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ECONOMIC ASSESSMENT OF CATFISH FARMING IN NIGERIA: A CASE STUDY OF THE FEDERAL CAPITAL TERRITORY

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ABSTRACT

The production costs, profitability and importance of inputs management in catfish farming in Nigeria was assessed taking the Federal Capital Territory as a case study. Lists of farmers were obtained from government agencies and major suppliers of fish feed in order to capture unregistered but practising farmers. The survey was carried out using a structured questionnaire and oral interviews during July and August 2019 as well as in January 2020. The farms sampled were categorised into small, medium and large scale. The average annual production cost was higher for medium, followed by small- and large-scale farms. Though the overall profitability assessment as indicated by the GM and NFI shows catfish farming to be profitable, the scale-wise analysis indicates that on average only the large farms were profitable. The profitability analysis revealed lack of profit among small and medium farms although some of the small (50%) and medium (40%) farms also made profits (NFI). Results from the technical efficiency analysis indicate that overall, 64% of the farmers were within the upper band of the index having an efficiency score of 0.70 and above. The estimated output elasticities of all the input variables were positive, except for the number of fingerlings used. The feed and maintenance were the most significant factors influencing catfish production but years of experience of farmers contribute to knowledge of management practices which has resulted in profit. The lack of profitability in most of the farms could not be totally attributed to lack of technical efficiency alone but also to poor economic management. This study identified training of farmers on economic management of catfish farms as a policy measure to ensure catfish farm enterprises are profitable and sustainable.

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List of Abbreviations

BCR	Benefit Cost Ratio
CBN	Central Bank of Nigeria
CFI	Corporate Finance Institute
GM	Gross Margin
GR	Gross Ratio
LR	Likelihood Ratio
MLE	Maximum Likelihood Estimates
NFI	Net Farm Income
OLS	Ordinary Least Squares
OPM	Operatin Profit Margin
RoI	Return on Investment
SFA	Stochastic Frontier Analysis/Approach
TE	Technical Efficiency

1 INTRODUCTION

The African catfish is an important aquaculture species in various regions in the world. Nigeria contributes more than 67% of the total global production (Figure 1), followed by Uganda, Cuba, Sudan, Hungary, Netherlands, Benin and Brazil (FAO, 2019).

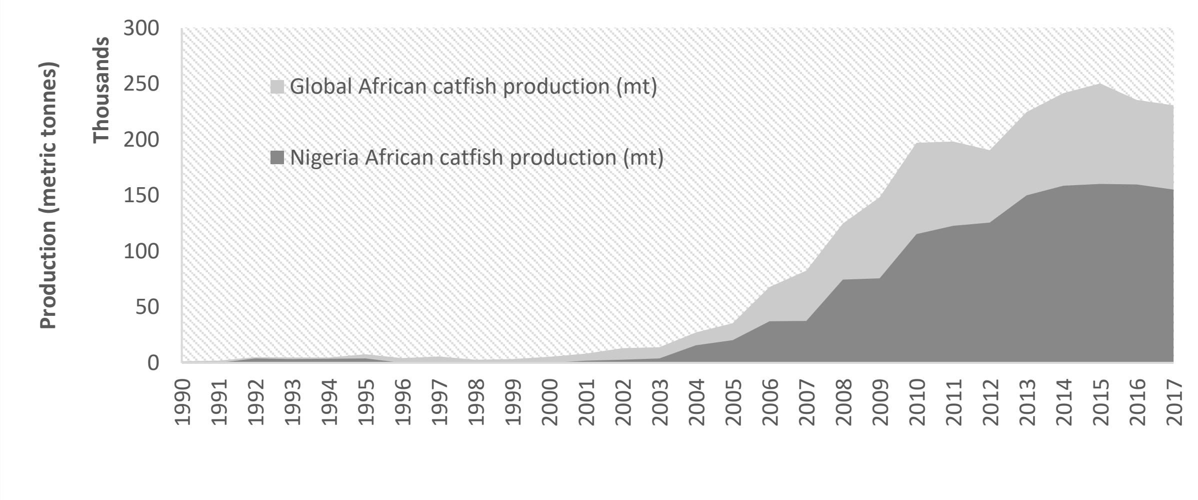

Figure 1. Global production of the African catfish (*Clarias gariepinus*, Burchell, 1822) Source: (FAO, 2019).

Aquaculture in Nigeria is predominantly freshwater based. It was only recently that a major stride was made in the mariculture of shrimp. The African catfish has been the most popular farmed species owing to its ability to tolerate adverse environmental conditions such as different salinity levels, low dissolved oxygen and low pH, rapid growth rate allowing for two cycles to be completed in a year, resistance to diseases and efficient food conversion ratios (FCR). It also enjoys preference among freshly prepared live-fish (a.k.a. point-and-kill) consumers as it can be kept alive at restaurants until its ready to be prepared.

Nigerian aquaculture dates back to the colonial era when in the 1950s catfish, carp and tilapia were reported to have been introduced into different parts of the country (Anetekhai, 2013). Aquaculture practise at the time was basically an extensive system and mostly at the subsistence level which made no significant contribution to national production (Miller & Atanda, 2011). A major change in aquaculture began by the further promotion of production of the African catfish in the early 1980s with the training of government staff, specifically from fisheries departments, on its artificial propagation. Most of the established government farms were not only producing fingerlings but also served as technology transfer centres. By the early 90s, a substantial number of private farmers had adopted the culture of the species with most of them using locally made feeds.

Increasing population created a large market for fish which led to an intensification of culture with high growth in small-to-medium-sized farms and the establishment of large scale intensively managed fish farms. An annual growth rate of 20% was reported post-2000 (Miller & Atanda, 2011). This growth, though considered to be market-driven (Muir, Gitonga, Omar, Pouomogne, & Radwan, 2005), also coincided with a period of increased availability and usage of commercial protein-rich fish feeds. In 2004, the number of fish farms inventoried was 2,658 with a concentration in the southern part of the country. By 2009, the figure had risen to over 5000 farms (Miller & Atanda, 2011). Taking the same rate of growth that occurred between 2004-2009, the current number of fish farms in Nigeria would be in excess of 20,000. During the past 35 years global aquaculture has on average grown by 8% while in Nigeria it has been 12% from about 6,000 mt in 1980 to above 300,000 mt in 2016 (WorldFish, 2018). Nigeria has become the largest producer of catfish in Africa and the world and the second-largest aquaculture producer in Africa after Egypt (Dauda, Natrah, Karim, Kamarudin, & Bichi, 2018).

Aquaculture, especially catfish farming, has been recognised as a major way to boost fish production in Nigeria and capable of moving the country towards self-sufficiency in fish production (Adediran, 2002; Ugwumba, 2005). The contribution of aquaculture to domestic production has increased over the years from 5.1% in 2001 to 30.8% in 2015 (FAO, 2019b, 2019c). Aquaculture has, therefore, become an important alternative to increase domestic fish production in Nigeria and, globally, it has been projected to overtake the capture fisheries in the near future (OECD/FAO, 2019).

Despite the potential of aquaculture in Nigeria, recent data show a decline in aquaculture production from 2015 to 2017 (Figure 2). There have been reports of increasing withdrawal of farmers from fish farming in favour 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 & Oladele, 2017). The profitability of fish farming can, however, be considered the major cause as any of these challenges is expected to have economic implications.

