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Cost-Benefit Analysis of Earthen Ponds against Concrete Tanks Production System in Fish Farming in Abuja FCT, Nigeria

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Abstract. This study comparatively analysed the costs and benefits of fish production for earthen ponds and concrete tanks system in Abuja (FCT), Nigeria. A reconnaissance survey of the six area councils of the area was carried out to locate the fishers. The study further employed multistage sampling technique to select the study respondents. In all, 80 fishers were chosen. Data for the study were collected from primary sources using a well-structured questionnaire with open-ended and close-ended questions. The data was analysed using descriptive statistics (tables, percentages, frequency and mean). The cost-benefit analysis was determined using simple budgetary techniques such as Gross Margin, Net Farm Income, Benefit Cost Ratio and Profitability Ratio. Multiple regression analysis was employed to analyse the factors that contribute to the technical, allocative and economic efficiencies of the two production systems in the study area. The result showed that the Gross Margin Index (GMI) for earthen ponds is 3,099,978.98 and 2,960,635.08 for concrete ponds with Cost Benefit Ratio of 2.4 and 2.2, respectively. Feed cost in earthen ponds represents 77% of the TVC, while it represents 67% in the concrete tank production system. Though the concrete tank production system uses more feed than the earthen pond production system. The revenue generated from fish sales is greatly influenced by the location and method of sale. The study concludes that earthen pond system was slightly more economic than the concrete tank production system. The study, therefore, recommends that fishers should come together to form a cohesive and strong association which will be able to negotiate with wholesalers and other middlemen for price bargaining.

Keywords: fish farming, earthen ponds, concrete tanks production system, fishers, cost-benefit analysis, Nigeria

Introduction

Nigeria, with a population exceeding 200 million, faces challenges in feeding its growing population as it spends a significant portion of revenue on food imports. Over 70% of the population lives below the poverty line, resulting in low animal protein consumption. Despite abundant inland water resources for fisheries and aquaculture, challenges like lack of research, overfishing, harmful chemical use, inadequate regulation, and water pollution, particularly in the Niger Delta region, hinder fish production. Approximately 92.7 million Nigerians lack daily animal protein intake (Daily Trust March 2021). Fish consumption is vital, with Nigeria being the largest consumer in Africa, but the country heavily relies on imports and cultured fish in ponds or tanks. Aquaculture is recognized as a viable solution, contributing to the increasing awareness of domestic fish production. Nigeria's fisheries and aquaculture are among the

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fastest-growing sectors, with an annual fish consumption of about 3.2 million metric tons. The aquaculture sub-sector is seen as crucial for achieving self-sufficiency in fish production and meeting nutritional needs. Fish farming, whether in earthen ponds, concrete, or mobile tanks, is considered an essential solution to meet the rising demand for fish products (Okonji, 2021).

History of Aquaculture

The history of aquaculture in Nigeria, primarily focused on fish farming, dates back to the early days of fish cultivation. Even before Nigeria gained independence from British colonialists, fish farming served as a source of food and commercial gains. During World War II (1939 – 1945), the British colonialists took an interest in Nigeria's aquatic resources, leading to the establishment of a fishery organization in Lagos in 1941. Exploratory experiments on lagoons, lakes, and ponds were conducted successfully, and by 1945, the fishery organization became a subsidiary of the Department of Commerce and Industries. In the 1950s, it evolved into the Federal Fisheries Services, and a few years before Nigeria's independence, a dichotomy between the federal government and regional governments occurred in 1954, contributing to the development of fish farming in Nigeria.

From 1960 to 1970, Nigeria's volume of fish catch grew by tenfold, and this encouraged more Nigerians to venture into fish farming. Today, fish farming has become one of the fastest-growing farming businesses in Nigeria. Some of the commonest fishes grown in the country are prawns, tilapia, and catfish (Philips, 2023).

