN 760.87 and NGN 734.72, and the study area price per kg was NGN 752.56. This was supported by Ebukiba and Anthony (2019), who reported that higher output is due to efficiency utilization of resources used in catfish production. (Imade, Ahmadu 2022)

The catfish farmers incurred several costs in the course of their production. In the short run, these costs include both variable and fixed costs of production. The variable costs, involved in catfish production as shown in Table 2, include catfish seeds (fingerlings), catfish feeds, labour, petrol, transportation and miscellaneous costs (Ugwumba and Chukwuji, 2010; Ochiaka and Obasi, 2019; and Onyekuru *et al*., 2019).

The majority of the farmers (75.44%) in the study area were small-scale catfish producers, producing less than 2,500kg of food-size catfish per production cycle. This is in agreement with a study conducted by Olagunju (2020). This further gives credence to the reason why Nigeria continues to rely on the importation of frozen fish such as mackerel, herring, etc. to supplement domestic production. Only 7.60% of the farmers were large-scale producers, while 16.96% were medium-scale catfish farmers (Abbas, Ebukiba, Otitoju, Iduseri, Agbonika, Adole, Gamba, Olutumise & Haruna 2023).

2.4 Economics

The average income from cat fish enterprises in the city of Ibadan was N630,049(US$ 3,150.25) while the total average variable cost to enterprise was N432,528.75 (US$ 2,162.64) given a gross margin of N197,520.25 (US$ 987.60). The average total cost was N447,475.96 (US$2,237.38) giving a net income of N182, 573.04 (US$912.87). This amounts to a monthly income of about N15,214.42 which is less than the national minimum wage of N18,000; (US$76.07) (Oluwasola, 2015). cost of feed for the fish constitute 79.2% of the total operating cost. Any policy and/or technical measure that substantially reduces the cost of feeding the fish will substantially increase farm income and hence profit. Labour cost constituted only 11.6% of operating cost. The low cost could have resulted from the use of family labour by majority of the fish farmers who were married with fairly large family sizes. Other cost components were very low. The financial ratio shows that the expense-structure ratio was 0.03 indicating that for every N100 spent on fish farms, N3 was incurred on fixed inputs while N97 was spent on variable inputs. This suggests that farmers can easily adjust to variations in market conditions as variable costs constitute the largest proportion of farm expenditure. However, it also implies that oscillations in the market price of variable inputs could impact gross margin realizable. Policies that will lead to a reduction in the costs of these inputs, particularly feed will significantly reduce the cost of production and make the enterprise profitable. The benefit - cost ratio of 1.41 suggests that every N100 invested in fish farming will yield an additional income of N4(Oluwasola,2015).

Results showed that the average variable cost (TVC) that include cost of fish seed (fingerlings and juvenile catfish) stocked in the ponds, cost of feed, wages of temporary labour, cost of medications, transportation, pond maintenance and fuel was ₦2,554,168.4. Average total fixed cost (TFC) which includes cost of pond rented for the production, water source, scales, pipes and pumping machine was ₦497,369.2. Therefore, average total cost, was ₦3,051,537.5. The average revenue generated from the sales of table size catfish in the study area was ₦3,770,291.7. The results further showed that the total variable cost (₦2,554,168.4) accounted for 83.7% of the total cost out of which 77.4% was expended on fish feeds. The gross margin (GM) was ₦1,216,123.3 with net farm returns of ₦718,754.1. The significant proportion of variable costs attributable to fish diets highlights the financial strain that feed costs have on catfish farmers. This result is consistent with other research, including studies by Omitoyin *et al*. (2018), which demonstrated that feed expenditures represent the largest outlay in aquaculture, frequently making up over 50% of the total operating costs. (Adeosun,2024)

Results reveal that number of ponds was a significant determinant of profitability of catfish farming (β=185906.937, $p<0.05$) while other variables were not significant determinants of profitability ($p>0.05$.). All the independent variables with the exception of the farm size and quantity of fish harvested were positive. According to Akinyemi and Ogbonna (2018), the number of ponds indicates the scale of operations, which has a substantial impact on profitability. This is why the number of ponds is a crucial variable. This suggests that because of economies of scale or greater manufacturing capacity, adding more ponds could result in higher profitability. The result also reveal that the overall model is statistically significant (F=2.231, p=0.037). Furthermore, all of the predictor variables are not statistically significant except number of ponds. From the results presented, the coefficient of determination (R square) was 0.122. (Adeosun,2024).

The results revealed that the average total cost incurred in catfish production across the state were NGN 500.04, NGN 547.54, NGN 596.32 and NGN 543.67, and revenue of NGN 760.22, NGN 760.87, NGN 734.72 and NGN 752.56 per kg fish was realized respectively in Edo-South, Edo-Central, Edo-North and Edo State as a pool. On average in the study area as a whole, a kg of catfish produced gave an average gross margin of NGN 224.35 and net profit of NGN 208.90 per production cycle. The return on sales was 0.28 indicating that for every one Naira of catfish sold, 28k profit was made. The gross ratio 0.72 implies that from every

N1.00 return to the farm enterprise, 72k expenses were incurred in the production. The operating ratio of 0.70 means 70% of the revenue was used to offset the variable costs. The B/C ratio (1.38) and the rate of return on investment of 0.38 imply that for every one Naira invested in catfish production by each catfish farmer, returns (NGN 1.38) and profit of NGN 0.38 was obtained. The Profitability analyses show that, the catfish production was profitable in the Study area. This result is consistent with the findings of Alawode and Ajagbe. (2020) on the profitability of small-scale catfish production in Southwest Nigeria. Also, it is similar to the findings by Ebukiba and Anthony (2019) which concluded that catfish production is a profitable business in Nassarawa State as well as Onyekuru., Ihemezie and Chima (2019) which also concluded that catfish production in Enugu State is profitable (Imade, Ahmadu 2022).

An average of 1000 fingerlings was stocked initially by the sampled fish farmers and was raised for an average period of six months. At the end of the period, 980 matured catfish were harvested and sold with each fish gaining an average weight of 1.5kg. This gives a total of 1470kg of market sized catfish sold on average. The price of catfish in the study area varies depending on the weight gained at maturity. Those weighing 1kg and above were sold at N800 per kilogram. The analysis indicates an average TVC, TFC and TC of N523,300.00, N51,868.00 and N575,168.00 respectively. The average GM is N652,700.00 while the average

NFI is N600,832.00 with RCI of 1.25. Since the NFI and BCR are positive, catfish production is a profitable enterprise in the study area. This is in agreement with the reports of Issa *et al*. (2014) and Olagunju *et al*. (2007) that catfish production is profitable. (Umaru, Okoh, Isihu 2021)

As indicated, the cost and returns analysis revealed that ₦1,185,662.22 was realized as average Total Revenue (TR) from the sales of catfish for one production cycle. The result also shows that an average catfish farmer invested ₦1,037,295.10 as Total Costs (TC) of production for the enterprise per cycle. These consist of both Total Variable Cost (TVC) and Total Fixed Cost(TFC). The TVC (₦717872.88) accounted for 62.2% of the total cost, while the TFC (₦319,422.22) accounted for 30.8% of the total cost of production. ₦22,720.00, which stands for fingerlings, represents 2.2% of total cost, while feed cost (₦654,533.33) represents 63.1% of TC, which is the largest part of the production cost. Electricity (₦36,737.78) represents 3.5% of the TC, while petrol and lime (₦3,881.77) account for less than 1% of the total cost of production (Akoh, Achelenge, Oloniyo 2025).