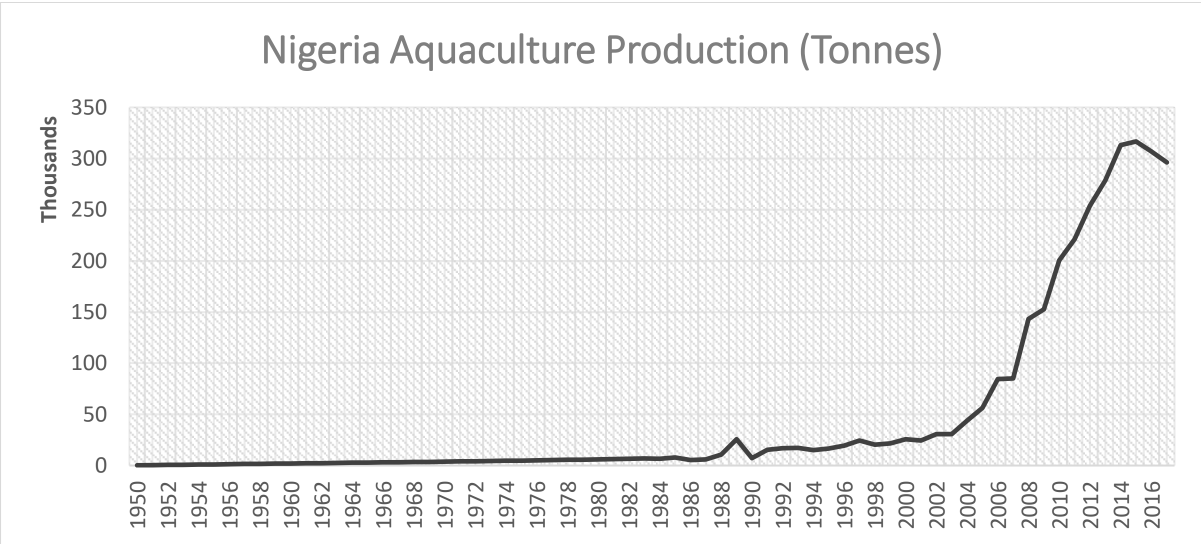

Figure 2. Historical Chart of Aquaculture Production in Nigeria (FAO, 2019)

Several studies have been carried out to assess the economic performance of fish farms in Nigeria and most have reported high profitability. Olaoye, et al. (2013) indicated a significant 70% profit. Outcomes of other studies include a 0.6 to 0.7 Rate of Returns by Bassey, Okon, Ibok, & Umoh (2013); Return on Investment (RoI) of 0.88 and above by Tunde, Kuton, Oladipo, & Olasunkanmi (2015); Kudi, Bako, & Atala (2008); Olukotun, et al. (2013); Issa, Abdulazeez, Kezi, Dare, & Umar (2014); Mmereole (2016). High profitability reported by all the studies should expectedly lead to more investments and increase in production, but this is not reflective of the current situation. However, there are indications that profitability of catfish farming may have been affected by increased cost of production and relatively stable farm gate price of fish over the years (Anetekhai, 2013; Bassey, Okon, Ibok, & Umoh, 2013; Itam, Etuk, & Ukpong, 2014; Mmereole, 2016).

However, since most profitability studies are based on total sample estimates, there is a likelihood that the effect of inefficient management of inputs in non-profitable smaller farms is shadowed by the outcome of more profitable larger established farms. The study of Ali, Rahman, Murshed-e-Jahan, & Dhar (2018) on the production economics of striped catfish in Bangladesh has shown that production cost and profitability varies among different farm operational scales. Also, most of the reported studies in Nigeria were based on the surveys carried out prior to the period of decline in Nigerian aquaculture production. Recent analysis in Nigeria (Busari, 2018), using the same method, also reported fish farming as profitable but noted a low operating profit margin.

The question, then, is: Is the Nigeria aquaculture sector currently as profitable as it has been portrayed? Does the outcome of profitability studies reflect the performance of most of the farms or are they due to a few strongly performing ones? If not, what are the profitable farms doing differently from non-profitable ones? This study was, therefore, carried out to assess the current profitability status, production cost management and efficiency of catfish farming based on different scales of operation. The result of the study will provide guidance for informed decision making to fish farmers and policymakers while also drawing attention to other profitability assessment methods. This paper is divided into 5 sections. Section 2 describes the method used, section 3 provides results and analysis, section 4 summarises and concludes the outcomes of the study while section 5 presents the study recommendations.

2 METHODOLOGY

2.1 Study Area

This study was carried out as part of a series of studies to identify the key challenges of the catfish farming industry in Nigeria covering aspects of broodstock management, seed production, feed quality performance and economic assessment of the industry-funded by the United Nations University-Fisheries Training Programme (UNU-FTP).

The survey was conducted in the Federal Capital Territory (FCT) of Nigeria which, like other parts of the country, has experienced growth of fish farming activities. The study area has also been selected for its centrality and possession of farms across different scales of operation.

2.2 Data collection procedure

As it is not mandatory for all farmers to register with the government or associations, official registries are likely to over represent established and large farms. Therefore, lists of farmers were obtained both from the government and from an independent secondary source. The secondary source of farms was obtained from the major fish feed dealers in order to capture unregistered but practising farmers. All catfish farmers rely on commercial starter feeds. Feed dealers are therefore very up to date on who is doing fish farming. The two major state agencies contacted were the Agriculture and Rural Development Secretariat of the FCT, and the Agricultural Development Programme in the FCT. A simple random sampling method was used to select catfish farmers from the collated list for interview. The farms sampled were categorised into small, medium and large-scale farms based on their estimated annual production using production scales of Veliu, Gessese, Ragasa, & Okali (2009) and farm operation and management characteristics (Table 1). The instruments used for data collection included a structured questionnaire, oral interviews and the researchers' observations conducted in each of the farms. Feed dealers and government fishery officers were also consulted on the performance of the sector and assessment of key indicators. The survey was conducted in July and August 2019 and in January 2020. Data collected included production inputs costs and quantities, harvests, prices, farm management practices and socioeconomic data. It was difficult obtaining complete data from some farmers due to poor record-keeping. The data collection was therefore focused mostly on the most recent production cycle whose data can be most easily remembered. Care was also taken in compiling the data, corroborating the qualitative and quantitative data with the knowledge of input price and obtainable sector practices. Due to the lack of records, it was observed that farmers tend to overestimate their harvest quantities. However, after consultation and clarification, they provided more credible data. This is noteworthy because reporting such exaggerated data would affect the outcome of profitability assessments. A similar data quality management method was adopted by Rahman, Nielsen, Khan, & Ankamah-Yeboah (2020).