Fisheries and aquaculture contribute 3 to 4 percent to Nigeria's annual GDP, playing a crucial role in meeting 50 percent of the population's animal-source food supply and providing essential dietary nutrients. The sector is a significant source of employment and income for fishers, fish farmers, and traders. Despite the potential of aquaculture, artisanal and inland fisheries, the country's domestic fish production falls below demand, leading to the importation of half the consumed fish. To address this issue and reduce reliance on imports, the Government of Nigeria has prioritized the expansion and development of aquaculture as a key food value chain (The Guardian, 2019).

Supply and Demand of Fish in Nigeria

According to the WorldFish Foresight Model, Nigeria is projected to experience a widening fish supply-demand gap in the coming decades. While marine capture fisheries are expected to remain stable, future growth in fish supplies must come from aquaculture, artisanal fisheries, and imports. The annual growth rate of aquaculture is anticipated to decrease over time. Fish imports are identified as crucial in bridging the supply-demand gap. Projections suggest an optimistic increase in average annual per capita fish consumption from 11.2 kg in 2015 to 14.8 kg in 2050, contrary to the World Bank's projection of declining fish consumption in sub-Saharan Africa. Presently, Nigeria's fish production is only 0.78 million metric tons, compensated by the importation of 750,000 MT of fish worth USD 600 billion (Tall, 2020). To meet the projected demand of at least 2.66 million MT per annum and maintain a per capita consumption level of at least 13.9 kg, significant efforts and strategies are required in the fisheries and aquaculture sector (Belton & Thilsted, 2014).

Production System in Fish Farming in Nigeria

Fish farming has been a prominent and rapidly growing business in Nigeria for decades, driven by increasing demand for its products. It is considered the fastest-growing farming business in the country, particularly thriving in the Southern and Northcentral regions. Fish farming, a form of aquaculture, involves breeding and rearing fish for commercial purposes using artificial means. Farmers can choose from different approaches, including monoculture (rearing one fish species), biculture (rearing two species), or polyculture (rearing two or more

species). In Nigeria, catfish and tilapia are the most commonly farmed species due to their adaptability to various water types and ability to survive under diverse conditions. Various rearing methods are employed, such as concrete ponds, earthen ponds, tarpaulin ponds, or tank ponds.

Earthen Ponds

An earthen pond is an artificial pond constructed by excavating and shaping the natural soil to create a basin for fish farming. These ponds closely mimic the natural habitat of fish, providing an environment suitable for breeding and rearing. Earthen ponds are commonly used in aquaculture, particularly for species like catfish and tilapia. The construction of earthen ponds involves digging into the ground to create a depression that holds water. While earthen ponds are cost-effective and provide a habitat close to natural conditions, they may have some challenges, such as vulnerability to erosion and the need for periodic maintenance. Proper management practices are essential to ensure the health and productivity of fish in earthen ponds.

Figure 1. Earthen Pond Picture by Noble farms

Concrete Ponds

A concrete pond is a type of artificial pond or tank constructed using concrete material. In the context of fish farming, concrete ponds are designed and built to provide a controlled environment for the breeding and rearing of fish, including species like catfish and tilapia. Unlike earthen ponds, concrete ponds are man-made structures with walls and a floor made of concrete, offering a more controlled and stable environment for fish cultivation.

Concrete ponds have several advantages, including durability, resistance to erosion, and ease of cleaning and maintenance. The construction of these ponds involves shaping and molding the concrete to form a structure that holds water securely. They are commonly used in aquaculture operations, allowing for efficient management of water quality and facilitating the monitoring of fish health. The design and construction of concrete ponds may vary based on factors such as the specific fish species being cultivated, the available space, and the preferences of the fish farmer.

Figure 2. A concrete Pond (Google)

Methodology

Study Area

The study was carried out among fish farmers in the Federal Capital Territory (FCT) of Nigeria, as shown in Figure 3. The FCT, which encompasses the city of Abuja has 6 Areas councils namely Abaji, Bwari, Abuja Municipal Council, Gwagwalada, Kuje and Kwali) spanning approximately 7,315 square kilometers and has a population of approximately 3,564,126 (estimated in 2016). It is in the North Central part of Nigeria, situated between latitudes 8°25` and 9°25′ N and longitudes 6°45′ and 7°45′ E (NPC, 2006). The region experiences a tropical climate with distinct dry and rainy seasons. The territory is located north of the confluence of the Niger and Benue rivers. It is bordered by the states of Niger to the West and Northwest, Kaduna to the Northeast, Nasarawa to the East and South, and Kogi to the Southwest.