2.5 Economic Viability and Profitability of Catfish Production in Nigeria

Catfish farming has become one of the most profitable aquaculture ventures in Nigeria, largely due to its relatively low startup time, high market demand, and adaptability to small-scale settings. Researchers have consistently found that it is economically viable and contributes meaningfully to rural livelihoods and food security.

Adewumi and Olaleye (2011) emphasized that catfish farming in Nigeria provides strong returns for both small- and medium-scale farmers. Their study showed that with a production cycle of 4 to 6 months, farmers were able to recover costs and still make a profit, evidenced by a benefit-cost ratio (BCR) greater than 1.2 and a net income exceeding ₦100,000 per cycle, depending on pond size and management.

Emokaro and Ekunwe (2009), in a study conducted in Edo State, reported that catfish farmers earned an average gross margin of ₦150,000 per cycle with return on investment (ROI) ranging from 1.5 to 2.8, confirming the enterprise's profitability even at a modest production scale.

Ayinla (2007) highlighted that feed alone accounts for 60–70% of total production costs, which makes cost management essential for profitability. Farmers who rely on imported or branded feed may face reduced margins, especially when market prices of feed rise. This is corroborated by Akinrotimi *et al*. (2007), who advocated the use of locally sourced or self-formulated feed to reduce input costs and improve profitability.

Ohen and Abang (2009) also observed that market demand for catfish is strong and growing, particularly in urban areas. The widespread consumption of catfish in fresh and smoked forms ensures that producers have multiple sales channels. This enhances market access and allows farmers to fetch favorable prices, thereby increasing net revenue.

However, profitability is not uniform across all farmers. Yusuf *et al*. (2015) noted that profitability often depends on technical efficiency, access to credit, and managerial skill. Farmers with access to extension services, better pond infrastructure (like concrete ponds), and experience in aquaculture tended to perform significantly better than others.

Despite its economic potential, the sector still faces constraints. According to Adeogun *et al*. (2010), high input costs, poor infrastructure, and limited access to formal credit systems can affect profitability. These issues, if not addressed, could hinder the sustainability of catfish farming in the long run.

2.6 Market Access and Price Fluctuation

Market instability and fluctuating prices are major challenges for catfish producers in Nigeria. The demand for catfish varies seasonally and regionally, often leading to periods of oversupply or scarcity that affect farm gate prices. Farmers face difficulties predicting market prices, which hinders their ability to plan production and secure profits (Adeola & Akinwale, 2018).

Price volatility is often caused by poor market information systems, inadequate storage facilities, and middlemen exploitation. Lack of reliable price data leads to farmers accepting lower prices during peak harvest periods, reducing their income (Adewuyi *et al*., 2019). Moreover, fluctuating feed costs further complicate profitability calculations, as feed is the largest operational cost in catfish production (Ibrahim & Bello, 2020).

Seasonal demand fluctuations, often linked to religious and cultural events, can create short-term price hikes or crashes. This unpredictability discourages investment and expansion within the sector (Okunmadewa *et al*., 2016; Nwachukwu *et al*., 2017). Improved market access and price stabilization mechanisms are crucial for enhancing the economic viability of catfish farming in Nigeria (Oluwatobi & Ajayi, 2018).

2.7 Infrastructural Challenges in Catfish Production in Nigeria

Infrastructural challenges significantly hinder the growth and productivity of catfish production in Nigeria. These challenges include unreliable electricity, poor road networks, inadequate water supply systems, limited storage and processing facilities, and insufficient access to modern technology and extension services.

Electricity and Energy Supply: Catfish farming, particularly in concrete ponds, relies heavily on electricity for aeration, water pumping, and processing. Frequent power outages and the high cost of fuel-powered generators increase operational costs and limit production efficiency. The unreliability of electricity supply has been identified as a major bottleneck in Nigerian aquaculture (Onyekuru & Obasi, 2019; FAO, 2018).

Road Networks and Transport Infrastructure: Poor road infrastructure delays the delivery of critical inputs like fish feed and fingerlings and complicates the transportation of harvested fish to markets. These delays lead to increased costs and post-harvest losses, negatively affecting farmers' income (Abdulkadir *et al*., 2020; Nwosu *et al*., 2017).

Water Supply, Storage and Quality Systems: Access to clean and reliable water is essential for fish health and growth. Many Nigerian catfish farms lack adequate water supply infrastructure such as boreholes and reservoirs, leading to poor water quality and high fish mortality rates (Oladimeji *et al*., 2021; Usman *et al*., 2019).

Processing, Storage and Cold Chain Facilities: Fish is highly perishable and without proper cold storage or processing facilities, farmers often sell at low prices immediately after harvest or face losses from spoilage. The limited cold chain infrastructure in Nigeria's aquaculture sector constrains value addition and profitability (Nwosu *et al*., 2017; FAO, 2018).

Access to Modern Technology and Extension Infrastructure: Modern aquaculture benefits from technologies such as water quality sensors, automated feeders, and ICT tools. However, Nigerian farmers often lack access to these technologies and adequate extension services, limiting their ability to optimize production and respond to challenges (Oladimeji *et al*., 2021; Onyekuru & Obasi, 2019).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Area/Scope of Study

Edo State, officially recognized as a state in Nigeria's South-South geopolitical zone, ranks 20th in population with approximately 5,250,000 residents as of 2024. According to earlier estimates from 2021, the state's population was around 4,777,000. In terms of land area, Edo State is the 21st largest state in Nigeria. The state's capital, Benin City, is not only the largest city in Edo State but also the fourth-largest city in Nigeria, serving as a central hub for the country's rubber industry. Established in 1991 from the former Bendel State, Edo State is often referred to as the heartbeat of the nation. Geographically, the state shares borders with Kogi State to the north (133 km), Anambra State to the east (approximately 4 km across the Niger River), Delta State to the southeast and south (350 km), and Ondo State to the west. Edo State features a tropical wet and dry climate, also known as a savanna climate.

The average annual temperature is 28.78 °C (83.8 °F), which is slightly lower than Nigeria's overall average by 0.68%. The state experiences significant rainfall, with an average of 183.49 millimeters (7.22 inches) of precipitation per year. Rainy days are common, with approximately 265.91 days per year (72.85% of the time) seeing rainfall. Edo State's elevation is 239.16 meters (784.65 feet) above sea level. The State lies approximately between Longitudes 05° 04’and 06° 43’ East and Latitudes 05°44 and 07°34’ North.

Ovia North-East is a Local Government Area (LGA) located in Edo State, Nigeria, with its administrative headquarters in Okada. The LGA is named after the Ovia River, which flows through its territory, and is one of two LGAs in Edo State bearing this name, the other being Ovia South-West. Ovia North-East covers an area of 2,301 square kilometers and had a population of 153,849 as of the 2006 census. The LGA comprises several major communities, including Okada, Uhen, Utese, Okokhuo, Uhiere, Isiuwa, Ekiadolor, Oluku, Iguoshodin, Utoka, Oghede, Egbeta, Ora, and Ogbese.

3.2 Sampling Procedure/Sample Size

A two-stage sampling procedure was employed to select the respondents for the study. In the first stage, four communities (Ogbese, Okada, Oluku, and Isiuwa) will be purposively chosen from the communities in Ovia North East Local Government Area, based on their significant population of concrete pond catfish farmers. The second stage involved applying a simple random sampling technique to select 30 concrete pond catfish farmers from each of the four chosen communities, resulting in a total of 120 concrete pond catfish farmers for the study.

3.3 Data Collection

The study's data was from primary sources through scheduled interviews using a questionnaire specifically designed to meet the study's objectives.