Table 1. Classification of farms into small, medium and large using their features

Features	Small	Medium	Large
Annual production capacity	< 5 tonnes	≥5 tonnes ≤10 tonnes	>10 tonnes
Labour and Management	Mostly self-managed/ Partial labour	Partial/ Fully paid labour	Fully paid labour/ Dedicated farm manager

2.3 Data analysis

Descriptive statistics in frequencies and percentages were used to analyse the socioeconomic data. The budgetary analysis was used to assess the economic performance of the farms. Multiple measures of profitability including Gross Margin (GM), Net Farm Income (NFI), rate of return on investment and operating profit margin ratio and others were used (Table 2). These provide for wider coverage of economic assessment (Kay, Edwards, & Duffy, 2008). The equations used in calculating costs and returns are provided in Table 2. Production management variables were estimated based on the quantity and prices of inputs and output (Table 3). These were estimated based on every kilogramme of fish harvested. Averages were calculated for the various categories of farmers defined by their related characteristics. All data obtained and estimates are for a single cycle of production. The farms were further rated based on the degrees of profit or loss made. The average production management variables were tested for significant difference across scales of operation using the Kruscall-Wallis multiple comparison test followed by Dunn-Bonferroni post hoc test.

Table 2. The equations used to calculate the cost and return of catfish farming

Costs and Returns	
Total cost	= Variable costs + Fixed costs
Variable costs	= Cost of fingerlings, feed, labour, others (transport, treatment, water, maintenance, electricity etc.)
Fixed costs	= Cost of depreciation + Land lease (Rental value of land)
Depreciation costs	= Prime cost depreciation rate was estimated for owned ponds*
Total cost per kg fish	= Total costs/total production
Total revenue	= Total production x farm gate price per kg of fish
Total revenue per kg fish	= Total revenue/ Total production
Gross margin	= Total revenue – Total variable cost
Net Farm Income (Net margin)	= Total revenue – Total cost

Net Farm Income per kg fish	= Net margin/ Total production
Profitability Ratios	
Benefit Cost Ratio	= Total revenue/Total cost
Rate of Return on Investment	= Net Farm Income/Total cost
Operating profit margin ratio	= ([Total revenue - Total cost]/ Total revenue) x 100
Operating Expense Ratio	= Fixed cost/Revenue
Gross margin ratio	= ([Total revenue - Total variable cost]/ Total revenue) x 100

*Based on two cycles a year, annual depreciated value was divided by two to account for cycle value (Igwe, 2014)

Table 3. Production management variables estimated per kg of fish

No. of seed/fingerlings per kg fish	= Total seed count/ Total production
Feed quantity per kg fish (FCR)	= Quantity of feed/ Total production
Labour (man-days)	= Labour (man-days)/Total production
Seed cost per kg fish	= Cost of seed/ Total production
Feed cost per kg fish	= Cost of feed/ Total production
Labour cost per kg fish	= Cost of labour/ Total production
Other costs per kg fish	= Other costs/ Total production
Variable cost per kg fish	= Variable cost/ Total production
Fixed cost per kg fish	= Fixed cost/ Total production
Total cost per kg fish	= Total cost/ Total production
Revenue per kg fish	= Revenue/ Total production
Profit per kg fish (NFI per kg fish)	= (Revenue – Total cost)/ Total production

Labour in man-days for aquaculture are usually estimated based on the total days of culture and intensity of culture (intensive, semi-intensive or extensive) which determines whether workers are employed or engaged full-time or part-time (Jadhav, 2009). In most intensive cultures, like in all the catfish farms surveyed, the culture practice was intensive. The number of labourers provided was those engaged full-time. Household labours who were not engaged full-time were excluded and their cost was not estimated. This is mostly applicable to small and medium farms. Due to the intensity of culture which required daily feeding throughout the culture period, labour in man-days was estimated from the total number of days of the culture period.

The total labour cost was provided as the sum of the monthly wages paid to the hired workers pro-rated per cycle. For the small-scale farmers who mostly engaged family labour, estimation of the cost was challenging, it was therefore treated as an opportunity cost for the farmer as considered by Ali, Rahman, Murshed-e-Jahan, & Dhar (2018). In this case, the next best value lower than utility from other farms was adopted (Greenlaw & Shapiro, 2018).

2.4 Production function model

The Cobb-Douglas functional form of the Stochastic Frontier Analysis (SFA) was used to assess the technical efficiency of the farmers considering the influence of the various inputs and variables on the production outputs. This approach has been used to analyse fish farming in various studies in Nigeria (Olayiwola, 2013; Ibeun, Ojo, Mohammed, & Adewumi, 2018; Ogunmefun & Achike, 2018). The theoretical framework of the stochastic frontier production function is specified as:

$Y = f(X_i: \beta) + e_i$, where $e_i = v_i - u_i$; Y is the quantity of fish output, Xi is a vector input quantity, βi is a vector of unknown parameter, v_i =random error term and u_i =non-negative one-sided error term that measures inefficiency relative to the stochastic frontier.

The parameter of the stochastic frontier production function was estimated using the Maximum Likelihood Estimates (MLE) method according to Battese & Coelli (1992).

The empirical Cobb Douglas frontier production function is defined as:

$$\ln Y= \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + d_1 D_1 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + e_i$$

where Y = fish production (kg), β_0- to β_5 are parameters to be estimated; X_1= fish feed (kg), X_2= fingerlings (number), X_3= Labour (man-days), X_4= Maintenance and other costs (₦), X_5= Fixed cost (₦), e_i= the composite error term, composed of random error and technical inefficiency. D_1 was provided as dummy variable to account for the effect of farms who were managed directly by owners, since these farms may have unreliable data on labour inputs. The main explanatory variables specified in the model are within the control of farmers. It was hypothesised that changes in the amount of these inputs would affect the output. Based on preliminary estimations, further analysis was limited to the years of experience of the farm managers, key explanatory variable that is likely to have greatest impact on production. This was added as a second dummy variable; D_2(1: more than 10 years of experience in fish farming, 0: otherwise). The SFA model was further compared with the corresponding Ordinary Least Square (OLS) model using the likelihood ratio test.

3 RESULTS AND DISCUSSIONS

3.1 General socioeconomics characteristics of the farms

Most of the fish farmers (43%) were within the age group 31-40 (Table 4) and can be characterised as young, energetic and economically active. Other studies have reported similar results (Olukotun, et al., 2013; Ume, Ebeniro, Ochiaka, & Uche, 2016; Ibeun, Ojo, Mohammed, & Adewumi, 2018). This indicates an increasing involvement of the younger generation in fish farming. This age group was followed by 41-50 and 51-60 each with 23%. Majority of the farmers have household size of < 5 and between 6-10 which were both 47%, accounting for 94% of the respondents. This agrees with the findings of other authors (Olukotun, et al., 2013; Omobepade, Adebayo, & Amos, 2014; Sogbesan, Suleman, & Madaki, 2015). These households are often engaged in part-time labour in the enterprise to reduce the cost of production. Fish farming in the study area is dominated by men (67%). This is in accordance with observations from other studies (Anozie, et al., 2016; Ibeun, Ojo, Mohammed, & Adewumi, 2018). As catfish farming requires high capital, low participation of women could be attributed to women’s limited access to finance. They are often more involved in fish processing which requires less capital (Ucha, Ume, Ivoke, Silo, & Ogbulie, 2018). All the respondents have undergone formal education with 93% having tertiary education and 7% secondary education. High level of education above 80% have been reported among fish farmers across the country: South (Anozie, et al., 2016), North West (Olukotun, et al., 2013) and North East (Sogbesan, Suleman, & Madaki, 2015). However, the particularly high level in the study area (100%) may be due to the urbanised nature of the study area as reported by companion study in neighbouring state (Ebukiba, 2019). Also, fish farming as a highly technical enterprise requires a good level of literacy for a farmer to be successful.