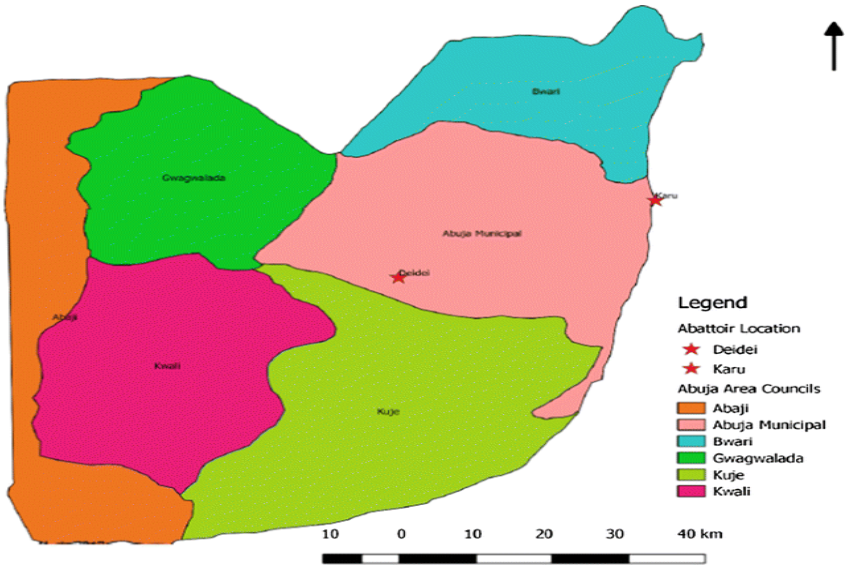

Figure 3. Map of Abuja FCT

Sampling Technique and Sampling Size

A reconnaissance survey of the six Area councils was carried out to locate fish farmers, thereafter the study employed multistage sample techniques to select respondents for the study. The first stage was a purposive sampling of four Area councils out of the six and the next stage

was to randomly select fish farmers in these four area councils who are either using earthen ponds or concrete tanks for fish production in the study area. The study was able to randomly select twenty fish farmers from each of the four area councils as respondents for the study. In all, eighty questionnaires were administered but only seventy - two had usable information for data analysis.

Data Collection Method and Sources

Data for the study was collected from primary sources using a well-structured questionnaire, which has open-ended and close ended questions. These questionnaires were administered by trained enumerators in the study area to elicit the needed information from the respondents and supervised by all of us. Oral interviews were conducted in Bwari market, Kuje market and Kado fish markets to gather additional information on fish and its production in the study area. The additional information formed part of the narratives of the study. Secondary data from previous studies, journal articles as well as newspaper publications were all used for the study. The questionnaire was divided into sessions to answer the objectives of the study. The sessions require information on the socio-economic characteristics of the farmers, the fish production questions and the cost- benefit of using either of the two systems of production.

Questionnaire

The study aims to conduct a cost-benefit analysis of fish farming methods, specifically comparing earthen ponds and concrete tanks in the Federal Capital Territory (FCT), Nigeria. The questionnaire is designed to gather information on the socio-economic characteristics, costs, returns, efficiency, and overall economic analysis of fish farmers utilizing these two different methods for fish production in the study area.

By collecting this information, the study aims to provide valuable insights into the economic viability and socio-economic impact of fish farming methods, helping policymakers and practitioners make informed decisions for sustainable aquaculture development in the study area.