3.4 Measurements of Variable

Independent variables:

The socioeconomic information of the respondents was measured by asking the respondents to indicate the following:

1. Sex: whether male or female. This was measured nominally with male scored 0 and female scored 1.
2. Age: Actual number of years. Interval scale was used to measure the age but will later be binned into categories.
3. Marital status: Measured nominally as follows: Single scored 1, Married scored 2, Divorced scored 3, Widowed scored 4 and Separated scored 5.
4. Level of education: This was measured on an ordinal scale as follows: primary education scored 1, secondary education scored 2, OND scored 3, HND scored 4, B.Sc scored 5, M.Sc scored 6 and Ph.D scored 7.
5. Training or Agricultural Education: This was measured using a nominal scale of: Yes 1 and No 0.

6. Nature of employment: This was measured using a nominal scale of: Temporarily scored 0 and Permanent staff scored 1.
7. Household size: Number of persons that feed from same pot and they live together. Interval scale was used to measure the household size but it will later be binned into categories to make the frequency table.
8. Job experience: Number of years they have spent in their work. Interval scale was used to measure their years of experience but will be binned into categories later to make a frequency table.
9. Income level: This was measured as low = 1, medium = 2, high = 3

Dependent variable

Output per pond/kg

3.5 Analytical Technique

Objective 1: To describe the socio-economic characteristics of farmers using concrete pond system for catfish production in Ovia North East Local Government Area of Edo State**.** Descriptive statistics such as means, percentages, standard deviation, and frequency counts was used to achieve this objective.

Objective 2: To determine the cost return and profitability of concrete pond system for catfish farming in Ovia North East Local Government Area of Edo State**,** net profit was used;

To calculate Net profit

Total Revenue (TR):

TR = Quantity of catfish sold x Average selling price

TVC= Total variable cost

Total Cost (TC):

TC = Fixed Costs (FC) + Variable Costs (VC)

Fixed cost like: land, equipment e.tc

Variable cost: labour, feed e.t.c

Net Profit (NP):

NP = TR - TC

=Total revenue- Total cost

Return on Investment (ROI):

ROI = (NP / TC) x 100

= Net profit/total cost×100

Objective 3: To estimate the technical and allocative efficiency of concrete pond system for catfish farming in Ovia North East Local Government Area of Edo State**.** This was analyzed using stochastic frontier production as given by Cobb-Douglas in implicit form as:

$Yi = f(Xi\beta)e(ViUi)$---( )

Where;

Yi = Output of the farm

Xi = Input quantities used by the farm

β = Vector of unknown parameters to be estimated

f = Function

e = Error term

The model in it's explicit form is given as

$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + Vi-$

Ui…… .(3.4)

ln = Natural logarithms

Y = Output of the farm (Total revenue or number of fish produced)

B_0 = Constant

$(\beta_1-\beta_6)$ = Coefficients to be estimated

X_1 = Quantity of feed (Kg)

X_2 = Family labour (Man day)

X_3 = Hired labour (Naira)

X_4 = Cost of medications (Naira)

X_5 = Total number of fish (Catfish stock size)

X_6 = Depreciation (Naira)

Vi = Random error term

Ui = Non-negative random error term

Inefficiency Model

The technical inefficiency was used to estimate the influence of some socio economic traits on farmers using concrete pond system of catfish farming in the study area and is specified as follows

$U = A_0 + A_1Z_1 + A_2Z_2 + A_3Z_3 + A_4Z_4 + A_5Z_5 + A_6Z_6$…………………………..(3.5)

Where

U = Technical inefficiency/Allocative efficiency

A_1-A_6 = Parameters to be estimated

Z_1 = Main occupation

Z_2 = Years of education (Years)

Z_3 = Household size (Number of persons)

Z_4 = Farming experience (Years)

Z_5 = Marital status (Single, married, divorced, widowed, separated)

Z_6 = Sex (Male, female)

Objective 4: To identify the constraints faced by Catfish farmers using the concrete pond system in ovia north east local government area of Edo State**.**

Using mean score analysis

Mean Score = (∑(Score x Frequency)) / Total Number of Respondents

Where:

- Score is the rating given by each respondent (e.g., 1-5)
- Frequency is the number of respondents who gave each score

- Total Number of Respondents is the total number of respondents in the survey

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Concrete pond catfish farmers in the Study Area

The socio-economic characteristics of concrete pond catfish farmers in the study area such as sex, age, marital status, household size level of education, nature of employment, job experience, income level are succinctly discussed below respectively.

Sex

Table 4.1 indicates that concrete pond catfish production in Ovia North East Local Government area is mostly dominated by the male gender;(62.83%) and females accounting for (37.17%). This suggests that concrete pond catfish production is not gender-restrictive, as both male and female actively participate in concrete pond catfish production. The representation may be attributed to the relatively high physical labor requirements compared to other agricultural enterprises, which aligns with Oluyeye(2024) that the business is dominated by the male gender.

Age

The age distribution of concrete pond catfish farmers in the study area as shown in table 4.1 indicates that the majority (41.59%) fall within the age groups 46-55 years, 33.63% aged 36-45 years, 19.47% aged 25-35 years and 5.31% aged between 56-55years age brackets. The mean age of 44years suggests that concrete pond catfish production in the area is dominated by young individuals, who are likely to be more energetic, innovative, and open to adopting modern concrete pond catfish management practices.

Marital status

The results indicate that a significant proportion of the respondents are married (85.84%), followed by single individuals (14.16%). The lower percentages of single farmers suggest that while concrete catfish production is accessible to all, it is more commonly undertaken by married individuals. The high participation of married individuals may be attributed to their responsibility for household sustenance, as concrete pond catfish production serves as a steady source of income. Married farmers may also have better access to labor through family support, which can enhance productivity. This emphasizes the advantage of higher family labour to single-member household catfish farmers as corroborated by Olajide and Omonona (2019).

Household size

The results show that most of the farmers have small to medium household sizes, with 99.12% having 1-5 persons and 0.88% having 6-10 persons. With a mean household size of 4 persons suggests limited family labor availability, possibly leading to increasing reliance on hired labor.

Educational status

Results in table 4.1 shows that most of the respondents have formal education, with 69.91% having tertiary education. The lower percentage secondary education (29.20%) and Primary education (0.88%) suggests that concrete pond catfish farming is more common among those with undergraduate qualifications. This is in line with Alabi and Anekwe (2022) who reported that educated farmers can adopt innovations and new farming techniques

Nature of employment

The results on table 4.1 reveals that 74.34% of the respondents engage in concrete pond catfish farming full-time, while 18.58% have other source of employment (other farming activities), 7.08% involve in other non-farming activity. This is in agreement to the findings of Yaqoob and Fasakin (2021) that farming is a major occupation for self-reliance and income generation.

Experience

The results in table 4.1 show that 51.33% of the respondents have experience of 6-10 years, 38.05% have 1- 5 year's experience and 10.62% >10 years with an average of 7 years. This implies that majority of the farmers had an experience in concrete pond catfish production above 6years and they can readily employ this experience to their advantage so as to obtain high yields from their pond.

Income level

Table 4.1 reveals that 44.25% of concrete pond catfish farmers earn an income between 70000-100000, while 44.25% earn an income of 101000-130000 and 11.50% fall earn an income >130000 with a mean of 110000. This indicates that concrete pond catfish production provides a sustainable livelihood for many, though income levels vary based on scale and efficiency.

Pondsize in square meters

Table 4.1 suggests that 82.30% of concrete pond catfish farmers has a pond size of between 50-80% and 17.70% has a pond size >80 with a mean size of 76. This suggest that majority of the respondent has a medium sized pond.

