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Economic Profitability of Nile Tilapia (*Oreochromis* niloticus Linnaeus 1757) in Semi Flow through Culture System

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Abstract Tilapia is one of the most productive and internationally traded food fish in the world. The production of farmed tilapia is among the fastest expanding food sectors in the world. Nile tilapia (*Oreochromis niloticus*) is the most cultured freshwater species among the farmed tilapia and contributes about 71% of the world total tilapia production. In Nigeria, Tilapia culture is a promising aquaculture business. In this study, we estimated the economic profitability of small-scale production of *O. niloticus* in semi flow-through system at three stocking density using the profitability index and the viability index. The economic profit indices measured were Gross profit, profit index and incidence of cost while the viability index was benefit/cost ratio. These were computed from the record kept during the experiment, which included stocking densities, type of feed used, labour cost, and other input cost. The results of the experiment suggested that fish fed Multi-feed were more profitable than those feed NIOMR feed. The results generated can guide farmers to develop standard farm enterprises and business plans.

Keywords: profit index, tilapia, economics, feed, protein efficiency ratio

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1. Introduction

Aquaculture has a great potential in struggle for improvement of the nutritional situation of the human population and in the alleviation of poverty of rural people especially in developing countries. The production of farmed tilapia is among the fastest expanding food sectors in the world [1]. Tilapia are produced most economically in tropical and sub-tropical countries which have favourable temperatures for their growth [2]. There are basically three systems of culturing tilapia: extensive, semi-intensive and intensive systems. Extensive system requires low capital input and is greatly influenced by environmental conditions. Earthen ponds or natural water bodies are used and low stocking densities are employed. little or no feeding is offered to the fish [3]. Tilapia production levels depend to a great extent on the natural productivity of the ponds and yields do not generally exceed one ton per ha. In semi-intensive system feeding is offered to the fish and the natural productivity of the pond is harnessed and supplemental aeration is normally done. Production levels can be as high as 5 tons per ha per crop. Intensive systems usually employ circular tanks, raceways and cross ways. Intensive systems generally require high

capital inputs, continuous aeration, and the feed used must be nutritionally complete. Yield can be as high as 100 tons per ha per crop [4]. Most fish farmers lack the economic support or finances to establish this system [5].

Intensive culture in flow-through system using fibre glass tanks offers several advantages over pond culture. For instance, high fish density in fibre glass tank disrupts breeding behaviour and allows male and female tilapia to be grown together to marketable size. Flow-through system allows the fish culturist to easily manage stocks and to exert a high degree of environmental control over parameters such as water temperature, dissolved oxygen (DO), pH, waste, that can be adjusted to maximise production in a flow through system. This may translate to better growth and fish yield for *O. niloticus*, which is noted to have excessive reproduction as a limitation [2].

Nile tilapia (*Oreochromis niloticus*) is the most cultured freshwater species among the farmed tilapia and contributes about 71% of the world total tilapia production [6]. *O. niloticus* is chosen in this study due to the additive characteristic that include fast growth, efficient food conversion, high fecundity, tolerance to a wide range of environmental parameters and good table quality.

In most African countries, fish- farmers do not easily access financial assistance from government or financial institutions because of the absence of the necessary economic data [7,8]. Economic data such as production cost and sales could assist fish farmers in determining the profitability of their fish farming activities. This information will enable fish-farmers to secure the needed financial assistance and support for investments and development.

The overall goal of this study is to estimate cost of producing *O. niloticus* in semi-flow through culture system using two feed types.

2. Materials and Methods

The study was conducted at the Nigerian Institute for Oceanography and Marine Research (NIOMR), Sapele Out-Station, Delta State, Nigeria (N05054'03.5 "E005039'56.4").

Twelve (12) circular fibre glass tanks of 3.08 m³ capacity each were used in this experiment in a flow-through system. Two feed types were used to feed the fish, Multi feed (foreign) and NIOMR feed (local) with 44% and 32% crude protein respectively at 5% of the total stocking biomass twice daily at 0800 hour and 1600 hour. Different stocking densities were used (300, 450 and 600 fish per tank), and the trial was duplicated. The stocking density of 300, 400, 600 fish per tank translated to 158, 237, and 316 m⁻³. Six experimental treatments were used namely:

I. = NIOMR feed @ 158 fish/m³

II. = MULTI feed @ 158 fish/m³

III. = NIOMR feed @ 237 fish/m³

IV. = MULTI feed @ 237 fish/m³

V = NIOMR feed @ 316 fish/m³

VI. = MULTI feed @ 316 fish/m³

Sampling of the cultured fish was carried out bi-weekly for a period of 24 weeks for the collection of data to determine the variation among the treatments.