Data Analysis Techniques

Data on the socio-economic characteristics was analysed using descriptive statistics (tables, percentages, frequency and mean). The cost-benefit analysis was done using simple budgeting techniques such as Gross Margin, Net Farm Income, Benefit Cost Ratio and Profitability Ratio. The multiple regression analysis was used to analyse the factors that contribute to the technical, allocative and economic efficiencies of the two production systems in the study area. The T-test was used to test the hypothesis at 1% and 5% confident level to see if there are or no significant differences in the two production systems.

The Cobb-Douglas Production Function using multiple regression analysis was used for the study and the functional form was used to analyse the technical efficiency of the fish farmers using the different production systems in the study area. This functional form has been used in many empirical studies (Ajibefin et al., 2022, Emokaro & Erhabor, 2006, Ekumwe & Orewa, 2007, Ekunwe et al., 2008, Okon et al., 2010, Shehu et al., 2010.)

$$LnYi = b0 + b1lnX1i + b2lnX2i + b3lnX3i + b4lnX4i + b5lnX5i + Ei \quad \text{——————Eq1}$$

Where ln = Natural logarithm
Y = Net Farm Income
X1 = Cost of feed
X2 = Labour cost
X3 = Cost of fingerlings
X4 = Cost of water
X5 = Selling price

The econometrics model used for the study to determine the extent to which factor used explains the variability in the net farm income of both production systems in the study area. The model in its general form is implicitly stated as:

Y = Net farm income

Y = F (X1, X2. X3, X4, X5—----------Xn, Ui)

Where

X1 = Age of farmer

X2 = Marital status

X3 = Educational level

X4 = Family size

X5 = Farming experience

UI = error term

Budgeting Technique, Cost and Return Analysis

Budgeting techniques were used to ascertain the cost, revenue and gross margins of the various systems. The cost and return analysis will be used to determine the cost and revenue structure in the two production systems: earthen pond system, and concrete tank system.

Total Cost (TC) = total fixed cost (TFC) + total variable cost (TVC)

Total variable cost (TVC) consists of all the operating cost incurred by the farmer throughout the period of farming from stocking to harvest. It includes costs of fish seed (fingerlings/ juveniles), fish feeds, hired labor, medication, fuel, transportation, and miscellaneous.

The Total Fixed Cost considered was the cost of construction of the concrete tank or the earthen ponds. The initial cost was depreciated since the medium has a lifespan of over 5 years. The declining balance method of depreciation was used for this study.

Total revenue (TR) consists of receipts from total sales. It is = quantity of fish (Kg) X price, simply the quantity harvested multiplied by the price of fish per kg.

Gross Revenue = Quantity Harvested (kg) × Price of fish.

Gross margin (GM)

Gross margin will be obtained by subtracting the total variable cost TVC from the Total revenue. Ettah et al. (2015), Farris and Bendle (2012) stated it thus.

GM = TR – TVC —----------Eq3

Where GM = Gross margin (₦); TR = Total Revenue (₦); TVC = Total variable cost (₦).

Net Farm Income

The net farm Income NFI or Net profit is obtained from Gross margin less the Total fixed cost

NFI = GM - TFC—----------Eq4

Where GM = Gross Margin

TR = Total Revenue

TVC = Total variable Cost

NFI = Net Farm Income

TFC = Total Fixed Cost

Profitability ratios

Rate of return on investment (ROI) Rate of return on investment (ROI) is used to evaluate the improvements made by several different investments. It is obtained by dividing the firm's net income by its total cost and is calculated as:

ROI = NI/TC —----------Eq5

Where NI = Net income and TC=Total cost.

BCR = TR/TC —----------Eq6

Where, BCR = Benefit Cost Ratio

TR = Total Revenue TC = Total Cost

Results and Discussion

Socio-Economic Characteristics of Respondents

Sex of respondents

The study's outcomes reveal a notable gender imbalance among fish farmers utilizing both production systems. Specifically, the majority of individuals engaged in fish farming are male, constituting 72% of those employing concrete tanks and 83% of those utilizing earthen ponds. Conversely, female representation is lower, with only 28% involved in the concrete tank system and 17% in the earthen pond system.

