ANALYSIS OF PROFITABILITY OF *Heterobranchus longifilis* VALENCIENNES, 1840 PRODUCTION IN A WATER RECIRCULATION SYSTEM

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ABSTRACT
This paper examines the costs and returns of Heterobranchus longifilis production within a water recirculation system. H. longifilis broodstock were artificially spawned using the synthetic hormone ovaprim at 0.5ml/kg. The costs of raising the hatchlings to table-size were analysed using the budgeting technique and benefit-cost ratio. Econometrics indicated that the variable cost constitutes 96.73% of the total cost of production. The cost of catfish feeds (68.77%) and electric power supply (14.21%) were the major variable costs incurred in fish production. The cost of production per 1,000 fish was ₦ 219,886.5 with a total revenue of ₦ 497,750 realized, making a net income of ₦ 277,863. The rate of return per capital invested and the rate of return on investment of 79% and 0.53 respectively showed that the production was profitable. The benefit cost ratio of 1.26 recorded indicates that the project is viable. It is recommended that the production of artificially spawned H. longifilis within a water recirculation system should be encouraged. Efforts should be geared towards reducing the cost of feeds in order to increase profitability of the enterprise.
Keywords: Cost, *Heterobranchus longifilis*, production, water recirculation system

INTRODUCTION

Production costs for the African catfish in tropical and subtropical countries vary from USD < 1.0/kg to USD 2.5/kg, depending on the production system (FAO, 2012). In Sub-Saharan Africa, market prices range from USD 2.5 – 5.0/kg; with smoked dried fish commanding high prices (FAO, 2016). The production cost of an 8g juvenile in the Netherlands is estimated at <USD 0.04; this is about half the cost of production in Nigeria and Cameroon; this is because of the current need to import suitable feeds and equipment in recirculation systems (FAO, 2011).

Estimates of demand of fish range as high as 2.66 million metric tonnes to 3.02 million metric tonnes annually between 2006 and 2010 (FAO, 2011). Sporting a total water surface area of about 12.55 million hectares, Nigeria is naturally primed for fisheries productivity. FAO estimates the fish farming potential of Nigeria to be over 65,000 metric tonnes per annum. Fish consumption varies widely with high consumption in coastal areas to relatively low consumption in the North. Average consumption estimate is about 10kg/capita compared with WHO recommended 20-30kg/capita (Bolorunduro, 2010). As a result of this, many Nigerians suffer from protein deficiency, due to low protein intake.

Aquaculture is acknowledged as the efficient means of providing food which is rich in protein, certain minerals, vitamins and advantageous lipids, source of income and employment opportunities to the populace (Ojutiku, 2008). Equally estimated was the possible creation of 300,000 jobs and generation of revenue of US$160 million per annum by the aquaculture industry (CBN, 2005).

The profitability of the aquaculture industry has become widely known (Huda *et al*., 2002). There is increased global attention on aquaculture because of the need to augment fish production from the wild. This is particularly noticeable in populous countries like Nigeria because of high protein demand (Owodeinde *et al*., 2011). The aquaculture industry contributed only 2.0% of the GDP and accounted for 0.2% of the total global fish production (Olapade and Adeokun, 2004). Nigeria has become one of the largest importers of fish in the developing world, importing some 600,000 metric tons annually (Olagunju *et al*., 2007).

Aquaculture in Nigeria is threatened by inadequate fish seed needed for production (Owodeinde *et al*., 2011). Artificial induction, hatchery management, water culture systems are cardinal aspects of mass fish production.

In Africa and Asia, clariids are of great economic importance as food fish (Offem *et al*., 2008). *Clarias gariepinus* and *H. longifilis* are two commonly cultured clariid fishes very popular among fish farmers and consumers alike (Ojutiku, 2008). They are reared all over the country especially in the south and have very good commercial value in Nigerian market (Owodeinde and Ndimele, 2011).

Several econometrics on the African catfish production among fish mongers within states in Nigeria have been conducted such as Okeke-Agulu and Chukwuone (2012) and Awoyemi (2011) in Plateau and Osun States, respectively. There is paucity of information on the profitability of raising artificially induced *H. longifilis* to table-size within a water recirculation system. This paper attempts to address this.

MATERIALS AND METHODS

The Fish Farm Complex

The study was conducted on the Sama Farm, Mando, Kaduna. Mando is situated in Igabi Local Government Area of Kaduna, Kaduna State which falls on latitude 10 º49'06" N and longitude 6 º42'00" E (Google Imagery, 2013). The fish farm complex consisted of; an indoor hatchery with four units of 1m by 1.2m rectangular plastic breeding troughs with a water depth of 60cm; an indoor nursery with six units of 5m by 1.5m dug-out rectangular concrete ponds with a water depth of 1m; sixteen units of 5m by 2.5m enclosed built-up rectangular concrete grow-out ponds with a water depth of 1m, and three units of 5m by 1.5m enclosed rectangular broodstock ponds with a water depth of 1m. A functional bore-hole, four water wells, a 5m by 4m built-up concrete reservoir, six units of 2,000litres plastic water storage tanks, the sedimentation, biofiltration and ultra violet treatment chambers and various aeration units are also among the production assets in the farm. The different sections were systematically connected in a water recirculation management system.