The economics of semi flow - through culture of O. niloticus at three stocking density were measured in two forms, namely the profitability index and the viability

index. The economic profit indices measured were Gross profit, profit index and incidence of cost while the viability index was benefit/cost ratio. These were computed from the record kept during the experiment, which included stocking densities, type of feed used, labour cost and other input cost. The analysis was based on farm-gate and market price of 1 Kg of O. niloticus. Economic parameters measured included:

a) Gross Profit: This was used to determine the profitability in form of gross margin profit of various treatments, and the Gross Margin analysis (GM) is given by the equation:

$$GP = TR - TC$$

Where; GP = Gross Profit, TR = Total Revenue (), TC = Total Cost ().

The rule of the thumb for Gross Profit is that when GP is greater than zero it is profitable.

b) The economic viability: This was compared using statistics to generate the following indices:

I.
$$Profit\ Index(Feed) = \frac{Total\ Value\ of\ Fish(\)}{Cost\ of\ Feed(\)}$$

II. Incidence of
$$Cost(Feed) = \frac{Cost\ of\ feed()}{Kg\ weight\ of\ fish\ produced}$$

III.
$$Benefit / cost Ratio = \frac{Profit()}{Totak Cost(())}$$

3. Results and Discussion

Table 1 shows the data input result. Fixed cost, cost of fingerlings, and labour cost are the same for both feed types, used. However, the quantity of Multi-feed (2.53 kg) used was higher than quantity of NIOMR feed (2.16 kg) used. These feed quantities corresponded to ₹725.27 and ₹576 respectively.

Table 1. Data input on fibre tank management and economic variables for base case

VARIABLES	QUANTITY	UNIT	VALUE
Fibre glass characteristics:	1	\mathbf{M}^3	3.08
Area of tank			
Fixed Cost:	6	₦ 12,500	₦ 75,000
Fibre glass tank: NIOMR			
Multi-feed	6	₩ 12,500	№ 75,000
Variable Costs:			
Fingerlings			
NIOMR	2700	₩ 10	₦ 27,000
Multi-feed	2700	₩ 10	₩ 27,000
Labour NIOMR	3	₩ 500	₩ 1500
Multi-feed	3	№ 500	₦ 1500
Feed (15 kg/Bag) NIOMR	2.16	₩4000	₦ 576
Multi-feed	2.53	₩ 4300	N 725.27

Economic analysis result for fish stocked 158 fish/m³ and fed NIOMR feed (Treatment I) and Multi-feed (Treatment II) is shown in Table 2. Treatment II recorded positive gross profit (\$\frac{1}{480}\$) while Treatment I showed

negative value (-+292.12). Benefit cost ration of +1.22 and +0.92 was recorded for Treatment II and I respectively.

Table 2. Economic analysis result for fish stocked at 158 fish/m³ fed NIOMR feed and Multi-feed

VARIABLES	QUANTITY	UNIT COST AMOUNT (₩)	TOTAL (#)			
	Treatment I	Treatment II	Treatment I	Treatment II	Treatment I	Treatment II
Variable Cost: Feed (15 kg/Bag)	510.39 (g)	633.01 (g)	0.2667	0.2867	136.12	181.48
Fingerlings	300	300	10	10	3000	3000
Total variable Cost	16.72 kg	22.41 kg			3344	4482.96
Revenue:	22.19 kg	26.54 kg	200	200	-292.12	801.48
Tilapia Sales						
Profitability: Gross Profit					24.57	24.7
Profit Index					8.14	8.1
Incidence of Cost					0.92	1.22
Variability:					0.85	1.01
Benefit/Cost Ratio						

Treatment IV showed a gross profit (N-59.56) while treatment III had a negative gross profit (Table 3).

Treatment IV is profitable while Treatment III showed a loss based on their benefit/cost ratio value.

Table 3. Economic analysis result for fish stocked at 316 fish/m³ fed NIOMR feed and Multi-feed

VARIABLES	QUANTITY		UNIT COST	UNIT COST AMOUNT (₩)		TOTAL (*)	
	Treatment III	Treatment IV	Treatment III	Treatment IV	Treatment III	Treatment IV	
Variable Cost:	749.98(g)	865.44 (g)	0.2667	0.2867	200.02	248.12	
Feed (15 kg/Bag)							
Fingerlings	450	450	10	10	4500	4500	
Labour	500	500	1	1	500	500	
Total variable Cost					5200.02	5248.12	
Revenue:	22.19 kg	26.54 kg	200	200	4437	5307.68	
Tilapia Sales							
Profitability:					-763.02	59.56	
Gross Profit							
Profit Index					22.18	21.39	
Incidence of Cost					9.01	9.35	
Variability:					0.85	1.01	
Benefit/Cost Ratio							

Table 4 showed Treatment VI recorded a negative gross profit (-№-1,340.46)while Treatment V gave a positive value of №-156.55. At this stocking density, NIOMR feed

was profitable with a benefit/cost ratio of 1.02. Multi-feed was operated a loss at this stocking density.