These results parallel the findings of prior research, notably the study by Adewuyi et al. in 2010, highlighting the prevalence of male dominance in production activities within agricultural enterprises. This trend is consistent with the observations of Olawasola and Ajayi in 2013, who emphasized the labour-intensive nature of fish production as a contributing factor to the higher involvement of males in the actual production process. Additional support for these findings comes from studies conducted by Egwenomhe et al. in 2020 and Oyetola et al. in 2020, both indicating that males constitute the majority, exceeding 80% of individuals engaged in fish production. These consistent patterns underscore the need for a more inclusive approach to encourage gender diversity within the fish farming sector, addressing barriers and fostering opportunities for increased female participation.

Marital status of respondents

The result of the study shows that the majority of the respondents using both systems of production were married, with 75% in concrete tank producers and 83% in earthen pond production, while 14% of concrete tanks were single and 11% in earthen pond producers were single, with the others status representing 8.3% under concrete tanks. This is like the findings of Nwosu and Onyeneke (2013), who studied fish pond farmers in Owerri agricultural zone Nigeria where majority (85%) were married. Similarly, Odefadehan et al. (2015) opined that farming populace often gets married quickly in order to have a helping hand from their offspring in the farming enterprise because labor is a significant resource input and could be scarce at very critical periods. Also, Oluwasola and Alimi (2007), in their study of Financial Intermediation in Agriculture in Nigeria also reported that fish farming is now majorly carried out by married fish farmers with large families in the rural-urban areas. Contrary to this finding is that of Okoedo and Ovharhe (2012) in Delta State where higher proportion (47.3%) of the fish farmers were single, they attributed this to the dominance of young respondents.

Age of respondents

The findings of the study indicate that the majority of individuals engaged in fish production in the study area are between the ages of 31-40, 41-50 and 51-60. This suggests that fish production requires both physical energy and economic resources, and only those with access to capital can successfully engage in fish production. Among those who used earthen ponds, 33% were between the ages of 41-50, followed by 31% representing ages 31-40 and 51-60. In the case of respondents using concrete tanks, 36% were between the ages of 41-50, while ages 31-40 and 51-60 accounted for 25% of the respondents. These findings align with a 2012 study by Yem and Deyi (2022) which reported that the average age of fish farmers in southwestern Nigeria is between 36-45. The study also suggested that the age of a farmer directly correlates with their efficiency**.**

Education status of respondents

Most respondents who use both production systems have some forms of tertiary education, with 47% representing earthen ponds and 50% representing concrete tanks. Additionally, 25% and 19% respectively have secondary education. Furthermore, 19% of respondents using concrete tanks have received vocational education training. This is because fish production requires innovative operations, and for farmers to remain competitive and break

even, they need to be educated. This finding aligns with the research conducted by Anozie et al. in 2015 and Olukotun et al. in 2013, which suggests that the high level of education among fish farmers in the study may be attributed to the urban nature of the study area. Moreover, recent findings by Oyetola in 2022 shows that 50% of fish farmers using concrete tanks in the FCT have tertiary education. Additionally, Ojo et al. suggest that a higher level of education enables farmers to adapt to best practices more effectively.

Years of experience of respondents

The findings indicate that the majority of respondents (47%) who use the earthen pond production system have between 4-6 years of fish production experience. Following them, 22% have 1-3 years of experience. On the other hand, among farmers using concrete tanks, the majority (44%) have 1-3 years of experience, while 31% have 4-6 years of experience. These findings suggest that fish producers in the study area have a moderate level of experience, which may affect their production scale, leading to inefficiencies in resource utilization. A study by Ighoche (2019) also found that years of experience and educational level were significantly related to output at a 5% level. This implies that more experienced fish farmers are more likely to adopt innovations and share their knowledge with aspiring farmers.

