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Profitability analysis of smallholder aquaculture farms: the case of Lagos State, Nigeria

Opeyemi Obafemi Adelesi [a,b,*], Olayinka Isiaka Baruwa [c]

[a] *Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute), University of Hohenheim, Germany*
[b] *Leibniz Institute of Agricultural Landscape Research (ZALF), Germany*
[c] *Obafemi Awolowo University, Ile-Ife, Nigeria*

Abstract

Nigeria is the largest (total) fish consumer in Africa and among the highest consumers in the world. The domestic fish production is short of the consumption demand despite the vast potentials in the fishery sector. Harnessing these potentials rightly will help to increase employment and increase food fish production and availability. It is clear given the importance of aquaculture in fish production that efforts must be made to encourage entrepreneurs to go into the business. Many have cast doubts on the profitability of aquaculture production, particularly on a smallholder level. This paper determines the profitability of smallholder aquaculture farmers in Lagos State, Nigeria, with a specific focus on catfish farmers. Eighty catfish farmers were interviewed using random sampling among farmers in fish farm estate in Ikorodu, Lagos. The study used enterprise budgeting, investment and sensitivity analysis to determine the profitability of catfish production in the study area. The study showed that current farmers are having positive cash flow. However, the investment analysis showed that investment in catfish production is not profitable. The enterprise became profitable due to the expansion of the farm enterprise by constructing at least five additional ponds.

Keywords: fish-farm, catfish, Ikorodu, investment

1 Introduction

The world faces a global challenge of feeding a population of nine billion people by 2050 in view of climate change challenges, global economic doubts, financial instability and growing competition for natural resources (FAO, 2016c). The number of undernourished people in the world has been on the increase in recent times with a total of 821 million undernourished people in 2017, which is estimated to be about 10.9 percent of the world's population. Africa is the most affected continent with about 21 percent of the total population undernourished (FAO, IFAD, UNICEF, 2018).

Fish play significant roles in nourishing the world's population due to their high nutritive quality as well as providing essential minerals, micronutrients and fatty acids (Béné *et al*., 2015; Alemayehu & Tamiru, 2019). Fish also contribute a high amount of animal protein to human diets as 15 to 20 percent of human animal protein consumption come from aquatic animals and they serve as important supplements in diets that lack essential vitamins and minerals (FAO, 2018).

For many years, countries around the world have depended mainly on capture fish to meet their fish requirement and capture fish production reached a relatively static point in the late 1980s. Aquaculture has since served as a means of meeting the supply gap of fish for human consumption. There has been an increase in the share of aquaculture in the total fish supply for human consumption from seven percent in 1974 to 39 percent in 2004 and in 2016, the total fish production from aquaculture (80 million tons) narrowed that of capture fish (90.9 million tons). This was a landmark achievement and a giant step in achieving the UN 2030 Agenda.

In Nigeria, the quantity of fish produced through aquaculture is just over 300,000 tons, which is lower than over 750,000 tons produced through capture fisheries (WorldFish, 2017; Bradley *et al*., 2020) and 523,320 tons through freshwater fisheries (FAOSTAT, 2013). According to the report published by the Fisheries Committee for the West Central

* Corresponding author – o.o.adelesi@gmail.com

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Gulf of Guinea in 2016, the total fish consumed by the Nigerian population of 180 million people in 2014 was 3.32 million metric tons and the total domestic fish production from aquaculture, artisanal and industrial fisheries in the same year was 1.123 million metric tons. However, the difference between domestic consumption and production was met by importation of 2.197 million metric tons (WorldFish, 2018).

The fisheries sector in Nigeria contributed about 0.48 percent to the agricultural GDP whereas agriculture contributed about 20.24 percent to the total GDP in 2014 (FAO, 2016b). In addition, Ozigbo *et al.* (2014) report that the fisheries sector contributes about 40 percent of the total animal protein intake of the Nigerian population and with an annual per capita fish consumption of 13.3 kg in 2013, which is short of the global average of 20kg per year. (FAO, 2016a, 2017; Bradley *et al*., 2020). Fish also contribute 36.6 g per day of net protein consumption in Nigerian homes, which is also short of the required amount by the World Health Organisation (WHO) (Amao *et al*., 2006).

The issue of the domestic fish production falling short of the consumption demand despite about three million people employed in the fishery sector brings unanswered questions. Also with availability of large hectares of swampland (Ozigbo *et al*., 2014), large water bodies (Adewolu *et al*., 2009) and a substantial market for fish products (Brummett *et al*., 2008). There are about 264 medium and large dams across Nigeria and a storage capacity up to 33 billion cubic meters of water. The federal government owns 210 dams, the state governments own 34 dams and private organisations own 20 dams. These dams are suitable for aquaculture production (Ozigbo *et al*., 2014; Akinsorotan *et al*., 2019). Despite these abundant human and natural resources that favour fish production, one therefore thinks that perhaps aquaculture is not a profitable venture and many small and large-scale entrepreneurs do not have enough incentives to go into this business.

Many authors have reviewed the prospects of the aquaculture enterprise to generate income (with high profits) for farmers and create employment opportunities, particularly in rural areas (Anetekhai *et al*., 2004; Béné *et al*., 2016; Onyekuru *et al*., 2019; Alawode & Ajagbe, 2020). Despite these prospects, Nigeria remains a net importer of fish (WorldFish, 2018; Adeleke *et al*., 2020). The question one then asks is, why the shortage in production of fish persists in Nigeria. This paper therefore, investigates the economic performance of smallholder aquaculture (catfish - *Clarias gariepinus*) farmers in Lagos State, by giving answers to specific questions of profitability of aquaculture business in the study area.