Heterobranchus Longifilis Production

Induced breeding activities were carried out in the rainy seasons in July, 2012 following methods described by De Graaf and Janssen (1996). Triplicate crosses were carried out. Each cross consisted of 2 females and a male of morphometrically similar broodfish (2,300 – 2,900 grams) from the same genetic pool. The synthetic hormone ovaprim was administered intramuscularly at the rate of 0.5ml/kg. Breeding and physicochemical indices were noted. 1600 juveniles per cross were stocked in twin concrete grow-out ponds. A total of 4,800 juveniles were raised within six built-up concrete ponds in a water recirculation system. They were fed decysted artemia and various pellet sizes of the Durante superior fish concentrate basically containing 45% crude protein. The growth and survival rates of the F1 were calculated following recommended methods of Madu *et al*. (2003) and Fagbenro (1996) respectively.

Economic Analyses

Farm records were kept from inception of project up to its termination. Economic analyses were performed to estimate the monetary cost required to raise a kilogram of fish fed a commercial feed while being cultured under controlled conditions. This was based on the prevailing market cost of the commercial feed and market value of a kilogram of fresh catfish in Nigeria at the time of the experiment (July-December, 2012). Data collected were analyzed by means of non - parametric (descriptive) statistics, enterprise budgeting technique (Okeke-Agulu and Chukwuone, 2012) and benefit-cost ratio (Amos and Bolorunduro, 2000).

The Enterprise Budgeting Technique

This involved the cost and return analysis. It was used to assess the profitability of the catfish farming enterprise in the study area within the study period as given below:

Model Specification

Gross margin (GM) = TR – TVC………… (1)

NFI = GM – TFC OR TR - TC………….. (2)

NROI = NFI / TC………………………… (3)

TP = TR - TC………………… Equation 1

TR= PQ……………………….. Equation 2

Returns per naira invested = TR/TC

Where:

GM = Gross margin
TR = Total revenue
TVC = Total variable cost
NFI = Net farm income
TC = Total cost
TFC = Total fixed cost
NROI = Net returns on investment.
TP= Total Profit
P= Unit price of output
Q= Total quantity of output (N)

N.B: TR= Sales of table-sized fish, naira value of home consumed fish and naira value of fish given out as gifts

TFC = a+b+c

Where, a = depreciation on pond
b = depreciation on tanks/containers
c = depreciation on pumping machine

TVC = a+b+c+d+e

Where, a = cost of fingerlings
b = cost of feed
c = cost of labour
d = cost of treatment
e = cost of water

The Benefit Cost Ratio

Accrued benefits expended fund TR-TC: TC. This was computed to show the ratio of the accrued benefits of the project to the expended funds (Amos and Bolorunduro, 2000).

RESULTS

Costs and Returns Analysis of Fish Production

The costs and returns analysis is presented in Table 1. The variable cost constitutes 96.73% of the total cost of products while the fixed cost constitutes 3.27%. The results indicate that the cost of catfish feeds (68.77%) and electric power supply (14.21%) were the major variable costs incurred in fish production. Catfish broodstock and treatment accounted for the least costs of ₦3000 and ₦3, 131.25, respectively.

The enterprise budgeting assessed the profitability of producing table-size *H. longifilis* fed a 45% CP pelletised diet within concrete tanks under a water recirculation aquaculture system. The results are as presented in Table 2.The average table size of fish was 1.11kg and price per table size fish was ₦497.75. The quantity of fish actually harvested for sale was 3,982. The cost of production per 1,000 fish was ₦ 219,886.5 with a total revenue of ₦ 497,750 realized, making a net income of ₦ 277,863.

Profitability of *Heterobranchus longifilis* Production

With respect to evaluation of the profitability of *H. longifilis* production within the water recirculation system, the rate of return per capital invested of 79% was greater than the prevailing bank lending rate of 17%. A rate of return on investment of 0.53 was recorded. The accrued benefits were compared to expended funds. A benefit cost ratio of 1.26 was obtained.