Fish Production

In the study area, it was found that all concrete tank producers focused exclusively on raising catfish, practicing monoculture with various catfish species. In the earthen pond production system, 83% of producers practiced monoculture with various catfish species, while 17% engaged in polyculture by combining catfish and Tilapia. The reason for mixing Tilapia and catfish was twofold. Firstly, Tilapia was used as a food source for the catfish due to their ability to reproduce quickly. Secondly, in the event of a predator entering the pond, it would preferentially feed on the bony Tilapia before targeting the more valuable catfish. Tilapia is of lesser value due to its low price, mainly because of its bony nature. These findings are consistent with the research of Adewumi et al. (2015), suggesting that catfish were the most cultured fish in the study area. This preference for catfish in Nigeria aligns with the findings of Oliver and Aboudon (2021).

Cycle of Production

Approximately 72% of concrete producers engage in production twice a year, while 25% produce three times within the same time frame. The reason behind this is that many concrete tank producers do not rear their fish until they reach a size suitable for direct consumption. Instead, they focus on rearing fish for smoking, processing, and packaging purposes to cater to the market's demand. On the other hand, the majority of earthen pond producers (around 83%) follow a production cycle of twice a year, with only 13% opting for three cycles. This is significant because most earthen pond producers rear their fish until they reach a size appropriate for direct consumption, which typically takes around 5-6 months. By doing so, they can sell fish weighing above 1 kg twice within a cycle, resulting in higher profits, and the fish can be sold fresh. This finding aligns with previous studies conducted by WorldFish Center in 2021.

Water Source

The majority (58 %) of concrete tank producers obtain water from bore holes since their farms are often located near their homes or in urban areas. Another 33% source their water from wells. This is why the cost of water is higher in concrete production, accounting for 3 % of the variable production cost. However, in the case of earthen pond systems, the majority of water used for fish rearing comes from natural sources, with 55% from underground water and 33% from rivers. The only exception is during the dry season when farmers supplement the

water level in the pond with well water using pumping machines. The availability of these natural water sources significantly reduces the cost of water, making it only 2% of the total variable cost. This, in turn, helps lower the overall production cost and increases profit margins. These findings align with the research conducted by Etuk et al. (2021) who found out that the cost of production in earthen pond is relatively lower than in concrete tanks

Labour Cost

In the earthen production system, labor costs account for approximately 17% of the total variable cost. (TVC). The majority of farmers, represented by 75%, rely on hired labor for their farm operations, while 17% utilize both hired and family labor. The study findings indicate that certain key operations in the earthen pond production system require specialized skills and often necessitate the use of skilled paid labor. Regarding the concrete tank production system, the study reveals that 39% of producers rely on a combination of family and hired labor, while 33% solely employ hired labor and 28% exclusively use family labor. This is primarily due to the fact that many concrete tank producers rear their fish near their residences and operate on a small scale. The average stocking capacity of the concrete tank production system is approximately 4,505. 6, while that of the earthen pond system averages around 5,055. 6. This suggests that fish production in the study area is still on a small scale and requires more investment in infrastructure, like pond construction and local feed formulation.

In conclusion, fish production in the study area predominantly occurs on a small scale, which aligns with the conclusions drawn in the study conducted by World fish center (2021) on the Nigeria fish futures. Aquaculture in Nigeria: Increasing Income, Diversifying Diets and Empowering Women Report that majority of fish farms in Nigeria operate at a small-scale level.

Feeding Cost

Feed cost in earthen ponds represents 77% of the TVC while it represents 67% in the concrete tank production system. By contrast, in implicit terms, the concrete tank production system uses more feed than the earthen pond production system. The reason for this is that the average carrying capacity of the earthen pond system in the study area is significantly higher than that of the concrete tanks. Another reason is that most of the earthen pond produced fish are reared to about 5-6 months and sold as fresh fish used for point and kill while in concrete tanks, the production cycle is less ranging between 3 to 4 months and majority are sold as processed smoked fish with high monetary value.