Table 4.1: Socioeconomic characteristics

Variables	Frequency	Percentage	Mean
Sex			
Male	71	62.83	
Female	42	37.17	
Level of Education			
Primary	1	0.88	
Secondary	33	29.20	
Tertiary	79	69.91	
Marital status			
Married	97	85.84	
Single	16	14.16	
Primary Occupation			
Catfish farming	84	74.34	
Other farming activities	21	18.58	
Non-farming activities	8	7.08	
Other sources of income			
Other farming activity	23	33.82	
Non-farming activity	27	39.71	
Salary/wages	18	26.47	
Age			
25-35	22	19.47	
36-45	38	33.63	44
46-55	47	41.59	
56-55	6	5.31	
Years of experience			
1-5	43	38.05	
6-10	58	51.33	7
>10	12	10.62	
Household size			
1-5	112	99.12	
6-10	1	0.88	4
Income Level			
70,000-100,000	50	44.25	
101,000-130,000	50	44.25	110,000
>130,000	13	11.50	
Pondsize in Square meters			
50-80	93	82.30	76
>80	20	17.70	

Source: Field survey, 2025

4.2 Cost and Return Analysis on concrete pond catfish production in Ovia north east local government area of Edo state

The cost and return analysis shown in table 4.2a reveals that concrete pond catfish production in the study area is a profitable venture. The total revenue generated per production cycle was ₦1,494,326 while the total cost incurred was ₦894,939.61 which is the summation of the total variable cost and the total fixed cost. Variable costs, including feed, labor, and other operational expenses, accounted for the majority (92.1%) of the expenses (₦824,643.73), while fixed costs stood at ₦70,295.88 represents 7.9% of the total cost.

The net profit stood at ₦599,386.39 which is the total revenue less the total cost, affirming that concrete pond catfish farming yields substantial returns in the study area.

The return on investment (ROI) was 2.49 meaning that for every N1 invested in concrete pond catfish production, N2.49 in return which includes both profit and capital. It shows that concrete pond catfish production is profitable as it generates more than double of it's investment.

Cost and return analysis by location

Isiuwa

The cost and return analysis shown in table 4.2b reveals that concrete pond catfish production in Isiuwa is a profitable venture. The total revenue generated per production cycle was ₦1,224,956 while the total cost incurred was ₦653,578.82 which is the summation of the total variable cost and the total fixed cost. Variable costs, including feed, labor, and other operational expenses, accounted for the majority (89.5%) of the expenses (₦584,746.46), while fixed costs stood at ₦68,832.36 represents 10.5% of the total cost.

The net profit stood at ₦571,377.18 which is the total revenue less the total cost, affirming that concrete pond catfish farming yields substantial returns in the study area.

The return on investment (ROI) was 1.89 meaning that for every N1 invested in concrete pond catfish production, N1.89 in return which includes both profit and capital. It shows that concrete pond catfish production is profitable.

Ogbese

The cost and return analysis shown in table 4.2b reveals that concrete pond catfish production in Ogbese is a profitable venture. The total revenue generated per production cycle was ₦1,438,333 while the total cost incurred was ₦913,950.00 which is the summation of the total variable cost and the total fixed cost. Variable costs, including feed, labor, and other operational expenses, accounted for the majority (91.9%) of the expenses (₦839,950.00), while fixed costs stood at ₦74,000 represents 8.1% of the total cost.

The net profit stood at ₦524,383 which is the total revenue less the total cost, affirming that concrete pond catfish farming yields substantial returns in the study area.

The return on investment (ROI) was 1.57 meaning that for every N1 invested in concrete pond catfish production, N1.57 in return which includes both profit and capital. It shows that concrete pond catfish production is profitable.

Okada

The cost and return analysis shown in table 4.2b reveals that concrete pond catfish production in Okada is a profitable venture. The total revenue generated per production cycle was ₦1,320,862 while the total cost incurred was ₦824,752.58 which is the summation of the total variable cost and the total fixed cost. Variable costs, including feed, labor, and other operational expenses, accounted for the majority (91.8%) of the expenses (₦757,512.56), while fixed costs stood at ₦67,240.02 represents 8.2% of the total cost.

The net profit stood at ₦496,109.42 which is the total revenue less the total cost, affirming that concrete pond catfish farming yields substantial returns in the study area.

The return on investment (ROI) was 1.60 meaning that for every N1 invested in concrete pond catfish production, N1.60 in return which includes both profit and capital. It shows that concrete pond catfish production is profitable.

Oluku

The cost and return analysis shown in table 4.2b reveals that concrete pond catfish production in Oluku is a profitable venture. The total revenue generated per production cycle was ₦1,086,296 while the total cost incurred was ₦886,564.07 which is the summation of the total variable cost and the total fixed cost. Variable costs, including feed, labor, and other operational expenses, accounted for the majority (91.9%) of the expenses (₦815,638.14), while fixed costs stood at ₦70,925.93 represents 8.1% of the total cost.

The net profit stood at ₦199,731.93 which is the total revenue less the total cost, affirming that concrete pond catfish farming yields substantial returns in the study area.

The return on investment (ROI) was 1.23 meaning that for every N1 invested in concrete pond catfish production, N1.23 in return which includes both profit and capital. It shows that concrete pond catfish production is profitable.

Table 4.2a: Cost and return

Variables	Costs
Feed	456,574.30
Labour	38,264.15
Fuel	211,504.4
Medication	77,168.14
Fingerling	41,132.74
Total Variable cost	824,643.73
Total fixed cost	70295.88
Total cost	894,939.61
Total Revenue	1,494,326
Profit	599,386.39
ROI	2.49

Source: Field survey, 2025

Table 4.2b: Cost and return by location.

Isiuwa		Ogbese		Okada		Oluku	
Variables	Costs	Variables	Costs	Variables	Costs	Variables	Costs
Feed	477,244.40	Feed	470,300.00	Feed	414,296.6	Feed	466,063.00
Labour	30,113.21	Labour	33,666.67	Labour	38,422.9	Labour	51,352.90
Fuel	243,333.3	Fuel	206,000.00	Fuel	199,310.3	Fuel	198,888.90
Medication	94,444.44	Medication	76,333.33	Medication	73,103.45	Medication	65,185.19
Fingerling	43,611.11	Fingerling	53,650.00	Fingerling	32,379.31	Fingerling	34,148.15
Total Variable cost	584,746.46	Total Variable cost	839,950.00	Total Variable cost	757,512.56	Total Variable cost	815,638.14
Total fixed cost	68,832.36	Total fixed cost	74,000.00	Total fixed cost	67,240.02	Total fixed cost	70,925.93
Total cost	653,578.82	Total cost	913,950.00	Total cost	824,752.58	Total cost	886,564.07
Total Revenue	1,224,956	Total Revenue	1,438,333	Total Revenue	1,320,862	Total Revenue	1,086,296
Profit	571,377.18	Profit	524,383	Profit	496,109.42	Profit	199,731.93
ROI	1.87	ROI	1.57	ROI	1.60	ROI	1.23

Source: Field survey, 2025

4.3 Technical efficiency

Technical efficiency relates to the ability of catfish farmers to maximize output from a given set of inputs. From the table 4.3a of technical efficiency results, several key variables significantly impact production like stock density, quantity of fingerlings and fuel while quantity of feed and medication were insignificant.

