EFFICIENCY OF RESOURCE-USE AND ELASTICITY OF PRODUCTION AMONG CATFISH FARMERS IN IBARAPA, OYO STATE, NIGERIA

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ABSTRACT
The productivity level in fish farming has remained low in the aquaculture sector despite its significant role in Nigeria's economy. This is largely due to inadequate knowledge on the optimum use of available resources. This study investigated the resource-use efficiency of catfish fish farmers' production in Ibarapa, Oyo state, Nigeria. Data were obtained from 40 catfish farmers selected by means of purposive random sampling technique through a structured questionnaire. The Cobb-Douglas production function revealed that capital, pond size, fish seed, and feed were significant at $P<0.05$ *but labor was not significant* ($P>0.05$) *and was found to be low. This showed that farms were operating at decreasing returns to scale with a value of 0.432 obtained. Resource use efficiency values were -0.158, 0.022, 3.343, 0.898, and -0.002 for fixed input, pond size, fish seed, feed, and labor respectively. This suggests that overutilization is recorded for a fixed input, pond size, feed, and labor with efficiency ratios of less than one, indicating a stage III of catfish production while the fish seed is under- utilized. It was recommended that appropriate training be given to fish farmers in the area that will ensure optimal utilization of the resource.*
Keywords: Aquaculture, Fish production, Profitability and Utilization

INTRODUCTION

The clamor for eating protein-rich food is on the increase because protein is essential for body cell and tissue growth. Adequate consumption of protein is important during periods of rapid growth or increased demand, such as childhood, adolescence, pregnancy, and breastfeeding (EFSA, 2012). Unfortunately, high protein food is very costly especially, animal proteins such as meat, egg, and milk but fish as a source of protein has proven to be a way out of this exorbitant expenditure on protein food. Fish contains high-quality protein and is relatively cheap (Adebayo *et al.*, 2014). According to FAO (2016), when fish is eaten whole, it provides essential fats (such as long-chain omega-3 fatty acid), vitamins (A, B, and D), and minerals (including calcium, iodine, zinc, iron, phosphorus, and selenium). Its lysine and vitamins ‘A’ content are essential for good health and growth. The demand for fish therefore will continue to increase as the human population increases. However, as compared to the global average of 20.3kg/capita/year, household fish consumption in Nigeria is low, at 13.3 kg/capita/year (FAO, 2018). This national average conceals a substantially lower average among resource-constrained and vulnerable populations, as well as a significant supply-demand gap.

Fish can be cultured to generate income thereby improving the living standards of the fish farmer. Catfish has become a popular fish in Nigeria because it is highly delicious and nourishing. Young, adult and old people find it easy to consume. It can be cooked and eaten fresh as well as smoked. The most acceptable farmed and well-consumed catfish species by the generality of the populace in Nigeria are *Clarias gariepinus* and *Heterobranchus bidorsalis,* from clariidae family. However, local fish production has failed to meet the country's domestic demand (Oladimeji, 2017) despite the considerably laudable benefits. A gap in demand and supply of fish in Nigeria is inevitable in this situation.

According to FAO (2005), increased catfish production in the country can close the country's troubling demand-supply fish gap. Catfish farming like any other agricultural product involves production. Production is the process of transforming resources known as inputs (capital, labour, and land) into goods and services called output/yield (Boyes and Melvin (2002). In the process of transforming input to output, the producer or farm/firm aims at attaining fundamental objectives. These objectives are profit maximization, output maximization, cost minimization, or utility maximization. It can as well be the four objectives at the same time. However, to achieve these objectives, all the available resources must be efficiently combined. In other words, input resources must be used maximally to obtain maximum output from a minimum set of input. This is where efficiency comes into play. Efficiency measures the best combination of variable input/factor such that zero waste is achieved. Moreover, to achieve production efficiency, inputs must be allocated to produce the highest possible amount of goods and services at their relative prices.

Efficiency analysis is an issue of great concern which must be well understood in any business otherwise, failure will become inevitable.