2 Materials and methods

2.1 Study area

Lagos State is located in southwest geo-political zone of Nigeria on the narrow plain of the Bight of Benin. The state is lying approximately between longitude 2°42' E and 3°42' E and latitude 6°22' N and 6°52' N (Badmos *et al*., 2020). The state shares the northern and eastern borders with Ogun State and the western borders are shared with Republic of Benin. The southern border however, extends for about 180 kilometres (km) along the Guinea Coast of the Bight of Benin on the Atlantic Ocean. The state has a total land mass of 3,577 km^2, which is about 0.4 percent of Nigeria's territorial land mass of 923,773 km^2 and the Lagos Lagoons represent 22 percent of the land mass of the state (786.94 km^2). The large water bodies support different species of fish and aquatic life and provide great opportunities for fishermen in the region (Lagos State Government, 2018; Williams *et al*., 2012). The state is divided into five administrative divisions of Ikeja, Badagry, Ikorodu, Lagos (Eko) and Epe, which are collectively referred to as IBILE. These divisions are further divided into 20 local government areas (LGA) and 37 local development council areas. The state is estimated to accommodate about 24.6 million inhabitants in 2015 (Lagos State Government, 2018).

The study was carried out at the Fish Farm Estate, Odogunyan community in Ikorodu, which is located approximately 36 km North of Lagos. The Lagoon supplies the local government with abundance of water resources. Geographically, the LGA is located at 3°18' E longitude and 6°22' N latitude (Boge, 2007).

The fish farm estate was set up by the Lagos State government in 2011 to boost aquaculture fish production in the state. According to the government, the estate was set up to meet the needs of low-income groups, such as artisan fishermen, school leavers, high-income groups and corporate bodies. The estate is a public-private initiative established to create employment and help to increase local fish production. The estate is on a 34-hectare land with 262 production plots, which were allocated to 176 farmers. The estate produces about 10,000 tons of catfish annually and it also has a technology demonstration centre which comprised 50,000 juveniles and 300 kg fish.

2.2 Sampling technique and data collection

The sampling frame for the quantitative data was based on the farmers' information obtained from the Lagos State ministry of agriculture, Alausa, Lagos. The estate was chosen because it is a representation of typical fish farmers in the state. Eighty (80) fish farmers were randomly se-

lected among the list of farmers at the fish estate and the selected farmers were identified with the help of the estate management. Primary data were collected with the aid of structured questionnaires through personal interviews of the respondents. Data were analysed using descriptive analysis, enterprise budget analysis, investment analysis and sensitivity analysis.

2.3 Enterprise budget

The enterprise budget analysis was done in order to list the incomes, all the inputs and production processes associated with the aquaculture enterprise. The gross income (gross revenue), was determined by adding the total income (revenue) obtained in the farm. The total cost accrued in the farm was then calculated by adding the total variable cost and the total fixed cost.

$$TC = TFC + TVC \tag{1}$$

Where, TC = total cost, TFC = total fixed cost, and TVC = total variable cost.

2.4 Depreciation

The depreciation value for all depreciable assets was calculated using straight line method because it is widely and easy-to-use-method and it estimates the same annual depreciation for each full year of an item's lifespan (Ronald & Edwards, 2016).

$$\text{Depreciation} = \frac{\text{cost of asset} - \text{salvage value}}{\text{useful life}} \tag{2}$$

The depreciation value was used in computing the fixed costs as using the cost of the assets will overestimate the current cost for any particular year since the assets have a useful life more than one year. From the enterprise budget the net farm income (net profit) was calculated by subtracting the total costs from the total revenue.

$$NFI = TR - TC \tag{3}$$

Where, NFI = net farm income, TR = total revenue, and TC = total cost.

The gross margin (income above variable costs), which shows how much an enterprise unit will contribute toward payment of fixed costs (Ronald & Edwards, 2016), was calculated using the formula:

$$GM = TVC - GR \tag{4}$$

Where, GM = gross margin, TVC = total variable cost, and GR = gross revenue.

Break-even price or total cost of production shows more insight into the overall flexibility of the operation of the enterprise. It measures the cost of production of a single unit of the product (fish) and it is calculated by dividing the total variable cost by the quantity produced (Engle, 2010).

$$BEP = \frac{TVC}{q} \tag{5}$$

Where, BEP = break-even price, TVC = total variable cost, and q = quantity produced/yield.

2.5 Investment analysis

Investment analysis was carried out to determine how investment in catfish farming is likely to perform. The cost prices of all non-current assets were summed up to obtain the total non-current asset value. The payback period shows how long it will take for an investment to return the amount invested through the revenue it generates (Ronald & Edwards, 2016). It was calculated by dividing the initial cost of the investment by the expected annual revenue.

$$PP = \frac{ICV}{R} \tag{6}$$

Where, PP = payback period, ICV = initial cost of investment (total non-current asset), and R = expected annual revenue (the revenue on an annual basis).

In addition, the rate of return was calculated in order to determine the efficiency of the investments. It shows the average generated revenue as a percentage of the investment (Engle, 2010). This was calculated by dividing the average net revenue by the initial cost of investment and multiplying the result by 100.

$$RR = \frac{ANR}{C} \times 100 \tag{7}$$

Where, RR =rate of return, ANR = average net revenue, and C = initial cost of investment.

The average net revenue was calculated using a 15 years[1] investment period by adding the expected annual return each year (total net revenue). The initial amount invested was deducted from the total net revenue and then divided by the total year of investment.

Net present value (NPV) was calculated in order to account for the differences in the value of money over time

[1] 15 years investment period was used in order to cover a long term period in the investment analysis that will allow coverage for the Payback period, which was about 13 years (see Table 4).

due to inflation. This was done by using a 20–year[2] investment period and the expected annual return for each year was discounted by dividing the yearly cash flow by 1 plus the discount rate and raised to the power of the years to obtain the present value of each year using:

$$\mathrm{PV} = \frac{\mathrm{P}_n}{(1+\mathrm{I})^n} \tag{8}$$

Where, PV = present value, P_n = cash flow for year n, and I = discount rate.