Stock Density (Coef. = 0.6525, t = 5.17, p = 0.000)**:** Stock density, with a coefficient of 0.6525, t-value of 5.17, and a p-value of 0.00, shows a strong and statistically significant positive influence on technical efficiency in concrete pond catfish production. This implies that as the number of fish stocked per unit area increases, technical efficiency also improves, meaning farmers are able to produce more output using available inputs more effectively. The high t-value and extremely low p-value confirm that this relationship is not due to chance. Therefore, optimal stock density enhances pond utilization and resource use, contributing to better productivity. However, it is important for farmers to maintain balance, as overstocking can lead to poor water quality, disease, and reduced growth rates, which could negate efficiency gains. This aligns with findings such as those by Imade & Ahmadu (2022), who emphasized that efficient management practices, including stocking rates, significantly impact catfish production efficiency in Nigeria.

Quantity of Fingerlings (Coef. = 0.3314, t = 4.15, p = 0.000): The quantity of fingerlings, with a coefficient of 0.3314, a t-value of 4.15, and a p-value of 0.00, has a statistically significant and positive effect on technical efficiency in concrete pond catfish production. This indicates that increasing the number of fingerlings used, when done optimally, leads to higher efficiency by maximizing the use of available pond space and resources, ultimately resulting in higher output. The significance ($p < 0.01$) confirms that this relationship is not random. This finding aligns with Imade and Ahmadu (2022), who reported that the number of fingerlings stocked significantly affected catfish productivity and efficiency in Edo State. Similarly, Adeosun et al. (2024) observed that adequate and timely stocking improves survival rate and growth performance, contributing to better technical efficiency.

Fuel (Coef. = -0.8154, t = 5.25, p = 0.000): Fuel, with a coefficient of -0.8154, a t-value of 5.25, and a p-value of 0.00, shows a statistically significant negative relationship with technical efficiency in concrete pond catfish production. This suggests that an increase in fuel usage is associated with lower technical efficiency, possibly due to inefficient energy use, over-reliance on generators, or poor maintenance of pumping and aeration systems. In essence, higher fuel consumption may indicate wasteful input usage that does not proportionally increase output, thus reducing overall efficiency. This finding aligns with Imade and Ogieva (2022), who noted that high energy costs negatively affected the profitability and efficiency of catfish farms in Edo State. Similarly, PIND (2017) emphasized the need for energy-efficient practices in aquaculture to reduce production costs and improve technical performance. Reducing fuel dependency through alternative energy sources or more efficient equipment could therefore enhance efficiency outcomes.

Medication (coeff= -5.310, t= -1.56 p= 0.118) Medication, with a coefficient of -5.30, a t-value of -1.56, and a p-value of 0.118, shows a negative but statistically insignificant relationship with technical efficiency in concrete pond catfish production. The negative coefficient suggests that increased spending or use of medication might be linked to lower efficiency, possibly due to poor disease management practices, overmedication, or reactive rather than preventive health strategies. However, since the p-value is greater than 0.05, the result is not statistically significant, indicating that we cannot confidently say medication has a consistent effect—positive or negative—on efficiency. This finding contrasts with Ogunremi et al. (2022), who found that effective disease prevention and timely use of medication improved productivity. The insignificance here may reflect inconsistent use, lack of proper dosage, or poor record-keeping. It points to the need for better health management training and standardized treatment protocols to ensure medication contributes positively to technical outcomes.

Quantity of feed (coeff= -2.3119, t= -1.30 p= 0.194) The variable Quantity of feed, with a coefficient of -2.3119, a t-value of -1.30, and a p-value of 0.194, shows a negative and statistically insignificant relationship with technical efficiency in concrete pond catfish production. The negative coefficient implies that increasing the quantity of feed could lead to reduced technical efficiency, possibly due to overfeeding, poor feed conversion ratios, or feed wastage. However, because the p-value is greater than 0.05, the result is not statistically significant, meaning the effect is not strong or consistent enough to draw a firm conclusion. This aligns with the findings of PIND (2017), which noted that inappropriate feeding practices—such as feeding more than necessary or using low-quality feed—can lead to higher production costs without improving yield. It also echoes Imade and Ahmadu (2022), who highlighted that feed management plays a critical role in farm efficiency. These results suggest that farmers need proper training on feed quantity estimation and feeding schedules to optimize input use and enhance efficiency.

Inefficiency Variables:

The results of the inefficiency model is also presented in table 4.3 with the signs and magnitude of the coefficients of variables of the inefficiency model.

The technical inefficiency effects of concrete pond catfish production were estimated using the Stochastic Frontier Analysis (SFA) model. The variables included in the inefficiency model were age, farming experience, household size, income, and size of pond. All coefficients were statistically significant at the 1%

level ($p < 0.01$), indicating a positive or negative influence on technical inefficiency. The direction and magnitude of each variable are discussed below:

Age (-6.105; t = -6.88; p = 0.00): The age variable, with a coefficient of -6.105, t-value of -6.88, and a p-value of 0.00, indicates a strong, negative, and statistically significant relationship with technical inefficiency in concrete pond catfish production. This means that as the age of the farmer increases, technical inefficiency decreases significantly. In simpler terms, older farmers tend to be more technically efficient than younger ones. This could be attributed to the greater experience, better decision-making ability, and deeper understanding of fish farming practices that come with age. The p-value of 0.00 confirms that this relationship is highly statistically significant, and the t-value further reinforces the strength of this negative effect. This finding aligns with Imade & Ahmadu (2022) and Adeosun et al. (2024), who also observed that older catfish farmers in Nigeria tended to make better use of available resources, likely due to years of hands-on experience and practical knowledge of pond management, feeding, and disease control. Thus, age is a key factor in reducing inefficiency and enhancing productivity in catfish farming.

Experience (11.555; t = 6.90; p = 0.00): The experience variable, with a coefficient of 11.555, t-value of 6.90, and p-value of 0.00, shows a positive and statistically significant relationship with technical inefficiency in concrete pond catfish production. This implies that as the farmer's experience increases, technical inefficiency increases as well. This result is somewhat unexpected because usually more experience is associated with better efficiency. However, this could suggest that more experienced farmers may be resistant to adopting new or improved farming techniques, relying instead on traditional methods that might not be as efficient. It might also indicate complacency or less motivation to optimize inputs effectively. The p-value of 0.00 means this result is highly significant, and the high t-value confirms the strength of this positive effect. This finding contrasts with some studies like Imade & Ahmadu (2022) which found that experience often reduces inefficiency, but aligns with others suggesting that experience without continuous learning can lead to inefficiency (e.g., lack of innovation or reluctance to change).

Household Size (3.701; t = 6.65; p = 0.00): The household size variable, with a coefficient of 3.701, t-value of 6.65, and p-value of 0.00, shows a positive and statistically significant effect on technical inefficiency in concrete pond catfish production. This means that as household size increases, technical inefficiency also increases. A larger household size might imply more dependents, which can lead to divided attention or limited labor availability for the farm, resulting in less efficient farm management. The significant p-value (0.00) and high t-value indicate a strong and reliable relationship. In the context of Nigerian rural farms, this aligns with findings from studies such as Ogunremi et al. (2022), which noted that larger household sizes can sometimes strain resources and reduce productivity if labor is not efficiently allocated. Therefore, larger households may face challenges in optimizing resource use on the farm, contributing to technical inefficiency. Proper labor management or mechanization could help mitigate this inefficiency.

Income (0.002; t = 5.11; p = 0.00): The income variable, with a coefficient of 0.002, t-value of 5.11, and p-value of 0.00, indicates a positive and statistically significant relationship with technical inefficiency in concrete pond catfish production. This suggests that as income increases, technical inefficiency also increases slightly. While this might seem counterintuitive, it could imply that higher income farmers may rely more on inputs or adopt less efficient practices, or possibly become complacent, reducing the drive for optimal resource use. The significant p-value (0.00) and high t-value confirm that this relationship is statistically robust. This finding aligns with Imade & Ogieva, 2022, where income level doesn't always guarantee technical efficiency, especially if not coupled with good management practices. Thus, increased income alone does not ensure better technical efficiency; attention to efficient resource use and farm management remains crucial.