Economic efficiency is made up of technical efficiency (TE) and allocative efficiency (AE). Both efficiencies differ. TE shows the ability of a firm or farm to obtain maximum outputs from a set of inputs, while allocative efficiency according to Farell, 1957 reveals the capability to make use of the available inputs in optimal amount, with their respective prices. Allocative efficiency is the ability of a firm to choose optimum input levels for a given factor price (Ogundari and Ojo, 2006). It identifies with the ideal resources utilization use, given their respective costs (Olayide and Heady, 1982). Allocative efficiency could be derived by the use of the marginal measure which could be utilized for deciding the ideal amount of input under the assumptions of pure competition in which prices of inputs and output are constant, perfect certainty (i.e. input-output relationships are known), and profit maximization as the choice indicator of the fish farmer. The point/level of ideal efficient resource utilization is resolved when the Marginal Value Product (MVP) of an input (X) and its unit price value (Px) are equivalent. This is affirmed by Yotopoulos and Lau (1973), who believed that the allocative efficiency of a firm is optimal when the level of the marginal product value of the resources used in the production should be adjusted to the cost of the unit of the same resources. Inoni, (2007) likewise asserted that allocative productivity is valuable in deciding the efficiency of production whenever there is a bunch of technically efficient alternative strategies of production and there is a need to pick between them. Technical efficiency and allocative efficiency are important to attain the overall economic efficiency in resource

The MVP is arrived at from the respective regression coefficients of the lead equation of the functional form when an appropriate ideal level of output is utilized. The MFC is the market cost of one unit of information. This is used in allocative efficiency measures to determine whether a resource is being utilized well, under-utilized, and over-utilized. A ratio of less than one implies that input is being over-utilized, while a ratio greater than one means that the input is underutilized (Haruna, *et al.*, (2008). Allocative efficiency (AE) is measured as follows:

$$E = \frac{MVP_1}{P_1}$$

Fish farming is a significant business that requires special knowledge and cautious planning. Individuals with little or no expertise in fish farming, as well as limited resources, must be well-trained to become successful fish farmers. Many small-scale fish farmers have been crippled because they do not possess sufficient knowledge on how to put resources together that will bring about a profitable venture. The study will also go a long way to assist the fish farmers in the area of fish production. Moreover, the study will guide policymakers in Oyo state and the country of Nigeria as a whole in pointing the right direction of future development and management. The overall objective is to examine the resource-use efficiency of catfish fish production in the study area. The following specific objectives were examined: analysis of the profitability of catfish fish production through the estimation of gross margin of the respondents, estimation of production elasticity, and determination efficiency ratio of resources used in catfish fish farming.

MATERIALS AND METHODS

Study Area

The study was conducted in the Ibarapa zone, comprising three local governments areas; (Ibarapa Central, Ibarapa East, and Ibarapa North). Ibarapa region falls within latitude 7º15'N and 7º55'N and longitude 3º 00E and 3º 30'E.

Due to the few fish farms in the areas, "a purposive sampling technique" was adopted for the study. Forty structured questionnaires were distributed to gather primary data for the study, being augmented with secondary data from Journals and books. Data analysis was done using descriptive statistics, gross margin analysis, profitability ratio, and Cobb-Douglas regression.

Gross margin analysis

Gross margin investigation was utilized for this examination which contained the accompanying costs parts and their estimations:

(i) **Fixed costs (FC):** These are costs, which do not vary with output. Land, pond construction, building and fencing, harvesting equipment, pumping devices, and other fixed costs are included. However, the final values of these fixed cost items used in this study were depreciated values, not the direct values.

ii**) Depreciation (D):** This is the allowance in monetary terms, for the value of the fixed costs used in production. This is accomplished by utilizing the straight-line technique to depreciate the fixed costs used in production.

$D = \frac{C-S}{N}$ **………………………..** Equation (1)

D = annual depreciation
C = cost of the fixed item
S = salvage value
N = the useful life of the fixed cost item

(iv) Useful Life: This is the period that an item can be utilized before it becomes unusable for its intended use. The values used for this project are those given by the respondents

The gross margin is given by

GM= TR-TVC ……………Equation (2)

Where

GM = Gross margin (₦)

TR = Total Revenue (₦)
TVC = Total Variable Cost (₦)
The performance and economic worth of the respondents were measured after (Lee, 1997) by the use of the following profitability ratios:
Benefit-Cost Ratio (BCR) = $\frac{TR}{TC}$
Expense structure Ratio (ESR) = $\frac{FC}{VC}$
Rate of Return (ROR) = $\frac{NR}{TC}$
Gross Ratio (GR) = $\frac{TC}{TR}$

Resource-use efficiency: Marginal worth of item (MVP) is an essential way to measure allocative efficiency. It can be calculated from the production function. The resource-use efficiency can therefore be estimated by comparing MVP with MFC.