The discount rate was calculated by the weighted average of the interest rate of loan obtained by the respondents and the opportunity cost of the capital used by the respondents for the investment. This opportunity cost was obtained by the bank interest rates on savings in Nigeria, which according to StanbicIBTCBank - Nigeria (2018) is 4.2 percent[3]. The loan average was then obtained by dividing the loan amount by the initial cost of investment and multiplying the result by the interest rate.

$$\mathrm{LA} = i \times \left(\frac{\mathrm{L}}{\mathrm{ICV}}\right) \tag{9}$$

Where, LA = loan average, i = loan interest rate[4], L = loan amount, and ICV = initial cost of investment.

Also,

$$\mathrm{OEA} = i \times \left(\frac{\mathrm{OE}}{\mathrm{ICV}}\right) \tag{10}$$

Where, OEA = owner's equity average, i = bank interest rate, OE = owner equity, and ICV = initial cost of investment. The weighted average was then calculated by adding the loan average and the owner's equity average.

$$\mathrm{WADR} = \mathrm{LA} + \mathrm{OEA} \tag{11}$$

Where, WADR = weighted average discount rate, LA = loan average, and OEA = owner equity average.

With these above, the net present value was then calculated by adding all the present values and then deducting the initial cost of investment from it.

$$\mathrm{NPV} = \frac{\mathrm{P}_1}{(1+\mathrm{I})^1} + \frac{\mathrm{P}_2}{(1+\mathrm{I})^2} + \ldots. + \frac{\mathrm{P}_n}{(1+\mathrm{I})^n} - \mathrm{C} \tag{12}$$

Where, NPV = net present value, P1, 2, n = cash flow for year 1, 2, n, I = discount rate, and C = initial cost of investment.

The internal rate of return (IRR) was also calculated in order to determine the profitability of potential investments. The internal rate of return accounts for the time value of money and it calculates the discount rate that equates the NPV to zero (Engle, 2010).

$$0 = \frac{\mathrm{P}_1}{(1+\mathrm{I})^1} + \frac{\mathrm{P}_2}{(1+\mathrm{I})^2} + \ldots. + \frac{\mathrm{P}_n}{(1+\mathrm{I})^n} - \mathrm{C} \tag{13}$$

Benefit-cost ratio also known as profitability index, which gives the ratio of the future net cash flows over the life of the project to the net investment (Curtis, 1993). It was calculated by dividing the NPV by the initial investment:

$$\mathrm{BCR} = \frac{\mathrm{NPV}}{\mathrm{INV}} \tag{14}$$

Where, BCR = benefit cost ratio, NPV = net present value, and INV = initial investment.

Investment analysis[5] was also carried out for the farmers willing to expand their production. This was done by taking into consideration the non-current assets needed for expansion of production. An assumption that a farmer intends to expand production with five additional ponds was made. This assumption was made after performing a sensitivity analysis on the effect of additional ponds on the NPV and the IRR of the farmers' investment. With this, the outcome of the investment analysis was calculated for each additional pond and the farmers' investments became positive after the additon of five extra ponds. With this therefore, the farmer needs to purchase extra pieces of land to accommodate the additional ponds, construct additional boreholes and purchase a pumping machine; these costs were summed (see Appendix 1).

2.6 *Sensitivity analysis*

Furthermore, the profit obtained was subjected to sensitivity analysis to determine how robust the profit is to changes in certain input and output parameters. The input parameter used was feed cost because it accounted for a large part of the variable cost. The effect of increasing the feed cost by an additional 1 % on the profit until the enterprise gives a zero profit was determined. This was done by increasing the current fish price by 1 % and obtaining the net returns to management. This simulation was repeated until the net returns to management returns a negative value. In addition, the effects of the changes in yield of the fish on the profit

[2]20 years investment period was used because the payback was long and in order to cover a long-term period, a long-term investment period is preferred.

[3]4.2 percent is the average interest rates on savings in most Nigeria banks.

[4]Loan interest rate was obtained through the collected data.

[5]For the calculations of the investment analysis on expansion, all the additional non-current assets incurred as a result of the expansion were added and the calculations for average rate of returns, net present value, internal rate of return and benefit-cost ratio were calculated using the formulas presented here above.

were calculated. This was done by decreasing the yield by 10 %, until 40 % at the current market price of fish and then obtaining the returns to management at every percentage decrease.

3 Results

3.1 Social economic characteristics of catfish farmers

The results presented in Table 1 show that the farmers are in their economic active age (below 60) and are mentally and physically stable to carry out fish farming activities and also face the challenges that they may encounter in the production of catfish.

Table 1: *Social economic characteristics of respondents (N=79).*

Category	*Percentage*	*Mean*
Age group (years)		
20-29	15.2	
30-39	30.4	
40-49	24.1	40
50-59	13.9	
60-69	16.5	
Gender		
Female	36.7	
Male	63.3	
Marital status		
Single	44.3	
Married	55.7	
Education		
Secondary	19.0	
National Diploma	16.5	
Higher National Diploma	15.2	
Bachelor	27.8	
Master	20.3	
PhD	1.3	
Main occupation		
Fish farmer	96.2	
Retired	3.8	
Secondary occupation		
None	45.6	
Crop production	6.3	
Animal husbandry	19.05	
Mixed crop and livestock farmer	3.8	
Private sector employee	3.8	
Trader	6.3	
Own enterprise	10.1	
Job seeker	2.53	
Other	2.5	

3.2 Average production method and stocking capacities

Table 2 and 3 present the method of production and the average production parameters of the catfish farmers respectively. This information is important for the various calculations that involve the enterprise budget and investment analysis. The ponds where the fish are reared ranged from earthen ponds to concrete ponds and some of the farmers made use of tarpaulins. The result in Table 3 shows an average stocking density of 2,402 pieces of juveniles per pond with a minimum of 600 and a maximum of 6,000 pieces of fish. The annual amount of fish stocked (as at December, 2017) was 16,814 pieces and these fish were sold at an annual average weight of 15,326 kg. The production period for rearing a set of fish was on average 5 months with a minimum of 4 months and a maximum of 10 months. The average price of the fish sold was ₦ 734 kg^{-1} with a lowest price of ₦ 650 kg^{-1} and a highest price of ₦ 850 kg^{-1}. The fingerlings were bought at an average price of ₦ 20 per piece with a minimum price of ₦ 8 and a maximum price of ₦ 25.