Pond Size (0.063; t = 6.73; p = 0.00): The pond size variable, with a coefficient of 0.063, t-value of 6.73, and p-value of 0.00, shows a positive and statistically significant effect on technical inefficiency in concrete pond catfish production. This means that as pond size increases, technical inefficiency tends to increase as well. The significant p-value (0.00) and high t-value indicate this relationship is reliable. This could suggest that larger ponds might be harder to manage efficiently, leading to wastage of resources or less optimal production practices. It might reflect challenges like difficulty in monitoring, feeding, or maintaining water quality in bigger ponds, which can reduce efficiency. This aligns with findings from Imade & Ahmadu (2022), who noted that farm size can affect efficiency, with larger farms sometimes facing management difficulties that increase inefficiency. Hence, while expanding pond size could increase production capacity, it also requires improved management to avoid inefficiency.

Gamma ($\gamma = 2.69$): The gamma value represents the proportion of total variance in output explained by inefficiency effects. Although gamma typically ranges between 0 and 1, the high value here suggests a model-specific scale or possible misestimation. Nonetheless, it indicates that technical inefficiency accounts for a substantial portion of output variation among farms.

Sigma-squared ($\sigma^2 = 1.30$): This parameter reflects the total variance from the frontier. A sigma-squared value of 1.30 shows moderate variability in production among the sampled farmers.

The findings suggest that while age contributes positively to efficiency, other socioeconomic factors such as experience, household size, income, and pond size increase technical inefficiency. This highlights the need for continuous farmer education, efficient labor utilization, and improved management practices for larger ponds to enhance the overall productivity of catfish farming in concrete ponds.

Table 4.3a: Technical efficiency model

Variables	Coefficient	t-value	p-value
Stock density	0.6525	5.17	0.000***
Quantity of Fingerlings	0.3314	4.15	0.000***
Quantity of feed	-2.3119	-1.30	0.194
Medication	-5.310	-1.56	0.118
Fuel	-0.8154	5.25	0.000***
Inefficiency model			
Age	-6.105	-6.88	0.000***
Experience	11.555	6.90	0.000***
Household size	3.701	6.65	0.000***
Income	0.002	5.11	0.000***
Size of pond	0.063	6.73	0.000***
Gamma	2.69		
Sigma square	1.30		

Source: Field survey, 2025.
**= significant at 1%

Table 4.3b: Distribution of Technical efficiency

Efficiency level	Frequency	Percentage
0-90%	5	4.72
>90%	101	95.28

Source: Field survey, 2025
Mean: 94.46%

Returns to Scale (RTS) indicates how output responds to a proportional increase in all inputs. It is calculated as the sum of the elasticities (coefficients) of all input variables.

In this case, RTS = -7.4554, which is much less than 1, indicating decreasing Returns to Scale which economically abnormal and highly inefficient. An RTS (Return to Scale) value of -7.4554 in concrete pond catfish production indicates that the enterprise is operating in the irrational region of production (Stage III).

This negative value suggests that increasing all input resources—such as feed, labor, pond size, or fingerlings—results in a significant decline in output, pointing to severe technical inefficiency. At this stage, the marginal productivity of inputs is negative, meaning the farm is overusing resources beyond their optimal level, which leads to waste and reduced profitability. This is unsustainable and reflects poor resource allocation. To correct this, the farmer should scale back input usage, conduct a technical review of production practices, and focus on operating within Stage II, the rational zone where inputs contribute positively to output. Seeking guidance from extension officers, applying production planning tools, and using efficient feed-to-yield ratios can also help restore technical efficiency.

Table 4.3c: Returns to scale

Returns to scale

Inputs	**Coefficient**
Stock density	0.6525
Quantity of Fingerlings	0.3314
Quantity of feed	-2.3119
Medication	-5.310
Fuel	-0.8154
RTS	-7.4534

Source: Field survey, 2025

Allocative efficiency

Table 4.3d shows the output for allocative efficiency:

Allocative efficiency refers to the optimal use of resources to produce the mix of goods and services most desired by society, where inputs are used in such proportions that maximize the value of output given the prices of inputs and outputs. In simpler terms, it means producing what consumers want at the lowest possible cost, ensuring resources are not wasted or misallocated.Table 4.3d shows the output for allocative efficiency:

Cost of Fuel: Coefficient: 1.756 t-value: 2.76 p-value:0.006: Since the p-value is less than 0.05, this indicates that cost of fuel is statistically significant in affecting allocative efficiency. The positive coefficient means that as fuel costs increase, allocative efficiency also increases. This suggests that spending more on fuel is associated with better allocation of resources relative to output in concrete pond catfish production. It could imply that fuel is a critical input, possibly used for water pumping, transportation, or aeration, and investing adequately in it leads to improved production efficiency. This finding agrees with studies like Imade & Ogieva (2022) where energy inputs (such as fuel) are important determinants of efficient resource allocation in fish farming.

Cost of Feed- Coefficient:0.076 t-value:2.37 p-value: 0.018: Since the p-value is less than 0.05, the cost of feed is statistically significant in influencing allocative efficiency. The positive coefficient indicates that as spending on feed increases, allocative efficiency improves. This means that investing more in feed—which is a major input in catfish production—helps in the optimal allocation of resources relative to output, likely leading to better growth rates and productivity. This aligns with findings from Osagie & Ahmadu (2022) who noted that feed cost is a key factor affecting the economic efficiency of catfish farms in Nigeria.

Cost of Fingerlings Coefficient: 1.123 t-value: 2.21 p-value: 0.027: Since the p-value is below 0.05, this variable is statistically significant in affecting allocative efficiency. The positive coefficient indicates that higher spending on fingerlings positively influences allocative efficiency in catfish production. This suggests that investing adequately in quality fingerlings leads to a more efficient allocation of resources, which likely enhances production outcomes. This is consistent with findings by Akoh et al. (2024) who highlighted fingerling cost as a crucial input impacting profitability and efficiency in Nigerian catfish farms.

Cost of Medication- Coefficient:- 0.718 t-value: 1.45 p-value:0.146: Since the p-value > 0.05, this indicates the cost of medication is not statistically significant in explaining allocative efficiency in this context. The negative coefficient suggests that, if significant, an increase in medication cost might reduce allocative efficiency, meaning the resources spent on medication are not being optimally allocated relative to output. However, due to the lack of significance, we cannot confidently say medication cost impacts allocative efficiency in this study. It may indicate that medication expenses are not a critical factor in the cost-output relationship for these catfish farms. This aligns with findings where certain inputs, while important, might not influence optimal resource allocation significantly Akoh et al., 2024.

Cost of Labour- Coefficient: -1.897 - t-value: -2.64 p-value: 0.008: Since the p-value is less than 0.05, this variable is statistically significant in influencing allocative efficiency. The negative coefficient suggests that higher labour costs reduce allocative efficiency in catfish production. This means that spending too much on labour may lead to inefficient allocation of resources, possibly due to overstaffing or ineffective labor management. It highlights the need for optimizing labor inputs to improve cost-effectiveness and farm profitability. This finding aligns with studies such as Imade and Ogieva (2022), who emphasize managing labor costs to enhance economic efficiency in fish farming.

Depreciated Fixed Cost: Coefficient: -4.995 t-value: -2.26 p-value: 0.024: Since the p-value is below 0.05, this variable significantly affects allocative efficiency. The negative coefficient indicates that higher depreciated fixed costs are associated with lower allocative efficiency. This suggests that as fixed assets (like equipment and infrastructure) depreciate, the costs related to maintaining or replacing them may reduce the optimal allocation of resources, negatively impacting cost-efficiency in catfish production. Proper management and timely replacement of fixed assets are therefore crucial to maintain allocative efficiency and overall profitability.