This range of options available to concrete tank producers contributes to a higher average selling price compared to those who use earthen ponds for production. In contrast, the majority of respondents (75%) who use earthen ponds primarily sell to wholesalers, with only 11% selling to both wholesalers and consumers. This practice often leads to lower revenue for the average earthen pond producer, as wholesalers have a strong association and have the power to determine the price they are willing to pay per kilogram of fresh fish (Field study 2023).

Catfish are mostly marketed as fresh fish in the study area. This is due to lack of cold chain facilities and a lack of uninterrupted electricity supply resulting in people consuming a lot of processed fish (World Fish center, 2021).

According to the study findings, 67% of concrete tank producers prefer to sell their fish directly at the farm. Only 25% of respondents, representing a third of the participants, utilize the market as a selling platform. This indicates that those who choose to sell at the market likely offer processed fish, which are packaged and sold directly to consumers and retailers at a higher price compared to fresh sales. On the other hand, the majority of earthen pond producers (83%) sell their fish to wholesalers who visit the different farms to purchase from fish farmers. Additionally, 11% of these producers sell their fish directly in the market,

suggesting that the farmers aim to earn more by cutting out the middlemen and eliminating the wholesalers' margin.

The revenue generated from fish sales is greatly influenced by the location and method of sale. According to the study, the majority of respondents (44%) who use concrete tanks sell their fish to wholesalers. Additionally, 22% sell directly to consumers, while 14% sell to both wholesalers and consumers.

Table 1. Socio-economic characteristics of respondents

	Earthen Pond Production System			Concrete Tank Production System		
	#	Frequency	Percentage	#	Frequency	Percentage
Sex	Male	30	83%	Male	26	72.2%
	Female	7	17%	Female	10	2.8%
Marital Status	Married	30	83%	Married	27	75%
	Single	4	11%	Single	5	14%
	Divorced	0	0%	Divorced	1	3%
	Widow	0	0%	Widow	3	8.3%
	Widower	2	6%	Widower	0	0%
Age	19-30yrs	1	2.8%	19-30yrs	0	0%
	31-40yrs	11	30.6%	31-40yrs	9	25%
	41-50yrs	12	33.3%	41-50yrs	13	36%
	51-60yrs	11	30.6%	51-60yrs	9	25%
	61 & Above	1	2.8%	61 & Above	5	14%
Education	Adult Education	2	5.6%	Adult Education	3	8.3%
	Primary School	2	5.6%	Primary School	1	2.8%
	Secondary School	9	25%	Secondary School	7	19.4%
	Tertiary Education	17	47%	Tertiary Education	18	50%
	Vocational Education	6	17%	Vocational Education	7	19.4%
Family Size	1-4yrs	15	42%	1-4yrs	15	42%
	5-8yrs	12	33%	5-8yrs	17	47%
	9& above	9	25%	9& above	4	11%
Experience	Less than 1 yr.	4	11.2%	Less than 1 yr.	3	8%
	1-3yrs	8	22.2%	1-3yrs	16	44%
	4-6yrs	17	47.4%	4-6yrs	11	31%
	8yrs & above	7	19.4%	8yrs & above	6	17%

Table 2. Fish production

	Earthen Pond Production System			Concrete Tank Production System		
	#	Frequency	Percentage	#	Frequency	Percentage
Years of Experience	Less than 1 year	5	14%	Less than 1 year	5	14%
	1-3yrs	10	28%	1-3yrs	9	25%
	5-7yrs	14	39%	5-7yrs	13	36%
	8& above	7	19%	8& above	9	25%
Production System	Earthen Ponds	36	100%	Concrete tanks	28	78%
	Earthen Pond & Concrete	10	28%	Concrete & Plastic	2	6%
				Concrete & Tarpaulin	6	17%
Cycle of Production	6 times	0	0%	6 times	1	2.8%
	3 times	5	14%	3 times	9	25%
	2 times	30	83%	2 times	26	72%
	Once	1	3%	Once	0	0%
Fish Species	Catfish	30	83%	Catfish	36	100%
	Tilapia	0	0%	Tilapia	0	0%
	Catfish & Tilapia	6	17%	Catfish & Tilapia	0	0%