Table 2: *Distribution of fish farmers' pond type (N=79).*

Pond type	*Percentage*
Earthen	10
Concrete	61
Flow through system	2
Tanks	12
Tarpaulin	7
Others	7
Average number of ponds owned	7

Table 3: *Production averages per fish farmer (N=79).*

Category	*Unit*	*Average*	*Min*	*Max*
Stocking density	Fish pond^{-1}	2,402	600	6,000
Fish stocked year^{-1}	Pieces	16,814	2,000	50,000
Fish sold year^{-1}	kg	15,325	1,500	50,500
Production cycle	Months	5 months	4	10
Survival rate	%	88.88	80	98
Harvest weight	kg	1,104	800	1,850
Fish price	₦ kg^{-1}*	734	650	850
Fingerlings price	₦*	20	8	25

*$1 is equivalent to ₦ 305.75 as at August 2018 (Central Bank of Nigeria, 2018). See also appendix 2 for ₦ to $ price chart.

3.3 Enterprise budget analysis

An enterprise budget analysis that provides an estimate of the revenue, costs and profit for catfish farmers in the study area is presented in Table 4. The enterprise budget is done

Table 4: *Enterprise budget for a 1.5 plots (0.1 ha) catfish farm in Lagos State.*

Item	*Description*	*Unit*	*Quantity*	*Price per unit (₦)*	*Total (₦)*
Revenue					
Grown out fish sold		kg	15,325	733.9	11,247,455
Smoked sold		kg	125	1,000	125,000
Fingerlings sold		₦	30,744	16.6	510,358
Gross income					*11,882,813*
Variable costs					
Seasonal worker's wage*	EA	₦	20	14,790	295,800
Cost of fingerlings	EA	₦	18,558	12	222,694
Feed cost	EA	kg	1,046.7	8,200	8,582,740
Drugs (total)	EA	₦			18,687
Security (total)	EA	₦			3,725
Fuel	EA	litre	168.35	145	244,111
Gasoline	EA	litre	7.6	315.56	2,400
Limestone	EA	kg	30	100	7,580
Fertiliser	EA	kg	1.6	800	3,000
Lime	EA	kg			1,267
Miscellaneous	EA				32,269
Total variable costs					*9,414,274*
Gross margin					*2,468,540*
Fixed costs					
Pumping machine	EA	₦		116,333‖	19,389†
Drag net	EA	₦		4,230	4,230
Vehicle	EA	₦		150,000‖	30,000†
Refrigerator	EA	₦		70,000‖	11,667†
Wheel barrow	EA	₦		13,500‖	2,700†
Hoes	EA	₦		2,700‖	1,350†
Cutlass	EA	₦		2,825‖	1,412†
Weighing scale	EA	₦		34,750‖	11,583†
Test kit	EA	₦		14,000‖	2,333†
Shovel	EA	₦		4,733‖	2,367†
Equipment maintenance	EA	₦			22,600
Fence repairs	EA	₦			195,000
Household consumption	EA	₦			3,500
Borehole construction	EA	₦		552,692‖	27,635†
Land§	OC	₦			310,587
Repayment on loan	EA	₦			53,521
Permanent labour‡	EA	₦		42,133	632,000
Pond construction	EA	₦			435,508
Total fixed costs					*1,767,382*
Total cost					*11,181,655*
Profit (net returns to management)					701,158
Breakeven price	₦				723
Breakeven yield	kg				15,235
Cost of production (per fish)	₦				665

EA = empirical average; OC = opportunity cost.
*These workers are used only during specific periods like sorting or harvesting of fish. †Annual depreciated cost. ‖Total item costs - see Table A1 in Appendix 3. ‡Labour cost are calculated on an annual basis. Opportunity cost of labour was used to calculate the family labour of the enterprise. The wages earned by the farm labourers were used.
§Opportunity cost of land = annual rental cost of land (Some farmers owned land while some rented the land. For those that owned the land, the annual cost of the land was calculated using the opportunity cost of land, which is the rent of the amount of land. The total annual payment of the land was the addition of the opportunity cost of land owned and the total amount paid for rented land.)

on an annual basis and it represent the year ending at August 2018. Based on the results, the total revenue earned was ₦ 11,882,813 and the total variable cost as at this period was ₦ 9,414,274. The gross margin was ₦ 2,468,539. The result of the gross margin show that the business can run without problems in the short run period and it therefore means that the enterprise will contribute ₦ 2,468,538 to the payment of the fixed cost. The economic profit of catfish enterprise in the study area was ₦ 701,158. This proves that the current catfish farmers in the study area are making profits (positive cash flow) at their current level of production.

3.4 Depreciation schedule

Table A1 (Appendix 3) presents the depreciation schedule used for the depreciable fixed assets. The results show that total cost of these assets was ₦ 3,143,302 and the annual depreciation cost paid on the assets was ₦ 550,174. The assets have a useful life ranging from one to twenty years and none of them has a salvage value.

3.5 Investment analysis

3.5.1 Expected annual returns and payback period

Table A2 (Appendix 3) shows the market costs of the non-current (long-term) assets, which are for investment purposes. The total amount of capital investment was ₦ 8,839,303. This cost includes the full purchasing cost of land, cost of boreholes, cost of ponds and pumping machines. The expected annual return based on the enterprise budget (Table 3) was ₦ 701,158. The payback period is 12.6 years. This therefore means that it will take about 13 years for the investment to return its original cost. This is a very long waiting period for the farmers to wait before recouping their capital invested.

3.5.2 Net cash revenue

The average net revenue over a 15-year period is ₦ 111,871. However, the rate of returns is 1.27 percent (see eqtn. 4 – 9 in Appendix 4). This means that the return on investment of capital is very low. This does not make investment in this business very attractive and profitable.