In an input market, farmers are assumed to be price takers therefore, the price of factor *I* will approximate MFC. Allocative efficiency (AE) is given by equation 3

AE= $\frac{MVP_i}{P_i}$ ……………………Equation (3)

Therefore the efficiency is indicated as follows
AE= 1, Resources are efficiently utilized
AE > 1, Resources are under-utilized
AE < 1, Resources are over-utilized

Production function

The relationship between the output and inputs to measure the resource-use efficiency of the inputs employed by the fish farmers was measured using Cobb-Douglass production model according to Acharya *et al* (2014). The general form of Cobb-Douglas (CD) production function is reported in Equation 3. According to Kossovskaya, (2006), the implicit form of the production function used is expressed as

$Y = (X_1 \ldots X_5, ei)$ ………….. Equation (4)

For this study
Y = Output of table fish produced (₦)
X_1 = Fixed input (₦)
X_2 =Pond size (₦)
X_3 = Seed (Fish seed) (₦)
X_4 = Feed (₦)
X_5 =Labor (₦)
ei = Random Error Terms

In this study, the exponential production function was the lead equation and its explicit form is given by:

$\text{Log } y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + ei$ …… Equation (5)

Where y, $X_1 \ldots X_5$ were defined earlier and
b_0 = constant term
$b_1 \ldots b_5$ = coefficients
ei = Random error term

This elasticity for the exponential function was computed using the formula by Jirgi *et al*., 2010
e.bi.Xi
Where
e = elasticity of input Xi
bi= estimated regression coefficient of input Xi
X
i = the geometric mean

RESULTS

The result of profitability of fish production in the study area, Production function Analysis, Production Elasticity, Efficiency ratio of resources, and Problems Confronting Production of fish are presented in Table the tables below.

Table 1:- Estimated cost and return for the catfish farms/ annum (₦)

Variable cost items	Variable cost (₦)	Total cost (%)
Feed	755,400.00	68.95
Fertilizer/lime	14,330.45	1.30
Labour	23,500.00	2.14
Fingerlings	101,250.00	9.24
Transportation	23,750.00	2.16
Others	12,400.00	1.13
Total fixed cost	165,023.00	15.06
Total variable cost	930,630.45	84.94
Total cost	1,095,653.45	
Total revenue	1,711,200.00	
GM (TR-TVC)	780,569.55	
B/C	1.56	
ESR	0.177	
ROI	56%	

Source: Field survey, 2019

Table 2: Regression estimates of fish output

Variables	Coefficients	Standard error	t-values	p-value
Capital input	-0.312	0.086*	-3.614	0.002
Pond size	0.292	0.086*	3.312	0.004

Fish seed	0.343	0.086*	3.973	0.001
Feed	0.155	0.047*	3.280	0.004
Labour	-0.046	0.081	-0.573	0.574
R^2	0.918			
Adjusted R^2	0.906			
F-statistic	75.806*			
Durbin-Watson	1.697			

**significant at (P<0.05)
Source: Data from researcher's field survey, 2019

Table 3: Production Elasticity

Independent variable	Production Elasticity
Fixed input	-0.312
Pond size	0.292
Fish seed	0.343
Feed	0.155
Labour	-0.046
Return to Scale (RTS)	**0.432**

Source: Field survey, 2019.

Table 4: Estimate of efficiency ratio of resources used in catfish fish farming

Variables	**b_1**	**MPP**	**MVP**	**MFC (₦)**	**r**
UTILIZATION					
Fixed input (X_1)	-0.312	-0.2576	-167.457	1060	-0.158
Over					
Pond size (X_2)	0.292	0.0399	25.943	1200	0.022
Over					
Fish seed (X_3)	0.343	0.1286	83.569	25	3.343
Under					
Feed (X_4)	0.155	0.6500	422.421	470	0.898
Over					
Labour (X_5)	-0.046	1484.16	-0.001	500	-0.001
Over					

Table 5: Constraints of Fish Farmers

Constraints of fish production	No of respondents
High feed cost	35
Credit facilities	35
Poaching	10
Marketing	28
Seasonality of water	20
Predators	18
Unavailability of fingerlings	21
Total	167*

Note: *Multiple responses
Source: Field survey, 2019

DISCUSSION

Analysis of Profitability of fish production

Results from the Table 1 revealed that feed cost constituted 68.95% while labor and fingerlings cost was 4.35% and 15.45 % respectively. This clearly shows that a huge amount of money is spent on fish feed purchase by fish farmers. The fixed cost of production which consisted of the cost of fixed assets (pumps, vehicles, aerators, and ponds) attributed to 15.06% while the variable accounted for 84.94% of total production cost. The result revealed that the variable cost accounted for the greater proportion of the total cost of production.