Source: Field data 2023

Table 3. Cost and return of Earthen Ponds and concrete tank production systems

TVC	Earthen pond	Percentage	Concrete tanks	Percentage
Cost of feed	1,797,208.33	76.88	1,519,473.22	66.70
Average selling price	1,215.28		1,936.11	
Capacity	5,055.56		4,505.56	
Maintenance cost	47,531.43	2.03	36,806.45	1.62
Cost of fingerlings	235,708.33	10.08	259,444.44	11.39
Cost of water	57,742.86	2.47	83,474.14	3.66
Labour cost	387,941.18	16.60	242,666.67	10.65
Total production cost TC	2,337,616.67		2,278,144.00	
Total Revenue (TR)	5,626,111.11		5,102,500.00	
Total Fixed Cost (TFC)	103,914.29		129,250.00	
Profit TR - TC	3,288,494.44		2,824,356.00	
Gross Margin GM=TR-TVC				
TVC Total variable cost	2,526,132.13		2,141,864.92	
Gross Margin	3,099,978.98		2,960,635.08	
Net Farm Income NFI				
NFI = (GM-TFC)	2,996,064.69		2,831,385.08	
BCR= TR/TC	2.406772326		2.239761841	

Source: Field date 2023

The benefit -cost ratio shows that both systems of production are profitable, while the BCR of earthen pond is 2.4 that of concrete pond is 2.2 meaning that the earthen pond system

is more profitable in the study area. This is consistent with Adeniyi et al. (2015) who obtained similar result in his work Economic Analysis of Costs and Return of Fish Farming in Saki-East Local Government Area of Oyo State, Nigeria. Who found that earthen ponds yield higher profit than concrete tank production?

Conclusion/Recommendation

The study therefore recommends the following to policy makers, potential investors and fishers.

The study revealed that earthen ponds exhibited a slightly higher return on investment compared to concrete tanks. Despite the marginal disparity, this finding underscores the economic advantage of utilizing earthen ponds over concrete tanks in fish farming operations.

The study recommends that individuals who are new to fish farming and have limited knowledge of the industry should prioritize acquiring the necessary training and expertise before venturing into the fishing business. This step is necessary for ensuring success and sustainability in fish farming endeavours. By investing in comprehensive training programs and gaining practical experience, first-timers can develop the skills and knowledge needed to effectively manage all aspects of a fish fishing operations. This proactive approach not only enhances the chances of success but also helps mitigate risks and challenges commonly associated with beginner fish farmers.

The study emphasizes the importance of fish farmers forming an association. Such an association would enable them to collectively negotiate with wholesalers and other intermediaries for better prices and terms. By joining forces, fish farmers can amplify their bargaining power and advocate for fairer prices that reflect the true value of their products. Additionally, a strong association can serve as a platform for sharing information, resources, and best practices among members, fostering collaboration and collective growth within the industry. This collaborative approach not only benefits individual fish farmers but also contributes to the overall development and sustainability of the fish farming sector.

The study advocates for fishers to explore the option of adding value or processing fish before selling as a strategy to increase revenue and maximize profit. Processing fish, such as smoking, or packaging, not only extends the shelf life of the product but also adds value, making it more appealing to consumers. By engaging in processing activities, fishers can reduce their reliance on middlemen who often take advantage of the perishable nature of fish to dictate prices. Instead, processed fish products command higher prices in the market and offer fishers greater control over their earnings. Additionally, investing in processing facilities and techniques can create opportunities for diversification and value-added products, further enhancing profitability in the fishing business.

The study highlights that fish farming in the study area is predominantly male dominated. However, there is a pressing need to actively encourage and promote the participation of females in fish farming through targeted initiatives such as training programs and financial support. Involving females in fish farming not only diversifies the industry but also serves as a form of empowerment for female fishers, providing them with economic opportunities and financial independence. By breaking gender barriers and promoting inclusivity, the fishing community can harness the valuable contributions and perspectives of female fishers, leading to more resilient and sustainable fish farming practices in the study area.

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