3.5.3 Net present value analysis

Net present value is a more reliable way of assessing investments as it is a discounted cash flow technique (Curtis, 1993), which accounts for the time value of money. The discounted rate used was eight percent, it was calculated by a weighted average between the interest rates on loan and the opportunity cost of owner's equity (eqtn. 10 – 15 in Appendix 5). Eqtn. 16 – 19 (Appendix 6) show the NPV of the investments for a catfish enterprise in the study region. Despite the time of a twenty (20) years investment period, the NPV was negative (–₦ 1,955,231). This shows that investment in catfish production is not profitable because the money invested is greater than the present value of the net cash flow. The investment is therefore rejected since it earns less than its opportunity cost (Engle, 2010). Eqtn. 20 and 21 also show that the IRR of the investment to be five percent. This also confirms that the investment is not profitable because the IRR is less than the opportunity cost of the capital invested (eight percent).

3.6 Expansion of production

For the existing farmers that are making only a positive cash flow, there is a need to know if expanding their farming operations will enable them to make profits on their investments in a short period. This section therefore shows the profitability of an expansion of a single cat fish farm. For a farmer to expand his farming operation, he/she needs to purchase and construct some additional non-current assets. The farmer needs to construct more ponds, purchase extra piece of land to contain the expansion, he/she needs to construct boreholes and purchase pumping machines. The farmer will also incur additional operating costs due to the expansion. It is therefore, important to state the conditions by which the existing farms operate before making assumptions and calculations for expansion. The existing farms operate their seven ponds under the following assumptions:

1. Number of fish annually stocked: 16,814;
2. Number of fish stocked per pond: 2,402;
3. Fish survival rate: 88.9 %;
4. Fish sold at ₦ 734 per piece;
5. Total cost of ponds (7) construction: ₦ 2,177,538;
6. Total cost of land owned: ₦ 5,696,000;
7. Borehole costs: ₦ 552,692;
8. Cost of pumping machine: ₦ 116,333.

The expansion is based on the assumption that the farmer intends to construct five additional ponds under the existing conditions. Five additional ponds were used for the calculation after obtaining the results (investment analysis) of adding one extra pond to the current enterprise and a minimum of five ponds added to the existing seven ponds is observed to be profitable for the farmers.

Table 5 shows the extra costs incurred due to the expansion of the enterprise. To construct five additional ponds, the farmers will have to pay ₦ 1,555,385 for pond construction. The farmer also needs to purchase an additional piece of land

for ₦4,068,571. The total investment for the expansion of the farming operation amounts to ₦12,826,313. The operational costs include all the associated costs that would be incurred to keep the expanded ponds running and this most importantly, include labour costs.

Table 5: *Costs accrued due to expansion.*

	costs for	
Item	*one pond*	*five ponds*
Pond construction	311,077	₦ 1,555,385
Exta land	813,713	₦ 4,068,571
Borehole	78,956	₦ 394,780
Pumping machine	16,619	₦ 83,095
Operating costs*	1,344,896	₦ 6,724,482
Total		₦ 12,826,313

*These costs include labour costs.

The revenue obtained due to the additional investments can be calculate as follows:

$$\text{ARDTFP} = \text{RSP} \times 5$$

Where, ARDTFP = Additional annual revenue due to five additional ponds and RSP = Annual revenue of a single pond.

FSTPP = Fish stock per pond = 2402; considering a survivability percentage of 88.9 % = 2135 fish per pond.

RSP = FSTPP × price = 2135 × 734 = ₦1,566,889

ARDTFP = RSP × 5 = ₦7,834,445

The total net revenue for a 5-year period will be ₦39,172,225 at an average net revenue of ₦1,756,394 per year.

3.7 Expansion investment analysis

Table 6 shows the NPV of the proposed additional investments (including the 5 additional ponds, which adds the total number of ponds to 12) of catfish enterprise in the study area. A discount rate of eight percent was used based on the previous calculations and conditions. The results indicate a positive NPV, which means that it is a profitable investment and that it earns more than its opportunity cost of capital. The IRR is 54 percent and it further confirms that the investment is very profitable as it is greater than the opportunity cost of invested capital (8 percent). Therefore, it is profitable for the farmers to invest in five additional ponds under the existing conditions in Lagos. Furthermore, the benefit-cost ratio (profitability index) is 1.44 and this is favourable because it is greater than one.

Table 6: *Net present value (NPV), internal rate of returns (IRR) and benefit cost ratio due to expansion.*

Year	*Net cash flow*	*Present value factor*	*Present value*
0	–₦ 12,826,313		
1	₦ 7,834,445	0.925925926	₦ 7,254,116
2	₦ 7,834,445	0.857338820	₦ 6,716,774
3	₦ 7,834,445	0.793832241	₦ 6,219,235
4	₦ 7,834,445	0.735029853	₦ 5,758,551
5	₦ 7,834,445	0.680583197	₦ 5,331,992
		Total	₦ 31,280,667
		Less cost	₦ 12,826,313
		NPV	₦ 18,454,354
		IRR	54 %
		Benefit cost ratio	1.44

Calculations based on expansion of the catfish enterprise show that investments in catfish farm enterprise could be profitable (due to economies of scale) if the farmers expand their level of production. The farmers are therefore, advised to add more capital to the business to expand their production by at least 5 additional ponds making an average of 12 ponds in order to become more productive.

3.8 Effects of inputs and output parameters on profitability- A sensitivity analysis

Feed cost was found to be a major input parameter that affects the production of a catfish enterprise. However, performing a sensitivity analysis on the feed prices to the returns to management (net farm income) will show to what extent the feed prices are allowed to increase and the farmers can still breakeven or make a positive cash flow. Table A3 in Appendix 7 shows that a nine percent increase in the current feed prices will lead to a negative cash flow, thereby resulting in the farmers making losses. If a farmer invests half of his savings and his labour (with that of his family) and a devaluation in the Nigerian currency to the US dollar (a major determinants of feed prices because they are mostly imported) for instance increases the price of feeds by nine percent, he will run at a loss. At the time of this study, 1 US dollar was ₦305.75 and these numbers are even much higher in recent time (see Fig. A1 in Appendix for detailed exchange rate). Table A4 (Appendix 7) on the other hand shows that a four percent decrease in the output price of fish at the current output quantity will lead to negative cash flow. If conditions like unemployment in the study area or a change in the consumer's taste negatively affects the price to decrease to as low as four percent or more, it means that the farmers will run at a loss.