Table 4. Distribution of socio-economic characteristics of catfish farms in the Federal Capital Territory

Group	Frequency	Percentage
	Age of farmers	
<30	1	3%
31-40	13	43%
41-50	7	23%
51-60	7	23%
>60	2	7%
Grand Total	30	100%
	Household Size	
<5	14	47%
6-10	14	47%
16 and above	2	7%
Grand Total	30	100%
	Gender	
Female	10	33%
Male	20	67%
Grand Total	30	100%
	Education	
Secondary	2	7%
ND/NCE	4	13%
Degree (HND/BA/BSc)	13	43%
MSc/Above	11	37%
Grand Total	30	100%

Source: Field survey (2019/2020)

Most of the respondents (60%) have fish farming as their major occupation which validates the prospects available in the enterprise and willingness of individuals to invest in it. This is further substantiated by the high percentage of farms which have less than 10 years in operation, 37% between 0-5 years, and 40% between 5-10 years. This indicates a high rate of growth the sector experienced in the last decade. Several studies have reported a very high rate of new entrants in those periods. For instance 99% in North West (Olukotun, et al., 2013) and above 80% in South West (Olasunkanmi, 2012; Omobepade, Adebayo, & Amos, 2014; Busari, 2018) .

Majority of the farmers depended on other farmers (33%) and attendance of training courses (33%) as a source of technical support in their operation with the least (3%) depending on extension agents. This could however not be attributed to the lack of interest of the farmers in extension service but rather to lack of adequate extension services and workers (Ebukiba, 2019).

Inadequate funds and high operational cost ranked highest (53%) among the challenges being faced by the farmers. This was followed by poor fish performance (27%) and marketing (10%). Issues of high cost of production and challenges with supply and quality of fingerlings have been identified as major constraints being reported by farmers over the years (Akpabio, 2007; Sogbesan, Suleman, & Madaki, 2015; Anozie, et al., 2016; Umar, 2017; Amachree & Jamabo, 2019).

Table 4 (Cont'd). Distribution of socio-economic characteristics of catfish farms in the Federal Capital Territory

Group	Frequency	Percentage
Main Occupation		
Civil Servant	6	20%
Fish Farming	18	60%
Trading	6	20%
Grand Total	30	100%
Fish Farming Experience		
Less than 5	11	37%
Btw 5-10	12	40%
Btw11-15	5	17%
Above15	2	7%
Grand Total	30	100%
Technical Support Source		
Extension Agent	1	3%
Other Farmers	10	33%
Social Media	9	30%
Training Courses	10	33%
Grand Total	30	100%
Major constraint		
Fund/Operational Cost	16	53%
Poor Fish Performance	8	27%
Marketing	3	10%
Inadequate Technical Knowledge	2	7%
Animal Interference	1	3%
Grand Total	30	100%

Source: Field survey (2019/2020)

Most of the farms sampled were farmer-owned (73%) while the rest were rented. The hardiness of catfish which makes it thrive under seemingly difficult conditions has made it a favourite choice for homestead fish farming. The two major culture systems surveyed were concrete ponds (53%) and earthen ponds (23%). Use of concrete ponds has been favoured among homestead fish farmers while earthen ponds (23%) often exist in clusters which enable small and medium farmers to culture their fish in earthen ponds. Most of these ponds are not owned but usually rented. Olaoye, et al. (2013) also reported concrete and earthen ponds as a majorly used culture system. Most farmers get their water from a borehole (67%). Most of the farms (90%) sourced their fingerlings from other farms and hatcheries. This agrees with the findings of surveys carried out in other parts of the country; Abia State (Igwe, 2014), Nassarawa State (Ebukiba, 2019) and Niger Delta (comprising of 9 Southern States) (Iruo, Onyeneke, Eze, Uwadoka, & Igberi, 2019). This, however, contradicts Olaoye, et al. (2013) who found that 63% of farmers are producing their own fingerlings in Oyo State. Nevertheless, this practice is reducing gradually as the fish farming industry seems to be tending towards increased specialisation (Iruo, Onyeneke, Eze, Uwadoka, & Igberi, 2019). Majority of the farmers (93%) used commercial feeds among which Blue crown (43%) and Ecofloat (23%) were most used. These brands are commonly used to raise the fish from the second month of culture to table size. The preference for these brands seemed to be due to the price of the feeds and their performance as reported by the farmers. Other reports indicate that most farmers use commercial feeds because of their perceived good quality (Olayiwola, 2013; Igwe, 2014; Sogbesan, Suleman, & Madaki, 2015; Ebukiba, 2019). The stocking density adopted by most of the farmers 5-50 fingerlings/m^2(40%) and 51-100 fingerlings/m^2 (33%) were within limits that could allow good productivity (Dasuki, Auta, & Oniye, 2013; FAO, 1996). However, this also depends on other water quality management practices adopted by the farmer.

Table 4 (Cont'd). Distribution of socio-economic characteristics of catfish farms in the Federal Capital Territory

Group	Frequency	Percentage
	Pond Ownership	
Owned	22	73%
Rented	8	27%
Grand Total	30	100%
	Culture facility type	
Plastic tank	2	7%
Earthen pond	7	23%
Concrete tank	16	53%
Concrete & Plastic tank	3	10%
Collapsible tank	2	7%
Grand Total	30	100%
	Water source	
Borehole	20	67%
Spring	5	17%
Stream/River	4	13%
Well & Borehole	1	3%
Grand Total	30	100%
	Fingerlings source	
On-Farm	3	10%
Other Farms	27	90%
Grand Total	30	100%
	Major feed used	
Blue Crown	13	43%
CHI	3	10%
Ecofloat	7	23%
Local feed	2	7%
Skretting	1	3%
Top feed	2	7%
Vital feed	2	7%
Grand Total	30	100%
	Stocking density (fingerlings/m^2)	
5-50	12	40%
51-100	10	33%
101-150	5	17%
151-200	3	10%
Grand Total	30	100%

Source: Field survey (2019/2020)

3.2 Socioeconomic characteristics of farms by scales of operation

Majority of the farmers (53%) were small-scale farmers, this was followed by the medium-scale (33%) and large-scale (13%) (Table 5). The prevalence of small farms may be due to limited access to funds as production costs increase with scales of operation.

The socioeconomic characteristics of the different scales of operation were further analysed. About 69% of small-scale farmers were males while 50% were female among the medium scale farmers. All the large-scale farms were owned by males. Most large-scale (75%) farmers had more than 10 years' experience in fish farming, while medium scale (80%) and small scale (87.5%) farmers had 10 or less years of experience. The medium scale farmers however had the highest (50%) number of farmers with less than 5 years of experience.

Majority (75%) of the large scale depended on training for technical support while 50% of medium scale farmers relied on social media and 53% of small scale sourced technical support from other farmers. The major constraints considered by the large-scale farmers was poor fish performance (75%) while most of medium-(70%) and small-(50%) scale farmers reported funding and high cost of operation. All (100%) the small-scale farmers surveyed sourced their fingerlings from other farms while some of the medium scale farms (10%) produced their own fingerlings. Some of the large-scale farmers (50%) produced their fingerlings on-farm while others could not adequately meet their fingerlings need and as a result had to source fingerlings from other farms the quality of which they find questionable most of the time. This pattern was also reported by Ali, Rahman, Murshed-e-Jahan, & Dhar (2018) where the tendency to produce fingerlings in own hatcheries reduced across scale from large (90%) to medium (80%) and small (27%). The high experience of large-scale farmers in this present study have enhanced their capacity technically to produce their own fingerlings.