Inefficiency Variables

The results of the inefficiency model is also presented in table 4.3 with the signs and magnitude of the coefficients of variables of the inefficiency model.

The allocative inefficiency effects of concrete pond catfish production were estimated using the Stochastic Frontier Analysis (SFA) model. The variables included in the inefficiency model were age, farming experience, household size, income, and size of pond. All coefficients were statistically significant at the 1% level ($p < 0.01$), indicating a positive or negative influence on allocative inefficiency. The direction and magnitude of each variable are discussed below:

Age (coefficient= 0.8262, t= 3.4211, p= 0.001): The coefficient of age (0.8362) with a t-value of 3.4211 and a p-value of 0.001 in the allocative inefficiency model indicates that age significantly and positively influences allocative inefficiency among catfish farmers. This means that as farmers grow older, they tend to become less allocatively efficient, possibly due to resistance to adopting modern production practices or slower adaptability to fluctuating input prices. The statistical significance ($p < 0.05$) confirms that this relationship is not due to chance. Older farmers may rely more on traditional knowledge rather than cost-effective methods, which increases input costs and reduces economic efficiency. Therefore, it is essential to provide tailored capacity-building programs that help older farmers improve decision-making regarding resource allocation and adapt to market changes. This finding aligns with Imade and Ahmadu (2022), who noted that older producers often exhibit higher levels of inefficiency in resource use.

Household size (coefficient= 1.6445, t= 4.5348, p=0.00): The coefficient for household size (1.6445), with a t-value of 4.5348 and a p-value of 0.00, shows a strong and statistically significant positive relationship with allocative inefficiency in catfish production. This means that as household size increases, farmers tend to become less efficient in allocating resources. Larger households may increase the financial burden on the farmer, diverting resources from optimal input use or causing inefficient labor distribution. It could also reflect increased dependence on unpaid family labor, which may not be as productive or efficient as hired skilled labor. The significance level (p = 0.00) confirms that this relationship is statistically reliable. This finding aligns with Imade & Ahmadu (2022) and Ogunremi et al. (2022), who noted that socio-economic pressures from larger households may reduce the farmer's focus on profit-maximizing input choices. To mitigate this inefficiency, training farmers in basic farm budgeting and resource allocation could help improve cost-effectiveness, regardless of household size.

Income (coefficient= 0.6467, t= 2.0334, 0.033): The coefficient for income (0.6467), with a t-value of 2.0334 and a p-value of 0.033, indicates a positive and statistically significant relationship with allocative inefficiency in concrete pond catfish production. This suggests that as farmers' income increases, their efficiency in allocating resources tends to decrease. In practical terms, higher income may lead to less cautious or suboptimal spending on production inputs, possibly due to reduced cost sensitivity or poor financial planning. The statistical significance ($p < 0.05$) confirms that this result is not due to chance. This finding supports earlier research by Imade & Ogieva (2022) and Adeosun et al. (2024), which observed that some higher-income farmers may overinvest in inputs or fail to optimize cost structures, leading to allocative inefficiency. To address this, extension services and financial literacy training could help farmers better plan and monitor input use, ensuring income is translated into cost-effective and profit-maximizing decisions.

Experience (coefficient= -0.2745, t= -1.6576, p= 0.034): The coefficient for experience (–0.2745) with a t-value of –1.6576 and a p-value of 0.034 indicates that farming experience has a statistically significant negative relationship with allocative inefficiency in catfish production. This means that as farmers gain more years of experience, their allocative inefficiency decreases — in other words, they become more efficient in allocating resources to minimize costs and maximize output. Experienced farmers are likely to make better decisions regarding the use of inputs like feed, labour, and medication, based on their knowledge of cost-effective practices and market dynamics. The p-value being less than 0.05 confirms that this result is statistically significant. This finding supports studies like Imade and Ogieva (2022), who observed that experience enhances farmers' ability to respond to price signals and allocate inputs more economically. Hence, promoting mentorship and knowledge-sharing among farmers could further improve overall allocative efficiency in the sector.

Size of pond (coefficient= -0.8976, t= -3.6754, p= 0.0000): The coefficient for size of pond is -0.8976, with a t-value of -3.6754 and a p-value of 0.00, indicating a negative and statistically significant relationship with allocative inefficiency in concrete pond catfish production. This means that as the size of the pond increases, allocative inefficiency decreases—larger pond operators tend to be more efficient in allocating their production resources.This could be because larger farms often benefit from economies of scale, more structured management practices, and better planning, allowing for more optimal input combinations relative to their output. It aligns with findings from Imade & Ahmadu (2022) and

Osagie & Ahmadu (2022), who reported that larger-scale catfish farmers in Edo State showed better cost efficiency compared to smaller operators.

Table 4.3d: Allocative efficiency

Variables	Coefficient	t- value	p- value
Cost of medication	-0.718	-1.45	0.146
Cost of fuel	1.756	2.76	0.006**
Cost of feed	0.076	2.37	0.018
Cost of fingerling	1.123	2.21	0.027
Cost of labour	-1.897	-2.64	0.008**
Depreciated fixed cost	-4.995	-2.26	0.024
Inefficiency model			
Age	0.8362	3.4211	0.001
Experience	-0.2745	-1.6576	0.034
Household size	1.6445	4.5348	0.000
Income	0.6467	2.0334	0.033
Size of pond	-0.8976	-3.6754	0.000

Source: Field survey, 2025
**= significant at 10%

4.4 Constraints faced by concrete pond catfish farmers in ovia north east local government area of Edo state.

The results in table 4.5 identified several challenges affecting concrete pond catfish production in Ovia-north east LGA, The table presents the major constraints faced by concrete pond catfish farmers, measured using mean scores and standard deviations. These results reflect how frequently or severely each constraint is perceived by the respondents.

High Cost of Feed (Mean = 3.98, SD = 0.13): This is the most significant constraint, with the highest mean value (close to 4 on a 5-point Likert scale), suggesting that almost all respondents agree it is a major challenge.his result is supported by Obianefo *et al*. (2020) in their study on the analysis of resource management ability by catfish farmers in Nigeria, where they reported the high cost of feed as the main problem confronting catfish farmers. This results also agreed with the findings of saagulo et al.(2017), Ahmadu,Boheje Odum and Osariemen (2021) and imade, Ahmadu (2022) that also reported this constraint as serious constraint in their respective study areas.

Low standard deviation (0.13) indicates a high level of agreement among respondents.

Feed constitutes the largest portion of input cost in aquaculture. Rising feed prices reduce profit margins and discourage expansion.

Disease Outbreak (Mean = 1.81, SD = 0.87): This constraint is moderately important. The lower mean indicates that while it affects some farmers, it's not as universally experienced as feed cost.

Higher standard deviation (0.87) shows that perceptions vary widely — some farmers may be severely affected, others not at all. Inconsistent disease management practices may explain the variation.

Water Quality Management (Mean = 1.74, SD = 0.58): Water management is also a moderately rated constraint.- Moderate variability (SD = 0.58) suggests differing levels of access to clean water or knowledge of water treatment.

Poor water quality can increase mortality and reduce growth rates, but may be managed better by some farmers.

Marketing (Mean = 1.36, SD = 0.57): Marketing is perceived as a less serious constraint by most farmers.This might be due to the presence of local buyers or ready markets, although some still face difficulties accessing profitable markets or fair prices.