4 Discussion

The socio economic characteristics showed that the average age of the catfish farmers is 40 years, with the majority of the farmers falling within the age range of 30–39 years. This result agrees with the findings of Ogunmefun & Achike (2017), who stated that majority of catfish farmers in Lagos State fall within the age range of 35–40 years. Majority of these farmers are male and this is an expected outcome as Ogunmefun & Achike (2017) noted that the high number of males compared to females in fish farming is because fish farming is capital and labour intensive in nature with a lot of risk and uncertainty attached to it and women are said to be risk averse. The results also showed that the majority of the farmers (55.7 %) are married. This is in line with the report of National Population Commission (2014) that stated that Nigerian men and women tend to marry at an early age.

The results obtained from the enterprise budget showed that the farmers are having a positive economic profit. These results agree with the findings of Adebayo *et al.* (2013), who found the profit of catfish farmers in Ibadan to be ₦574,112. This study arrived at the same conclusion as several previous studies that concluded that catfish production gives a positive cash flow (Adebayo & Daramola, 2013; Adewuyi *et al.*, 2010; Awoyemi & Ajiboye, 2011; Emokaro *et al.*, 2010; Olasunkami, 2012). The previous studies however, concluded that catfish production is profitable in the study area based on enterprise budget analysis alone. This conclusion is overestimated because it does not fully consider the investment of the farmers in the enterprise. The only conclusion that can be made based on the result obtained in this study is that the farmers that are currently into catfish production (those continuing existing ponds) are making a positive cash flow (which can be positive or negative profits). For a statement on profitability of the catfish enterprise, this study therefore continued with the investment analysis.

The results from the investment analysis proved that investments in a catfish enterprise in the study area are not profitable for most of the smallholder farmers as many findings like that of Yemi (2012) and Adebayo *et al.* (2013) suggest. Although authors like Alawode & Ajagbe (2020), Ogunmefun & Achike (2017) and Onyekuru *et al.* (2019) acknowledge that there are many constraints that these smallholder farmers should overcome to increase their profit margin, yet they also concluded on the basis of an enterprise budg*et al*one that the enterprise is profitable. Concluding this way can be misleading as enterprise budget will not show the profitability of the investments. This study clearly showed why we cannot conclude that these farmers are running a profitable enterprise until a clear analysis of their investments is carried out. Based on this, we can clearly answer the question why investors are reluctant to invest in catfish production in Nigeria, consequently leading to low production of fish in Nigeria. One then asks why these farmers continue to work in the sector despite not making profit. One of the answers to this is in the unemployment rate in the country, which according to the National Bureau of Statistics in 2018 is 18.8 percent and 52.65 percent for youth unemployment. These farmers and the farm workers consequently have low opportunity cost of labour. Another pointer to why the farmers may choose to remain in the business despite not making so much profit is because many workers are believed to prefer self-employment to seeking employment (Blanchflower, 2004). This, therefore, means that the farmers may continue to work as a catfish farmer as long as they make positive cash flow and they cover their variable costs instead of seeking employment elsewhere. Also, some of these farmers may not know they are making little to no profits because the common misconception is that catfish business is profitable. In addition, this study assumed a positive opportunity cost of labour and land. However, a farmer who has already constructed ponds and other facilities on his land will have to spend additional capital to convert the land for other purposes. Land in this case may not have opportunity cost anymore as the fixed costs are already incurred. Therefore, the farmers may be reluctant to convert their enterprise to other enterprise (despite making negative profits) because of the cost implications.

The current catfish farmers can become more productive and run a profitable enterprise if they expand their catfish enterprise by at least 5 additional ponds to an average of 12 ponds. This is a similar conclusion made by Onyekuru *et al.* (2019), where these authors emphasized the need for expansion and large scale production in order to increase profitability. However, one must also look at the cost implications of embarking on such a capital intensive project. Digun-Aweto & Oladele (2017) mentioned that there is a challenge of lack of capital, which can be a hindrance to expansion of the farmer's enterprise. One way to overcome this is through flexible loan terms by microfinance and other financial institutions in Nigeria. In addition, these additional investments will only require a significant number of labour at the initial stage. After the expansion is done, the farmer do not need to worry so much about employing a high number of labourers as one extra labourer or even the existing number of labourers can operate the addition to the enterprise. These costs were also accounted for in the operating costs used for the calculations.

5 Conclusions

Based on the findings from this study, it can be concluded that investment in a catfish enterprise in Lagos State is not profitable (true for new investors-either skilled or unskilled). The conclusion was made based on the results from the investment analysis. The returns on investment in catfish enterprise in Lagos are very low and the payback period is very long, thereby resulting in long waiting period before investments can be recovered. In addition, farmers that are currently into catfish production are making a positive cash flow but a negative profit. This is because they are just earning enough to cover their fixed costs. These farmers are still in production because they have low opportunity cost of labour due to high unemployment.

The current catfish farmers can become more productive and run a profitable enterprise if they expand their catfish enterprise by at least five additional ponds. By doing so, the farmers will become more profitable than those who cannot expand due to economies of scale. Overtime, these farmers will drive out the non-profitable farms from the market. These findings clearly explain why there is shortage of fish supply in Nigeria despite the previous studies concluding that smallholder aquaculture production is profitable in Nigeria.

6 Limitations of the study

Majority of the farmers do not keep records and this made data collection process longer and stressful. The farmers responded to the author's questions based on head knowledge and they sometimes were not able to recall specific details. The author in such situations asked several other questions that helped to arrive at the target question. Based on these responses, the author then made computations to arrive at the answers for the initial questions.

In addition, it took several efforts by the author to convince the farmers that the study is solely for academic purposes and not from the government. Majority of the farmers complained that the government send agents regularly to obtain data, promising to help them solve some of their challenges but the government did not help them as promised. This made the farmers very reluctant to provide the information needed for this study.