Table 4. Economic analysis result for fish stocked at 316 fish/m³ fed NIOMR feed and Multi-feed

VARIABLES	QUANTITY		UNIT COST AMOUNT (₦)		TOTAL (*)	
	Treatment V	Treatment VI	Treatment V	Treatment VI	Treatment V	Treatment VI
Variable Cost:	887.97(g)	1034.88 (g)	0.2667	0.2867	236.82	296.7
Feed (15 kg/Bag)						
Fingerlings	600	600	10	10	6000	6000
Labour	500	500	1	1	500	500
Total variable Cost					6736.82	6796.7
Revenue:	34.47 kg	27.28 kg	200	200	6.893.37	5456.24
Tilapia Sales						
Profitability:					156.55	-1340.46
Gross Profit						
Profit Index					28.09	18.41
Incidence of Cost					6.45	6.77
Variability:					1.02	0.8
Benefit/Cost Ratio						

Treatments II, IV and V showed positive gross profit which increased from ₹59.56 for treatment IV to ₹801.48 for treatment II. In contrast, treatments I, III and VI recorded negative profit indices indicating less desirability. Two of the three treatments (II, IV) that showed positive profit index received Multi-feed at the low and intermediate stocking densities while the third treatment (V) received NIOMR feed at the high stocking density. Treatments that showed negative profit index included treatments I and III that received NIOMR feed at the low and high stocking densities and treatment VI that received Multi-feed at the high stocking density. It could be concluded that Multi-feed gives positive profit index when fed to *O. niloticus* stocked at the low and intermediate

stocking densities whereas NIOMR feed performed better than the Multi feed only at the high stockingdensity. It appears that Multi feed (32% crude protein) that costs \$\frac{1}{2}\pmathbb{4}\,300.00\rangle\$ bag gives more efficient growth performance at low and intermediate stocking densities whereas NIOMR feed (44.38% crude protein) and cheaper showed better growth performance only at the high stocking density. This is in accordance to the findings of [9] that showed that fish fed on 30% protein diet attained the highest growth (higher weight gain, higher daily weight gain and higher specific growth rate) and best food conversion ratio (FCR). They demonstrated that protein efficiency ratio (PER) was significantly affected by protein levels. PER decreased with increasing protein level.

The profit index showed that it was more beneficial in terms of feed input to invest on treatments III and V with a profit index of №22.18 and №28.09 respectively. This result was at variance with the pattern in the total net production and feed intake. The fish fed Multi-feed (treatment IV and VI) had better net production; this could be attributed to large number of individuals and consequently higher weigh at harvest. The incidence of cost for *O. niloticus* culture in semi water flow-through system at different stocking densities showed values for treatments, I, III and V to be 8.44, 9.01, and 6.45 respectively while treatments II, IV and VI had values 8.10, 9.35 and 6.77 respectively.

The benefit/cost ratio showed that only treatment II, IV and V were viable with values above 1. Reference [10] stated that benefit/cost ratio that is greater than 1 is viable. Thus, two stocking densities (II and IV) fed with Multifeed are economically viable while one stocking density (treatment V) fed with NIOMR feed is also economically viable. The viability of Multi-feed at treatment II and IV can be attributed to better growth performance and returns. In all the stocking densities NIOMR fed fish at treatments I and III that received NIOMR feed and treatment VI that received Multi-feed had benefit/cost ratio of less than 1, thus, making them not viable. Although Treatment VI recorded the highest mean biomass (yield) of 43.73 kg, its benefit/cost ratio showed that it is not profitable. This is in agreement with [10] that showed that highest yields per unit of area are not the most economical in culture systems that receive feed and/or fertilizers. Therefore, it is more economically viable to invest on culture of O. niloticus using water flow-through system at stocking densities of treatment II and IV using Multi-feed since it gives good return.

4. Conclusion

Fish farming among local fish farmers with limited financial resources remains a challenge. Most fish farmers face the challenge of unavailability of start-up capitals, high operating cost and poor management skill. Economic analysis is an important tool necessary for business planning, seeking financial assistance and successful management of the fish farm.

In this study, we estimated the economic profitability of small-scale production of *O. niloticus* in semi flow-through system at three stocking density using the profitability index and the viability index. The study showed that although NIOMR feed was cheaper than Multi-feed, using NIOMR feed was not profitable. However, Multi-feed which is more expensive was profitable. Thus, quality of feed ensures production of larger and higher quality fish that will attract a reasonable price at farm level. We recommend that studies especially in the areas of protein quality and protein-energy ratio are

suggested in the formulation of NIOMR feed in order to make it of better quality and yet affordable.

Competing Interests

None declared.

Authors' Contributions

YAF designed the experimental study. NNA participated in the bi-weekly weekly weighing of fishes and helped to draft the manuscript. AJO carried out daily feeding of fish. AOO contributed in bi-weekly weighing fishes. OED and ATE performed the bi-weekly water chemical measurement.

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