Table 5. Farm distribution based on operation scale

Group	Frequency	Percentage
Operation scale		
Large	4	13%
Medium	10	33%
Small	16	53%
Grand Total	30	100%

Source: Field survey (2019/2020)

3.3 Cost and return analysis

The cost and return in catfish farming were estimated based on the average overall estimates and by different scales of operation. The average production cost is provided in Table 6. In a similar way, the average per kg cost and return was also evaluated across the farms (Table 7). The cost estimates are provided in Naira ($1 = ₦306; average exchange rate for the survey period; CBN (2020)). Overall, the average total cost incurred by farmers was 2,331,701 Naira which increased from 392,496 on small farms, to 1,032,225 on medium farms and 13,337,213 for the farms producing more than 10 t per year (Large farms). On per kg basis, however, the medium farms spent the highest amount on average total cost (₦718.5), followed by small (₦694) and then large farms (₦598.5). This total cost expenditure order using relative estimate agrees with the findings of Ali, Rahman, Murshed-e-Jahan, & Dhar (2018) who compared different Pangasius farms in Bangladesh and found medium scales farmers spending highest, followed by small and large.

Out of the total cost of production, variable cost accounted for 98% and the fixed cost 2%. High variable cost has also been reported by other authors, 89% in Niger State by Ibeun, Ojo, Mohammed, & Adewumi (2018), 87.8% in Oyo State by Oluseye & Damilola (2019) while Umar (2017) reported 94% variable cost in Borno State. Among the variable costs, the feed cost accounted for 72%, 73% and 86% of the total cost for small, medium and large-scale farms respectively and an overall percentage of 83%. Olaoye, et al., (2013) reported 74.9% contribution of feed to total cost of production in Oyo State; Umar (2017) reported 66% in Borno State. While the percentage contribution may vary, it does show that feed cost contributes a significant part of variable cost and the total cost of production.

Table 6. Average production costs (in Naira) for catfish production by farm operation scale categories

	Operation Scale Categories							
Cost Items	**Small**		**Medium**		**Large**		**All Farms**	
A. VARIABLE COST	₦	%	₦	%	₦	%	₦	%
Feed cost	286,437	72	766,050	73	11,492,625	86	**1,940,466**	83
Fingerlings cost	51,234	13	136,100	13	445,831	3	**132,136**	6
Labour cost	23,000	6	51,600	5	1,084,782	8	**174,104**	7
Maintenance & other costs	17,441	4	40,100	4	247,625	2	**55,685**	2
Total Variable cost	378,112	95	993,850	95	13,270,863	99	**2,302,391**	98
B. FIXED COST								0
Depreciation cost	3,447	1	12,225	1	43,850	0.33	**11,760**	0.50
Rent (Lease)	10,938	3	26,150	3	22,500	0.17	**17,550**	0.75
Total fixed cost	14,384	4	38,375	4	66,350	0	**29,310**	1
C. TOTAL COST-TC (A+B)	392,496	100	1,032,225	100	13,337,213	100	**2,331,701**	100

Source: Field survey (2019/2020)
Note: $1 = ₦306 (average exchange rate for the survey period; CBN (2020))

In their study on economics of Pangasius production in India, Mugaonkar, Kumar, & Biradar (2019) have shown that large scale farmers have higher percentage of feed cost (80%) compared to small scale (76%). This was attributed to the tendency of small-scale farmers to utilise low cost feeds and use of supplementary feed. This is however not the case in this study as the average cost of feed per kg fish for large, medium and small were not significantly different at ($p<0.05$) with values ₦ 509.5, ₦ 509.3 and ₦ 492 respectively. Also, the higher percentage of feed cost may be more attributable to lesser cost spent by large scale farmers on other variable components. This is evidenced in the cost of fingerlings in which both small and medium scale spent 13% of total cost while large scale farmers spent only about 3%. Overall, fingerlings cost accounted for 6% of the total production cost. Oluseye & Damilola (2019) also reported 5.9% for percentage of fingerlings cost in the total production of an average fish farmer in Oyo State. The average per kg estimate however showed that the small and medium scale farmers utilised more seed in producing per kg of fish than large scale farmers. While the large-scale farmers utilise 1.3 fingerlings per kg fish, the small and medium farmers utilised 3.9 and 3.7 fingerlings per kg respectively. This was also reflected in the cost of fingerling per kg fish produced where small and medium farmed spent average of ₦96.1 and ₦104.4 on fingerlings per kg fish produced, whereas the large-scale farmers spent just an average of ₦32.1 per kg. The difference in cost of fingerlings per kg between the large scale and the small, medium scales was statistically significant (p<0.05).

Table 7. Input and cost estimates per kilogramme of harvest across operation scales

Per kg estimates	**Small**		**Medium**		**Large**	
	perkg	**%***	**perkg**	**%***	**perkg**	**%***
(n=)	**16**		**10**		**4**	
Fingerlings/kgfish	3.9		3.7		1.3	
FCR	1.3		1.2		1.4	
Labour(man-days)/ kgfish	0.4		0.2		0.1	
Fingerlings cost/kgfish	96.1	*13.84*	104.3	*14.51*	32.1	*5.36*
Feedcost/kgfish	492.8	*71.01*	509.3	*70.88*	509.2	*85.08*
Labourcost/kgfish	49.5	*7.13*	42.8	*5.95*	34.2	*5.72*
Maint+Othercost/kgfish	30.8	*4.44*	35.4	*4.92*	16.0	*2.68*
Variablecost/kgfish	669.2	*96.42*	691.7	*96.26*	591.5	*98.83*
Fixedcost/kgfish	24.8	*3.58*	26.9	*3.74*	7.0	*1.17*
Totalcost/kgfish	694.0	*100.00*	718.5	*100.00*	598.5	*100.00*
Profit NFI/kgfish	-53.2		-78.4		143.2	
GrossMargin/kgfish	-28.4		-51.5		150.2	
Rev/kg (Price)	640.81		640.15		741.71	

*percentages were estimated within each group

Average cost of labour overall was 174,104 accounting for 7% of the total cost of production. The percentage was higher for large scale farmer (8%) than small (6%) and medium (5%) as permanent labour were engaged by the large-scale farmers while the medium and small-scale farmers engage household labour whose cost are usually minimal when accounted for. In all, out of the total cost of production, the fixed cost was the least at about 2%. Within the fixed costs, the cost of renting the farms were higher than the cost provided for owning the ponds (provided as depreciated cost). Mugaonkar, Kumar, & Biradar (2019) also observed in a study carried out on Pangasius production in India that the cost of renting was the highest among the fixed cost components. It however implies that it is cheaper, in the long run, to own a pond than to rent it, though ownership attracts a higher initial cost. Generally, the per kg estimate of the fixed cost showed the large-scale farms spend lesser (₦7/kg) on fixed cost than medium and small scales who spent ₦26.9/kg and ₦24.8/kg respectively.