7 Recommendations

Based on the findings of this study, the study recommends the following:

1. Catfish farmers should be encouraged to expand their enterprise by digging more ponds and stocking them to full capacity. This will make them to be more productive and run profitable investments due to economies of scale.

2. The cost of feed constitutes a large percentage of the cost of production in a catfish enterprise. Efforts should therefore be made to reduce the price of feeds. This can be achieved through research on alternative means of feeding, encouraging domestic production of quality feeds with the use of readily available materials in the country.

3. Arrangements should be made to provide farmers with long term as well as flexible payment structure loans, which can help them to expand their enterprises without putting so much repayment pressure on them.

4. Farmers should be encouraged to practice combined enterprises rather than single enterprise. This will ensure that some of their cost of operation are been paid for by other enterprises and they also have income during waiting periods.

Supplement

The supplement related to this article is available online on the same landing page at: https://doi.org/10.17170/kobra-202203085851 .

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Conflict of interest

The authors declare that they have no conflict of interest.

References

Adebayo, O. O., & Daramola, A. O. (2013). Economic analysis of catfish (Clarias gariepinus) production in Ibadan metropolis. *Discourse Journal of Agriculture and Food Sciences*, 1(7), 128–134. https://www.semanticscholar.org/paper/Economic-analysis-of-catfish-(Clarias-gariepinus)-Adebayo-Daramola/54310926894d1044b2a4ceb15489bedc1494a33b.

Adeleke, B., Robertson-Andersson, D., Moodley, G., & Taylor, S. (2020). Aquaculture in Africa: A comparative review of Egypt, Nigeria, and Uganda vis-à-vis South Africa. *Reviews in Fisheries Science & Aquaculture*, 29(2), 1–31. https://doi.org/10.1080/23308249.2020.1795615.

Adewolu, M. A., Akintola, S. L., Jimoh, A. A., Owodehinde, F. G., Whenu, O. O., & Fakoya, K. A. (2009). Environmental threats to the development of aquaculture in Lagos State, Nigeria. *European Journal of Scientific Research*, 34(3), 337–347. https://www.semanticscholar.org/paper/Environmental-Threats-to-the-Development-of-in-JimohA./cad804c2d5da5e5aebb45044b3bdfb0755b12ab5.

Adewuyi, S. A., Phillip, B. B., Ayinde, I. A., & Akerele, D. (2010). Analysis of Profitability of Fish Farming in Ogun State, Nigeria. *Human Ecology*, 31(3), 179–184. https://doi.org/10.1080/09709274.2010.11906313.

Akinsorotan, A. M., Akinsorotan, O. A., Jimoh, J. O., Adene, I. C., & Akiwowo, U. A. (2019). Offshore aquaculture practice; a potential for meeting Nigeria fish demand – a review. *Journal of Physics: Conference Series*, 1299, 012111. https://doi.org/10.1088/1742-6596/1299/1/012111.

Alawode, O. O., & Ajagbe, S. O. (2020). Profitability of small-scale catfish production in southwest Nigeria: The challenges. *Economic Engineering in Agriculture and Rural Development*, 20(3), 77–88.

Alemayehu, A. W., & Tamiru, C. G. (2019). Socio-economic importance of Fish production and consumption status in Ethiopia: A review. *International Journal of Fisheries and Aquatic Studies*, 7(4), 206–211. https://www.fisheriesjournal.com/archives/?year=2019\&vol=7\&issue=4\&part=C\&ArticleId=1931.

Amao, J. O., Oluwatayo, I. B., & Osuntope, F. K. (2006). Economics of Fish Demands in Lagos State, Nigeria. *Human Ecology*, 19(1), 25–30. https://doi.org/10.1080/09709274.2006.11905853.

Anetekhai, M. A., Akin-Oriola, G. A., Aderinola, O. J., & Akintola, S. L. (2004). Steps ahead for aquaculture development in Sub-Saharan Africa - The case of Nigeria. *Aquaculture*, 239(1-4), 237–248. https://doi.org/10.1016/j.aquaculture.2004.06.006.

Awoyemi, T. T., & Ajiboye, A. J. (2011). Analysis of Profitability of Fish Farming Among Women in Osun State, Nigeria. *Journal of Economic and Sustainable Development*, 2(4), 1–9. https://www.semanticscholar.org/paper/Analysis-of-Profitability-of-Fish-Farming-Among-in-Awoyemi-Ajiboye/6fcb80ea3521e0caf73e33758a364843bfed1ad1.

Badmos, O. S., Callo-Concha, D., Agbola, B., Rienow, A., Badmos, B., Greve, K., & Jürgens, C. (2020). Determinants of residential location choices by slum dwellers in Lagos megacity. *Cities*, 98, 102589. https://doi.org/10.1016/j.cities.2019.102589.

Béné, C., Arthur, R., Norbury, H., Allison, E. H., Beveridge, M., Bush, S., Campling, L., Leschen, W., Little, D., Squires, D., Thilsted, S. H., Troell, M., & Williams, M. (2016). Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence. *World Development*, 79, 177–196. https://doi.org/10.1016/j.worlddev.2015.11.007.

Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G. I., & Williams, M. (2015). Feeding 9 billion by 2050 – Putting fish back on the menu. *Food Security*, 7(2), 261–274. https://doi.org/10.1007/s12571-015-0427-z.

Blanchflower, D. (2004). Self-Employment: More may not be better. *Swedish Economic Policy Review*, 11, 15–73. https://doi.org/10.3386/w10286.

Boge, F. I. (2007). Ikorodu in the Nineteenth Century: A Historical Foundation of a Suburban Society. *Development*, 134(4), 635–646. https://www.academia.edu/31426891/Ikorodu_in_the_Nineteenth_Century_A_Historical_Foundation_of_a_Suburban_Society?auto=download.