The size of fish on average was 0.8kg and the cost of table size fish amounted to ₦650.00. The number of fish sold was 2632.61kg. Table 1 also showed that the total cost of production, total revenue cost, and net income were ₦1,095,653.45, ₦1,711,200.00, and ₦615,546.55 respectively.

The benefit-cost ratio (BCR) was 1.07, the fish farmers in the study area indicated that investment in fish farming is worthwhile because the benefit-cost ratio is greater than 1. The ESR was 0.177, this implies that about 17.7% of the total production cost consisted of fixed cost components. This further confirmed that the business is profitable to venture into because an increase in production with variable costs will increase the total revenue while the fixed cost is unchanged. The rate of returns (ROR) in fish production in the study area was 85%. This reveals that for every ₦ 1.00 invested, 56 kobo was a gain to the fish farmers. This finding is in variance with that of Issa *et al*., (2014) in which they found out that catfish farmers in Kaduna state with earthen pond had a rate of return of 73.4% per production cycle. It shows that catfish farming in the study area is profitable.

Production function Analysis

The results of Cobb-Douglas production function analysis are presented in Table 2. This table showed that capital, pond size, fish seed, and feed were significant at (P<0.05), but labour was not significant. The insignificant labour cost could be because the fish farmers depend solely on family labour. Family labour utilization showed inefficiency since they were not trained, fish farmers. The negative coefficient of labor implied that for any unit increase in labour, there was a decrease of about 0.04 in total fish output. The negative value of the coefficient of capital input showed that for every unit increase in the capital there was a 0.31 decrease in total fish production. This finding can be attributed to the fact that huge capital was being used on small-scale fish farming. The coefficient of fish seed stocked in raising fish was positive and significant at 5%. This revealed that a unit increase in the number of fish seeds stocked will lead to an increase in the output of fish. This finding is in agreement with the result of Nwosu and Onyeneke (2013) who found out that fish farmers' higher output was recorded among the farmers who stocked more fish seed than those that stocked less number. The F-value of 75.806 showed that all the explanatory variables taken together have a significant effect on the dependent variable.

Production Elasticity

From Table 3, when each of the values of elasticity of the resources used was summed together, it gave a value of 0.432 which was found to be less than 1. This vividly showed a decreased return, meaning that each additional unit of resource will generate a small increase in fish output than the unit of resources used before. This is evidence of the stage 2 production phase, otherwise known as a rational stage of production where the sum of elasticities of production is greater than zero but less than one. The implication is that the more the inputs used, the higher the decreasing rate of fish production. This decreasing trend prevalent in the agricultural sector was reported by Ali *et al.,* (2017). Adewuyi *et al.,* (2010) in their study of the economic viability of catfish farming in Ogun state also confirmed a similar result.

Efficiency ratio of resources

The findings from the result on the efficiency ratio of resources (Table 4) showed that efficiency ratios of fixed capital, pond size, feed, and labour were less than one, which indicates that they were over-utilized, hence, in stage 3 of fish farming production phase in the study area. This is an indication that with a reduction in the use of fixed capital, pond size, feed, and labour levels, there will be an increase in fish output which will invariably increase revenue. This finding corroborated the findings of Williams *et al*, (2012). However, the efficiency of fish seed (fingerlings) was underutilized as revealed in table 5. This implies that there is a need for adjustment in the quantity of fish seed (fingerlings) stocked.

Problems Confronting Production of fish

The problem confronting the production of fish is shown in table 5. The table showed that the main issues experienced in fish production were cost of feed, credit facilities, and marketing as indicated by 35, 35, and 28 of the respondents respectively. Additionally, 20 respondents were faced with the problem of water supply while 21 respondents dealt with the issues of inaccessibility of fingerlings, which, nonetheless, was not serious. Concerning marketing, the fish farmers revealed that, the majority of their customers are pepper soup sellers within the towns and that they lack a coordinated fish showcasing framework which can bring together every one of the fish farmers selling their fresh fish at the farm gate.