3.4 Profitability indicators and ratios

The average revenue for all the farms was 2,664,996 which increased with the scales of farms from 367,395 to 1,027,545 and 15,949,024 in small, medium and large farms respectively (Table 8). The overall Gross Margin (GM) and Net Farm Income (NFI) for all farms were 362,605 and 333,295 respectively (Table 8). The GM accounts for the profit of the farm without deducting the fixed cost while the NFI accounts for fixed costs in profit estimation. The average for both profit indices for all farms, showed the ventures to be profitable. This would agree with the findings of several others who have studied catfish culture in Nigeria (Olaoye, et al., 2013; Olukotun, et al., 2013; Busari, 2018; Ucha, Ume, Ivoke, Silo, & Ogbulie, 2018). Among the average profitability ratios for all the farms, the BCR was greater than 1 and indicates profit. There was a positive, though low, rate of return on investment as well (0.01) which implies only ₦1 will be gained on every ₦100 invested. The average expense ratio for all the farms was 0.04 which implied that 4% of the total cost of production was made up of fixed component. This low figure is however good for farm operation as the lower the fixed cost the higher the rate at which variable cost will increase total revenue (Ucha, Ume, Ivoke, Silo, & Ogbulie, 2018).

Table 8. Return and economic indicators of catfish farms by operation scales

Performance indicators	Operation Scale Categories			
	Small	**Medium**	**Large**	**All farms**
Total Variable cost	378112	993850	13270863	2302391
Total fixed cost	14384	38375	66350	29310
Total cost	392496	1032225	13337213	2331701
Revenue	367395	1027545	15949024	2664996
Gross Margin	-10716	33695	2678161	362605
Net Farm Income	-25101	-4680	2611811	333295
Benefit-Cost Ratio	0.99	0.95	1.25	1.010
Rate of Return on Investment	-0.01	-0.05	0.25	0.010
Operating Profit Margin	-9.85	-12.98	18.53	-7.11
Expense Ratio	0.04	0.04	0.01	0.04
Gross Ratio (%)	-5.82	-8.69	19.52	-3.40

However, these profitability values are different when assessed across the different scales of operation. The average gross margin for both large and medium scale farms indicated profit while the value for small scale was negative indicating loss. The average NFI for both small and medium scale farms were however negative with only the large scale showing positive. This was also true for the RoI and the BCR. This shows that the positive overall profitability of the farms indeed masked the losses being experienced by some farmers operating on a smaller scale. In a similar way, while the values for the operating profit margin (OPM) and Gross Ratio (GR) were negative on average for all the farms, the scale-wise result of the farms, however, showed that large scale farmers had average OPM of 18.5% which implies that the income realised can cover the operating expenses. OPM usually above 10-12% is considered good and the higher the percentage, the more viable the investment (Umar, 2017). Different values of operating profit margin have been reported by different authors for fish farming in Nigeria. While Umar (2017) reported high OPM (66.8%), Busari (2018) reported very low OPM (8.08%). Though the margins are wide, this disparity could be clarified if the scales of operation were put into consideration. Like the OPM, the GR was positive for large scale farm at 19.5%. This means for every ₦100 revenue, ₦19.5 is returned while 80.5% is attributed to cost of producing that product. Higher GR indicates the farm is selling the product at higher profit percentage which is usually achieved by the higher sales price or reduced cost of production (CFI, 2020). These two indicators were fulfilled by the large-scale farms with average total cost per kg fish of ₦ 598.5 compared to ₦ 718,5 and ₦ 694 in medium and small-scale farms, respectively. The large-scale farmers ability to manage cost of production may be connected with their years of experience as most of them (75%) have above 10 years of experience. (Iruo, Onyeneke, Eze, Uwadoka, & Igberi, 2019) have affirmed that level of experience of farmers can determine their level of knowledge on management practices. This also may have influenced the high selling price they were able to secure for their farm produce.

A scale-wise approach to the assessment of production management and profitability is important especially when the influence of scale on profitability is suspected. Studies from other developing countries like Bangladesh and India have adopted such a scale wise approach in assessment of fish farms. Ali, Rahman, Murshed-e-Jahan, & Dhar (2018) assessed profitability across the different farm operation scales in Bangladesh and reported $0.25, $0.28 and $0.27 Net Margin per kg fish for small, medium and large farms, respectively. Also, the study of Mugaonkar, Kumar, & Biradar (2019) in India also observed different Net Income ₹588,666 and ₹397,470 for small and large scale, respectively. The reports showed that though all the profitability indicators were positive across all the farm categories, they vary among the different operation scales.

3.5 Profit or loss range across the categories of farms

Were all the farms profitable? Aside from having an overview of profitability across scales of operation, understanding the degree of profit or loss of farms within each category would show how the average profit outlook has influenced the category (Table 9). Overall, 53% of the farms were profitable while 47% did not make a profit. All large-scale farms were profitable, while only 40% of the medium-scale and half of the small-scale farms made profits. One in five small and medium scale farms (19% and 20%) made a major loss (more than 200 Naira per kg). The high degree of loss among the medium farms (60%), especially those belonging to the extreme loss category of above ₦200 per kg influenced the poor NFI/kg recorded for this category.

Table 9. Profit or loss range across the categories of farms

Profit or Loss Range (Naira per kg)	**Large**		**Medium**		**Small**		**Grand Total**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Loss			**6**	**60**	**8**	**50**	**14**	**47**
0-50		0		0	1	6	1	3
51-100		0	3	30	1	6	4	13
101-150		0	1	10	3	19	4	13
151-200		0	0	0	0	0	0	0
Above 200		0	2	20	3	19	5	17
Profit	**4**	**100**	**4**	**40**	**8**	**50**	**16**	**53**
0-50	1	25	2	20	4	25	7	23
51-100	0	0	0	0	0	0	0	0
101-150	1	25	1	10	0	0	2	7
151-200	0	0	0	0	4	25	4	13
Above 200	2	50	1	10	0	0	3	10
Grand Total	**4**	**100**	**10**	**100**	**16**	**100**	**30**	**100**

3.6 Technical efficiency of catfish farms in the study area

3.6.1 Summary statistics of technical efficiency

The average harvest of the sampled farms was 3,939 kg per cycle of fish as the majority of the farmers were small scale producers (Table 10). The average fingerlings stocked is 4,964 fingerlings. The average labour is 369 man-days which showed that a lot of man-days go into catfish production in Nigeria. The summary also shows that average maintenance cost and fixed cost were ₦55,685 and ₦29,310, respectively.