Theft (Mean = 1.78, SD = 0.74): Theft is a concern but not a top challenge. The relatively lower mean and moderate deviation show mixed experience. Some farms may have better security or are less exposed to theft depending on location.

Table 4.4: Constraints by concrete pond catfish farmers

Constraints	Mean	Standard deviation
High cost of feed	3.98	0.13
Disease outbreak	1.81	0.87
Water quality management	1.74	0.58
Marketing	1.36	0.57
Theft	1.78	0.74

Source: Field survey,2025
>2.5 significant constraints

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study examined the economics of concrete pond catfish production in ovia north east local government area, Edo State, with specific objectives focusing on the socio-economic characteristics of concrete pond catfish farmers, cost and return analysis, technical and allocative efficiency, and constraints faced by concrete pond catfish producers. The research employed descriptive statistics, net profit, stochastic frontier production function, and a Likert scale to analyze the data collected from 113 respondents.

The socio-economic analysis revealed that concrete pond catfish farming is evenly distributed between male (62.83%) and female (37.17%) farmers, indicating inclusivity in poultry production. The majority of farmers were within the economically active age range (46-55 years), with a mean age of 44 years, suggesting that younger individuals are more engaged in concrete pond catfish production. Most farmers had formal education, with 69.91% having tertiary education, which supports their ability to adopt modern farming technique. Furthermore, 74.34% of respondents engaged in full-time catfish farming, while the rest combined it with other occupations.

The cost and return analysis confirmed that concrete pond catfish production is highly profitable, with average total revenue of ₦1,494,326 per production cycle and a total cost of ₦894,939.61. The final net profit was ₦599,386.39, indicating strong financial viability with a return on investment of 2.49. These findings align with previous studies, reinforcing the economic potential of concrete pond catfish farming as a means of income generation and food security.

The technical and allocative efficiency analysis using the stochastic frontier model showed that 95.28% of farmers operated at >90% efficiency. The enterprise shows strengths in using certain inputs technically and allocatively, but inefficiencies in feed, medication, and labor cost management suggest areas for improvement to enhance productivity and profitability.

Lastly, the major constraints faced by concrete pond catfish farmers included high feed costs, disease outbreaks, water quality management, marketing and theft. These challenges significantly impacted profitability and efficiency, necessitating strategic interventions.

5.2 Conclusion

The study concludes that concrete pond catfish production in Ovia North East is a profitable agribusiness venture, capable of providing sustainable income for farmers. However, the technical and allocative efficiency remains suboptimal, indicating the need for improved resource utilization and modern management practices. Addressing the key constraints faced by concrete pond catfish farmers will further strengthen the industry, ensuring long-term sustainability and profitability.

5.3 Recommendations

Based on the findings of this study, several recommendations are proposed to enhance the profitability and efficiency of concrete pond catfish farmers.

1. Promote Optimal Stocking Density: Farmers should be educated on the importance of maintaining proper stocking density. Overstocking can reduce water quality and increase mortality, while understocking leads to underutilization of resources.

2. Invest in High-Quality Fingerlings: Since fingerlings significantly affect both technical and allocative efficiency, farmers should purchase from certified hatcheries to ensure better growth performance and survival rates.

3. Improve Feed Management: Although feed was not statistically significant in technical efficiency, it played a key role in allocative efficiency. Farmers should be trained on feed types, quantities, and timing to minimize waste and maximize conversion efficiency.

4. Targeted training should be offered, especially to older or experienced farmers, on best practices in pond management, disease control, and use of modern equipment.

5. Monitor and Regulate Fuel Use: Since fuel negatively affected technical efficiency, efforts should be made to introduce energy-efficient practices and alternative energy sources to reduce production costs without compromising operations.

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access to these technologies and adequate extension services, limiting their ability to optimize production and respond to challenges (Oladimeji *et al*., 2021; Onyekuru and Obasi, 2019).

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APPENDIX

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION SERVICES, FACULTY OF AGRICULTURE UNIVERSITY OF BENIN, BENIN CITY
QUESTIONNAIRE FOR ECONOMICS OF CONCRETE POND CATFISH PRODUCTION IN OVIA-NORTH EAST LOCAL GOVERNMENT OF EDO STATE, NIGERIA

Dear Sir/Madam,

REQUEST FOR ADMINISTRATION OF QUESTIONNAIRE

I am a final year student of the above named institution. I am carrying out a research on the topic" ECONOMICS OF CONCRETE POND CATFISH PRODUCTION IN OVIA NORTH EAST LOCAL GOVERNMENT AREA OF EDO STATE, NIGERIA**",** and I humbly solicit your assistance by responding to the questions accurately.

Be assured that all information provided will be used only for academic purpose and will be treated as confidential.

Thanks for your anticipated cooperation.

Yours sincerely,

Francisca Ogheneochuko OGHO

SECTION A: SOCIOECONOMIC CHARACTERISTICS OF CATFISH FARMERS

1. Age? ________________
2. Sex: Male [ ] Female[ ]
3. Level of education: Primary[ ] Secondary[ ] Tertiary [ ] Others (specify)______________
4. Years of experience do you have in catfish farming? ________________
5. Marital status: Married [ ] Single [ ] Divorced [.]
6. Household size: _______________

7. What is your primary occupation?
a) Catfish farming
b) Other farming activities (specify) ____________________
c) Non-farming activities (specify) ____________________
8. Monthly income from catfish farming? _______________
9. Do you have any other sources of income?Yes [   ]   No [   ]
10. If yes, what are your other sources of income? (Tick all that apply)
a) Other farming activities
b) Non-farming activities
c) Salary/wages
d) Others (specify) ____________________

SECTION B: PRODUCTION AND MANAGEMENT PRACTICES

1. Size of your concrete pond(s)? _______________
2. Average annual production of catfish in your farm?(before sales/kg) _______________
3. Stocking density of your catfish farm (number of fingerlings per cubic meter)? _______________
4. What type of feed do you use for your catfish?
a) Commercial feed
b) Homemade feed
c) Others (specify) ____________________
5. Source of water: ______________
6. What is the mortality rate of catfish in your farm?(per annum) _______________
7. Do you use any disease management practices?
a) Yes   (b) No
8. If yes, what practices do you use? (Tick all that apply)
a) Vaccination
b) Antibiotics
c) Probiotics
d) Others (specify) ____________________

SECTION C: COST AND RETURN OF CONCRETE POND SYSTEM

1. What is the total cost of establishing your concrete pond system? _______________
2. What is the average annual production cost of catfish farming in your concrete pond system? _______________
a) Feed cost _______________
b) Labor cost _______________

c) Fingerlings cost _______________
d) water cost _______________
d) Others (specify) ____________________
3. What is the average annual revenue from catfish sales? _______________
4. Do you have any other sources of revenue from your catfish farm?
a) Yes (b) No
5. If yes, what are your other sources of revenue? (Tick all that apply)
a) Sales of fingerlings
b) Sales of broodstock
c) Others (specify) ____________________

SECTION D: TECHNICAL AND ALLOCATIVE EFFICIENCY

Inputs	Quantity	Cost
Water		
Fingerlings(kg)		
Pond		
Feed		
Vaccine		
Labour		
Fuel(l)		
Medications		

Section E: Constraints Faced by Catfish Farmers

1. What are the major constraints you face in catfish farming using the concrete pond system? (Tick all that apply)

	Very severe	Severe	Not severe	Not a constraints
High cost of feed				
Disease outbreak				
Water quality management				
Marketing				
Theft				

3. What strategies do you use to mitigate these constraints? (Tick all that apply)
a) Use of probiotics
b) Regular water testing
c) Diversification of income sources
d) Others (specify) ____________________