CONCLUSION AND RECOMMENDATION

Fish farming was observed to be a profitable and lucrative business in the area of study. The fish farmers are inefficient in the use of available resources at their disposal. The inputs used are yet to be optimally utilized for efficient fish production. There was low skilled labour utilization in the area, as most farmers depended on family labour. The farmers are operating on a decreasing rate of return. However, the efficiency of the fish farmers can be greatly increased if improved technology, as well as adequate training, is adopted.

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FATTY ACID COMPOSITION OF *Heterobranchus* GEOFFROY SAINT-HILAIRE, 1808 SPECIES FROM RIVER GALMA, ZARIA, KADUNA STATE, NIGERIA

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ABSTRACT

The fatty acid profiles of Heterobranchus species were investigated from River Galma, Zaria Kaduna State, Nigeria. Fresh samples of H. bidorsalis and H. longifilis obtained from the water body were subjected to Soxhlet method of oil extraction using n-hexane as solvent and Gas Chromatography Mass-Selective Detection (GC-MSD; Agilent Technology) for the detection of fatty acids present in the fish species. The resulting profiles revealed 17 fatty acids in H. bidorsalis and 19 fatty acids in H. longifilis, whereas monounsaturated fatty acid (MUFA) forms the bulk of the fatty acid in both species, saturated (SFA), as well as polyunsaturated (PUFA) fatty acids, were also identified. More PUFA was found to be present in H. bidorsalis than in H. longifilis with the reverse occurring in MUFA. Dominant among the identified and qualitatively measured fatty acids include Myristic C14:0, Lauric C12:0, Pentadecylic C15:0, Palmitic C16:0, Margaric C17:0, Palmitoleic acid C16:1(n-7), Oleic Acid C18:1(n-9), Fumaric acid C18:1(n-11), and Linoleic C18:2(n-6). Essential fatty acids which are important sources of nutrients promoting good health, prevention, and healing of diseases were identified from the species.

Keywords: Freshwater, *H. bidorsalis, H. longifilis,* SFA, MUFA, PUFA

INTRODUCTION

Clariid catfishes occur in most freshwater bodies of Africa where they constitute a significant component of the catches and are of great economic importance as food fish. African catfish, *Clarias,* and *Heterobranchus* species are widely cultured in Africa and beyond. They are especially readily acceptable among fish farmers and consumers in Nigeria, and so have a high commercial value (Aluko and Shaba, 1999; Offem, et al., 2008, Froese and Pauly, 2017). Quality and nutritional value of food are important since there is an increasing awareness of the need for consumption of healthy diet among the public. The nutritional properties of fish and fish products generally make them valuable foodstuffs that are beneficial for human health, nevertheless, lipid composition and thus fatty acid composition in fish differs depending on various factors: some of these usually include their natural (aquatic) environment (marine water, freshwater, and cold or warm water) as well as the biological, physical, and chemical properties of that environment. Also, seasonal changes, migration, sexual maturity and spawning period, species, feeding habits, and whether reared in aquaculture or grown in natural habitats affect the lipid/fatty acid composition (Lee, 2013). Fish are the most important sources of these fatty acids, especially fatty fish like sardines, mackerel, anchovies, and some salmon species, which are high in EPA and DHA and have a high ratio of n3 to n6 fatty acids. Although fish cannot synthesize these fatty acids, they can obtain them from the food they eat (algae and planktons) (Falk-Petersen, et al., 1998). In recent years, increasing attention has been focused on the significance of polyunsaturated fatty acids (PUFAs) in human nutrition, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Graham *et al*., 2007).

Fatty acids are fundamental biomolecules and have been used as trophic biomarkers in food web analysis. The interest in fat, which holds an important place in human nutrition, has increased with the recently increased interest in, and awareness of, human health. Fats are important components of hormones, cell membranes, and signaling molecules, as well as being important energy sources, when ingested into the body, it is first stored in the liver, hypodermic connective tissues, mesentery, and muscles and used when necessary. The human body can produce some of these fatty acids, but others, some of which also contain n-3 and n-6 PUFA, cannot be produced by the body. These essential fatty acids (EFAs) need to be obtained through food intake (Tocher, 2010).

Seafood remains a rich source of high-quality proteins, vitamins, mineral elements which contribute a significant source in the human diet and most importantly ω-3 polyunsaturated fatty acids (PUFA), that play a beneficial and protective role towards cardiovascular, chronic, and inflammatory diseases. This study, therefore, investigates the fatty acids present in the clariid freshwater species.