Table 10. Summary statistics of the variables used in the stochastic production frontier model

	Mean	Standard Deviation	Range	Minimum	Maximum
Harvest	3,939	14,440	79,870	130	80,000
Feed	5,026	18,304	101,223	156	101,379
Fingerlings	4,964	9,535	53,033	300	53,333
Labour (man-days)	369	969	5,387	73	5,460
Maintenance cost	55,685	144,021	798,500	1,500	800,000
Fixed cost	29,310	35,089	133,500	250	133,750

Source: Field survey (2019/2020). Values reported for a single cycle of production

3.6.2 Frequency distribution of technical efficiency

The technical efficiency indices were derived from the MLE estimates obtained through the stochastic production frontier using the R-statistical software. The frequency distribution and the mean efficiency index of the farms are provided in Table 11. The variation among farmers ranges from 0.499- 0.999 with a mean efficiency index less than 100% which indicates the farmers in the study area are producing below the efficiency frontier. However, being at 0.782 implies that 78% of output is obtained from a combination of inputs used by the farmers and the farmers could increase their output by 22% through adoption of technologies and best management practices. This average efficiency level was higher than what was reported by Ibeun, Ojo, Mohammed, & Adewumi (2018) for fish farmers in Niger State, but lower than the 79% reported by Omobepade, Adebayo, & Amos (2014) for fish farmers in Ekiti State, and 88% reported by Ogunmefun & Achike (2018) for fish farmers in Lagos State. The implication is that an average farmer (mean= 0.782) could realise additional 22% increase in output by measuring up to the technical efficiency level of the most efficient farmer. Likewise, the most inefficient farmer (min.= 0.499) can increase production by 50% by measuring up to the most efficient farmer. In both cases, both cost and input saving will be achieved. Overall, 64% of the farmers were within the upper band of the index having an efficiency of 70% and above. This implies that the majority of the farmers have relatively high technical efficiency. There is a weak but significant correlation ($r=0.42$, $p<0.05$) between technical efficiency of farms with their profitability using the NFI. The technical efficiency of the farms cannot therefore not totally explain their profit outcome NFI.

Table 11. Distribution of technical efficiencies among the catfish farmers

Efficiency Index	Frequency (n=30)	Percentages
0.4-0.5	1	3%
0.5-0.6	3	10%
0.6-0.7	7	23%

0.7-0.8	5	17%
0.8-0.9	5	17%
0.9-1	9	30%
Mean	0.7819	
Maximum value	0.9996	
Minimum value	0.4995	
Correlation of efficiency index with farm profit (NFI) ($p< 0.05$)	r =0.42	

3.6.3 Maximum likelihood estimates of the stochastic production frontier

The sigma squared (δ^2) of the maximum likelihood estimates (MLE) which is an indicator of correctness and good fit of the specified distributed assumption of the composite error term was statistically significant (Table 12). The variance ratio, gamma, γ = approx. 1 and statistically significant, indicates that approximately 100% of the variation in the output of the farms were due to difference in their technical inefficiencies. The result of the judgement statistics (Likelihood Ratio test) confirms that the stochastic frontier model using the MLE is a significant improvement over the OLS estimates.

The estimated MLE coefficients of all the variables were positive except for the number of fingerlings used. Also, only the coefficients of feed and maintenance cost were significant at α=0.001 and α=0.05, respectively. The positive and significant coefficient of feed at 0.8475 means that if the quantity of feed was increased by 10%, the output will improve by a margin of 8.475%. While the positive coefficient indicates that increase in the input will result in a corresponding increasing in output, the negative coefficient observed in the fingerling indicates increase in fingerlings does not increase output but rather decreases it. Though this value is not significant, it substantiates the production management result which showed there was abuse of fingerlings in fish production especially by the small and medium scale farmers who constitute the majority. Excessive fingerling use was also observed by Igwe (2014) who reported a negative coefficient for fingerlings cost among farmers in Abia State. However, the production management result showed the large-scale farms fared better on fingerling usage.

Table 12. Maximum Likelihood Estimates of parameters of the Cobb Douglas – SFA model

Production factors	**Coefficient**	**Std. Error**	**z value**	**T-value**
(Intercept)	1.633e-01	1.15e-01	1.4258	0.15392
Log (Feed (kg))	8.475e-01***	7.72e-02	10.9758	< 2.2e-16
Log (Fingerlings) (No)	-8.565e-02	9.76e-02	-0.8778	0.38006
Log (Labour) (man-days)	2.207e-02	6.18e-02	0.3572	0.72093
D1	-5.140e-02	1.13e-01	-0.4569	0.64774
Log (Maintenance cost) (₦)	1.197e-01*	5.94e-02	2.0168	0.04371
Log (Fixed cost) (₦)	4.026e-02	5.31e-02	0.7581	0.44838
sigmaSq	1.169e-01***	2.77e-02	4.2187	2.458e-05
Gamma	1.000e+00***	4.69e-05	21299.5734	< 2.2e-16
Log likelihood function	10.5796			
Mean technical efficiency	0.7819			
LR test (P-value)	0.000736 ***			

Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

3.7 Key factors of profitability and efficiency

The production management and efficiency results show that fish farming is affected by input management and cost minimisation. High input costs and relatively low sales price were major factors that contributed to the loss faced by the medium and small-scale farms. While the sales price per kg were similar, higher production cost by medium farms resulted in them being affected most in this study. Moreover, it was observed that a very large percentage of medium farms falls within the least experienced groups having less than 5 years of experience. A separate analysis of contributors to technical inefficiency was conducted and indicated that experience of above 10 years has a significant negative coefficient which implies it contributes positively to improved technical efficiency. Further analysis of the relationship between experience and profit (NFI) was carried out (Figure 3) and it showed wide variations in profit exist across the low levels of experience and the majority of them made losses. Profitability increased with experience. This indicates that experienced farmers were able to take advantage of years of experience in maximising profit by either cost reduction or revenue increase through better market price. Both measures were however adopted by the large-scale farms, which happened to be the most experienced category with 75% having above 10 years of experience. This further demonstrates the role of experience in contributing to efficiency and profitability.

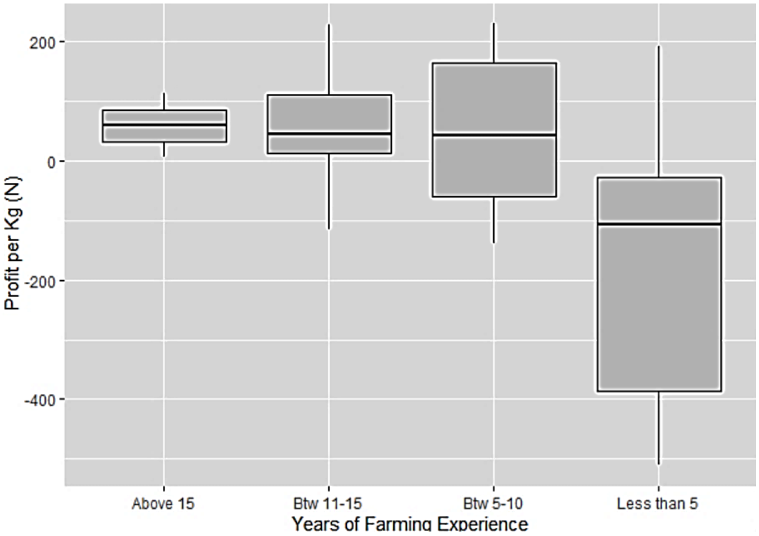

Figure 3. Plot of profit per kg against farmers experience

4 CONCLUSION

Catfish farming has grown very quickly over the last decades in Nigeria and is now a major venture. It contributes significantly to fish food security and job creation. However, the recent decline in production called for the need to investigate the profitability of the sector across different scales of operation. Though the overall profitability assessment as indicated by the GM & NFI shows the venture is profitable, the scale-wise analysis indicated that on average, only the large farms are profitable having high value of GM and NFI and positive values for BCR, RoI, OPM and GR while the average profitability assessment indicated lack of profit among small and medium farms. Nevertheless, some of the small (50%) and medium (40%) farms also made profits (NFI). Excessive production costs and improper use of inputs were found to have affected the profitability of medium and small-scale farms. Most of these farms have low years of experience (below 10 years).