Bradley, B., Byrd, K., Atkins, M., Isa, S., Akintola, S., Fakoya, K., Ene-Obong, H., & Thilsted, S. (2020). Fish in food systems in Nigeria: A review. https://digitalarchive.worldfishcenter.org/handle/20.500.12348/4210\#:~:text=In\%20Nigeria\%2C\%20like\%20many\%20coastal,people\%20(World\%20Bank\%202016).\&text=Increased\%20fish\%20production\%20and\%20consumption,alleviating\%20food\%20and\%20nutrition\%20insecurity.

Brummett, R. E., Lazard, J., & Moehl, J. (2008). African aquaculture: Realizing the potential. *Food Policy*, 33(5), 371–385. https://doi.org/10.1016/j.foodpol.2008.01.005.

Central Bank of Nigeria. (2018). *Exchange Rates*. https://www.cbn.gov.ng/rates/ExchRateByCurrency.asp.

Curtis, M. J., & Howard, A. C. (1993). *Economics of Aquacultue* (Issue October). The Haworth Press, Inc. https://doi.org/10.1201/9781003075165.

Digun-Aweto, O., & Oladele, A. H. (2017). Constraints to adoption of improved hatchery management practices among catfish farmers in Lagos State. *Journal of Central European Agriculture*, 18(4), 841–850. https://doi.org/10.5513/JCEA01/18.4.1965.

Emokaro, C. O., Ekunwe, P. A., & Achille, A. (2010). Profitability and Viability of Catfish Farming in Kogi State, Nigeria. *Research Journal of Agriculture and Biological Sciences*, 6(3), 215–219. https://www.semanticscholar.org/paper/Profitability-and-viability-of-catfish-farming-in-Emokaro-Ekunwe/39aee4a62ba113314356a9bce7db1ab58432ff58.

Engle, C. R. (2010). *Aquaculture Economics and Financing* (1st ed.). Wiley Blackwell.

FAO, IFAD, UNICEF, W. and W. (2018). *The State of Food Security and Nutrition in the World*. http://www.fao.org/3/I9553EN/i9553en.pdf.

FAO. (2016a). *FAO- Global per capita fish consumption rises above 20 kilograms in a year*. http://www.fao.org/news/story/en/item/421871/icode/.

FAO. (2016b). *FAO Statistical Pocketbook 2015*. In: Food and Agriculture Organization of the United Nations. https://www.fao.org/documents/card/en/c/383d384a-28e6-47b3-a1a2-2496a9e017b2/.

FAO. (2016c). *The State of World Fisheries and Aquaculture 2016*. Contributing to food security and nutrition for all. https://www.fao.org/3/i5555e/i5555e.pdf.

FAO. (2017). *Fishery and Aquaculture - Country Profiles - The Federal Republic of Nigeria*. https://www.fao.org/fishery/en/facp/159?lang=en.

FAO. (2018). *Fisheries and food security*. http://www.fao.org/focus/e/fisheries/intro.htm.

FAOSTAT. (2013). FAOSTAT. *Global Aquaculture Production 1950-2014*. http://www.fao.org/faostat/en/#data/CL.

Fisheries Committee for the West Central Gulf of Guinea. (2016). *Nigeria Fishery Statistics- 2016 Summary Report*. https://www.fcwc-fish.org/fisheries/statistics/nigeria.html.

Lagos State Government. (2018). *About Lagos – Lagos State Government*. https://lagosstate.gov.ng/about-lagos/.

National Bureau of Statistics. (2018). K*ey Statistics - Unemployment*. https://www.nigerianstat.gov.ng/.

National Population Commission. (2014). *Nigeria Demographic and Health Survey*. https://nationalpopulation.gov.ng/.

Ogunmefun, S. O., & Achike, A. I. (2017). Socioeconomic Characteristics and Constraints of Pond fish farmers in Lagos State, Nigeria. *Agricultural Science Research Journal*, 7(10), 304–317.

Olasunkami, J. B. (2012). Economic Analysis of Fish Farming in Osun State. South-Western Nigeria. *INFET Tanzania Proceedings*, 1–10.

Onyekuru, N. A., Ihemezie, E. J., & Chima, C. C. (2019). Socioeconomic and profitability analysis of catfish production: a case study of Nsukka Local Government Area of Enugu State, Nigeria. *Agro-Science*, 18(2), 51. https://doi.org/10.4314/as.v18i2.9.

Ozigbo, E., Anyadike, C., Adegite, O., & Kolawole, P. (2014). Review of Aquaculture Production and Management in Nigeria. American Journal of Experimental Agriculture, 4(10), 1137–1151. http://eprints.covenantuniversity.edu.ng/3561/1/AJEA\%20final\%20publication.pdf.

PM News Nigeria. (2011). Lagos Unveils Investment Opportunities In: *Fish Farming - PM NEWS Nigeria*. https://www.pmnewsnigeria.com/2011/08/15/lagos-unveils-investment-opportunities-in-fish-farming/.

Ronald, D. K., William, M. E., & Patricia, A. D. (2016). *Farm Management* (8th ed.). McGraw-Hill.

StanbicIBTCBank - Nigeria. (2018). *Savings Account*. http://www.stanbicibtc.com/Nigeria/Individual/Saving-and-investing/MaxYield.

Williams, S. B., Kareem, R. O., Adiegu, C. P., & Dipeolu, A. O. (2012). Resource-use Efficiency among Selected Fish Farms in Lagos State , Nigeria. *Journal of Agricultural Science*, 3(2), 85–94. https://doi.org/10.1080/09766898.2012.11884689.

WorldFish. (2017). *WorldFish in Nigeria*. Penang, Malaysia: WorldFish. Factsheet: 2017-17. https://hdl.handle.net/20.500.12348/267.

WorldFish. (2018). *WorldFish Nigeria Strategy 2018–2022*. http://pubs.iclarm.net/resource_centre/2018-09.pdf.

Yemi, A.-S., & Deji, A. (2012). Measuring Profitability in Small Scale Aquaculture Enterprises in South West Nigeria. *IIFET Tanzania Proceedings*, 2(1), 1–5. https://agris.fao.org/agris-search/search.do?recordID=AV20120100724.