Table 1: Estimated Costs for Table-sized *Heterobranchus longifilis* F1 Production

Variable	Value (₦)/1000 fish capacity	Percentage
Catfish broodstock	3,000*	1.36
Catfish feeds	151,225	68.77
Labor	17,500	7.96
Electric power	31,250	14.21
Treatment	3,131.25	1.42
Miscellaneous	6,592.75	3.00
Total Variable Cost (TVC)	212,699	96.73
Total Fixed Cost (TFC)	7,187.5	3.27
Total Cost (TVC + TFC)	219,886.5	100.00

***value in naira for a 1000 fish production capacity**

Table 2: Budgeting Enterprise for Table-sized *Heterobranchus longifilis* F1 Production

Variable	Value (₦)/1000 fish capacity
Total Variable Cost (TVC)	212,699
Total Fixed Cost (TFC)	7,187.5
Total Cost (TVC + TFC)	219,886.5
Total Revenue (TR)	497,750
Gross Margin (TR - TVC)	285,051
Net Fixed Income (GM - TFC)	277,863.5
Net Return on Investment (NFI/TC)	1.26
Returns/₦ Invested (TR/TC)	2.26
Rate of Return on Capital Invested (RORCI)	0.79
Return on Investment	0.53

DISCUSSION

Costs and Returns Analysis of Fish Production

The 68.77% of total cost accorded to feed in this study is slightly higher than the 59% recorded by Okeke-Agulu and Chukwuone (2012) probably due to the fact that the cost of feeding in this study also involved the fry to fingerling stage of growth as opposed to the latter study where fingerlings were purchased. Rana (2005) had noted that feed is the most important single cost item associated with catfish production due to ever increasing cost of fish feed ingredients. The cost of feeding (68.77%) recorded in this study corroborated the findings of Ugwumba *et al*. (2006) that the cost of catfish feeds accounted for over 60% of the total cost of production. This finding is also in tandem with Gamel *et al*. (2006) who concluded that feed costs represented 68.9% of the total production costs of fish in the Behera Region of Egypt.

The least cost of production accounted for by Catfish broodstock implies that sustainability of a high profit margin within any catfish production system is linked to its ability to produce seeds. As catfishes such as *Clarias* spp. and *Heterobranchus* spp. do not reproduce in captivity thus necessitating human intervention and manipulation via induced breeding programs (FAO, 2017). The low cost of treatment in this study was likely linked to the fact that treatment was basically prophylactic in nature. This study advances that the concrete ponds and water recirculation aquaculture system suits growth and enhances the wellbeing of *H. longifilis*. Reasons for these aren't far-fetched from the beneficial crop of blue-green algae associated with concrete ponds as opposed to the slime and bacterial film associated with plastic tanks (Artiola *et al*., 2012) and the oxygen regenerative and pollution ameliorating effects associated with water recirculation aquaculture systems. Recirculating aquaculture systems are an invaluable alternative of preventing water pollution (Ramirez-Godimez *et al*., 2013).

The net farm income and return per naira invested values of 277,863.5 and 2.26 in this study is similar to the 246,343 and 2.3 respectively reported by Okeke-Agwulu and Chukwuone (2012) for catfish production in Jos metropolis of Plateau state, Nigeria. Esu *et al*. (2009) recorded an outstanding lower value of 21.48% total variable cost for catfish fed in earthen ponds. This could probably be attributed to the supplementary nature of feeding in such fertilized earthen ponds and it could also be attributed to the polyculture system employed. It is, however, interesting to note that a mean net income of ₦151, 400.00 for fish farmers per production period was recorded in the earthen pond. This value is far lower than the ₦277, 863.50 recorded in this study.

Profitability of *Heterobranchus longifilis* Production

With respect to the profitability of *H. longifilis* production within the water recirculation system, the rate of return per capital invested of 79% was greater than the prevailing bank lending rate of 17% implying that *H. longifilis* production within the water recirculation system is profitable. The rate of return on investment of 0.53 implies that for everyone naira invested in *H. longifilis* within this system, a return of ₦1.53 and a profit of 53 kobo were obtained. If a farmer took loan from the bank to finance fish farming, he would be 53 kobo better off on every one naira spent after paying back the loan at the prevailing interest rate. The implication of this is that there is a considerable level of profitability in this enterprise, as the quantity of fish produced is equally proportional to the pond size (Awoyemi, 2011), as more fish require more space.

With respect to the comparism between the accrued benefits and expended funds, the benefit cost ratio of 1.26 obtained shows that the project is viable since its value is greater than unity (Amos and Bolorunduro, 2000). It also implies that profitability of *H. longifilis* culture is consistent with the volume of production since the benefit increases with increase in cost of production. It is important to note that this computation does not take care of depreciation, interest, and tax charges and invariably total fixed costs.

CONCLUSION

Econometrics revealed that the cost of feeding accounted for 68.77% of the total cost of production. The rate of return per capital invested and rate of return on investment of 79% and 0.53 respectively show that the production of artificially spawned *H. longifilis* within a water recirculation system is profitable. The establishment of hatcheries on standard commercial *H. longifilis* farms is recommended to provide seeds of known growth potentials to boost profit. The project is a viable one as evidenced by the benefit cost ratio of 1.26 recorded. A major constraint was the retailers who bought the fishes not only per kg but per size grade resulting in a mean price per table size fish of ₦497.75.

The production of artificially spawned *H. longifilis* within a water recirculation system is profitable. Efforts should be geared towards reducing the cost of feeds in order to increase profitability of the enterprise.

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