The frontiers result showed that the majority (97%) of farms are above 0.5 level of technical efficiency with 47% between 0.8 and 0.99. The efficiency coefficient of fingerlings showed negative and this could be corroborated by the outcome of the production management estimates. The mean efficiency results showed that the farmers have scope to increase fish production. However, the correlation between Net Farm Income and technical efficiency is only r=0.42 (p value <0.05). This implies that the lack of profitability cannot be exclusively explained by the TE. The production management evaluation as provided by the per Kg estimates showed that the observed lack of profitability of the farmers are more a result of poor economic management. This cannot be unconnected with lack of understanding of basic business management tools and the farmers are therefore not economically efficient in their operation.

The field experience showed that while many farmers take care of the technical aspects, the same cannot be said of the financial aspects of the operation. These farmers need a target oriented economic plan and management of the farms. The focus of most training on fish farming over the years has been on the technical aspect of production without consideration for the business component. In order to restore the production growth, further promote food and nutrition security, the overall profitability of catfish farming must be boosted by strengthening the weaker sections in the different production categories. This study suggests that while farmers need to improve on their technical efficiency, they need to be equipped with adequate knowledge on economic management of fish farming for the enterprise to be viable, profitable and sustainable.

5 RECOMMENDATIONS

5.1 Farmers

The fish farmers in the study area need to acquire more training on the business management aspect of fish production. There is need for adequate record keeping by farmers so that extension agents or trainers can properly assess the farm’s operation and advise accordingly. This record could also be used to train the farmer on the economic assessment of their operation.

5.2 Government

Government fisheries and extension officers should be trained more on the economic dimension of fish farming and not only the technical aspect. Mobile and online platforms should be provided where farmers can have access to basic aquaculture-tailored profitability ratios that could be adapted for their operation.

5.3 Further study

The result of the profitability study indicated the effect of poor cost management. There is therefore a need to assess the degree of efficiency of the farms allocatively (cost-wise), to understand their deviation from the optimum, and with that, there could be a comprehensive assessment of the farms’ economic efficiency.

Most aquaculture efficiency analyses are based on a single period data (annual or cycle) which could not capture the performance of the sector over time. Such information would be useful in understanding the growth of the sector over time and aid in developing suitable strategies for sustainable aquaculture management. Same could be done across production scales to see whether there has been any improvement in efficiency within different sizes of farms over time.

Lastly, the number of samples collected for the categories (especially large scale) assessed in the current study limited the depth of analysis that could be done. Subsequent study with more samples for each category would allow for the efficiency to be assessed on scale-wise basis. Likewise. the study could be scaled up to a national level to evaluate if the same observation is operational and this would guide in making key policy recommendation that would steer the future of the sector.

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APPENDIX: Fish farm socioeconomic characteristics by scales of operation

	Operation Scale Categories							
	Large		**Medium**		**Small**		**Grand Total**	
Age	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
< 30		0.0	1	10.0		0.0	1	3.3
>60		0.0	1	10.0	1	6.3	2	6.7
31-40	4	100.0	4	40.0	5	31.3	13	43.3
41-50		0.0		0.0	7	43.8	7	23.3
51-60		0.0	4	40.0	3	18.8	7	23.3
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Gender								
Female			5	50.0	5	31.3	10	33.3
Male	4	100.0	5	50.0	11	68.8	20	66.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Household Size								
<5	2	50.0	5	50.0	7	43.8	14	46.7
6-10	2	50.0	5	50.0	7	43.8	14	46.7
16 and above		0.0		0.0	2	12.5	2	6.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Highest Educational Level								
Secondary	1	25.0		0.0	1	6.3	2	6.7
ND/NCE		0.0	1	10.0	3	18.8	4	13.3
Degree	1	25.0	4	40.0	8	50.0	13	43.3
MSC Above	2	50.0	5	50.0	4	25.0	11	36.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Pond Ownership								
Owned	3	75.0	5	50.0	13	81.3	22	73.3
Rented	1	25.0	5	50.0	3	18.8	8	26.7
Grand Total	4	100.0	10	100.0	16	100.0	30	100.0
Main Occupation								
Civil Servant		0.0	3	30.0	3	18.8	6	20.0
Fish Farming	4	100.0	5	50.0	9	56.3	18	60.0
Trading		0.0	2	20.0	4	25.0	6	20.0
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Fish Farming Experience								
Less than 5		0.0	5	50.0	6	37.5	11	36.7
Btw 5-10	1	25.0	3	30.0	8	50.0	12	40.0
Btw 11-15	1	25.0	2	20.0	2	12.5	5	16.7
Above 15	2	50.0		0.0		0.0	2	6.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Technical Support Source								
Extension Agent		0.0	1	10.0		0.0	1	3.3
Other Farmers		0.0	1	10.0	9	56.3	10	33.3
Social Media	1	25.0	5	50.0	3	18.8	9	30.0
Training Courses	3	75.0	3	30.0	4	25.0	10	33.3
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**

Major constraints								
Animal Interference		0.0	1	10.0		0.0	1	3.3
Fund/OprCost	1	25.0	7	70.0	8	50.0	16	53.3
Inadequate Technical Knowledge		0.0		0.0	2	12.5	2	6.7
Marketing		0.0		0.0	3	18.8	3	10.0
Poor Fish Performance	3	75.0	2	20.0	3	18.8	8	26.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Fingerlings source								
On-Farm	2	50.0	1	10.0		0.0	3	10.0
Other Farms	2	50.0	9	90.0	16	100.0	27	90.0
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Water source								
Borehole	2	50.0	4	40.0	14	87.5	20	66.7
Spring		0.0	3	30.0	2	12.5	5	16.7
Stream/River	2	50.0	2	20.0		0.0	4	13.3
Well & Borehole		0.0	1	10.0		0.0	1	3.3
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Culture facility type								
Collapsible pond		0.0	1	10.0	1	6.3	2	6.7
Concrete & Plastic pond		0.0		0.0	3	18.8	3	10.0
Concrete pond	3	75.0	5	50.0	8	50.0	16	53.3
Earthen pond	1	25.0	4	40.0	2	12.5	7	23.3
Plastic pond		0.0		0.0	2	12.5	2	6.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Major feed used								
Blue Crown	1	25.0	5	50.0	7	43.8	13	43.3
CHI	1	25.0		0.0	2	12.5	3	10.0
Ecofloat	2	50.0	2	20.0	3	18.8	7	23.3
Local feed		0.0		0.0	2	12.5	2	6.7
Skretting		0.0		0.0	1	6.3	1	3.3
Top feed		0.0	2	20.0		0.0	2	6.7
Vital feed		0.0	1	10.0	1	6.3	2	6.7
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**
Stocking density range (sqm)								
1-50	2	50.0		0.0	10	62.5	12	40.0
51-100	2	50.0	5	50.0	3	18.8	10	33.3
101-150		0.0	3	30.0	2	12.5	5	16.7
151-200		0.0	2	20.0	1	6.3	3	10.0
Grand Total	**4**	**100.0**	**10**	**100.0**	**16**	**100.0**	**30**	**100.0**