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ECONOMIC ANALYSIS AND EFFICIENCY OF SMALL-SCALE CATFISH FARMS IN DELTA STATE, NIGERIA

Solomon ENIMU[1], O. Loveth OKUMA[1]*, Onome George EDET[2]

[1]*Delta State University, Faculty of Agriculture, Department of Agricultural Economics, Abraka, Delta State, Nigeria*
[2]*University of Calabar, Faculty of Agriculture, Department of Agricultural Economics, Calabar, Cross River, Nigeria*

Abstract: This study was carried out to evaluate the efficiency and profitability of catfish farms in Delta State, Nigeria. Specifically, the study sort to: evaluate the level of efficiency in catfish farms, ascertain the profitability of catfish farms, identify the strategies for enhancing efficiency among catfish farmers and determine the effect of socio-economic and institutional characteristics on the efficiency of cat fish farmers. A multi-stage and proportionate random sampling technique was adopted in the selection of 600 Catfish farmer. Primary data were collected using well-structured questionnaire. Data analysis was carried out on the objectives using the descriptive and inferential statistics of frequency, percentage, mean, budgetary analysis, and multiple regression technique. The result shows that majority 81% of catfish farmers were male with a mean age of 47 years. Most respondents 65% were married with a mean household size of 5 persons. Regarding education, 46.7% had secondary education and their primary sources of credit were cooperatives 41.9%. The mean farming experience was 11 years with 43.3% farming primarily for commercial purposes. The most common production method was tarpaulin 56.7%. The study identified various strategies for enhancing catfish production which include regular feeding, use of commercial feed, good water quality control, personal labor to reduce cost, and regular medication. The multiple regression model indicated that, variables such as the level of farming expertise, the type of labor employed, and educational qualification, stocking density, membership of association, pond size, and household size had significant effects on production efficiency of catfish farms. This result underscored the significance of providing customized training, group networking assistance and access to credit and extension services to enhance the overall efficiency of catfish farms in Delta State.

Keywords: Economics, Efficiency, Small-scale, Catfish

***Corresponding author:** Delta State University, Faculty of Agriculture, Department of Agricultural Economics, Abraka, Delta State, Nigeria
E mail: okumaloveth@gmail.com (O. L. OKUMA)
Solomon ENIMU https://orcid.org/0000-0001-8716-7679
O. Loveth OKUMA https://orcid.org/0000-0003-0894-8659
Onome George EDET https://orcid.org/0000-0001-5200-7763

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1. Introduction

The art, science, and business of raising fish in a controlled environment are known as aquaculture/aqua farming. Aquaculture according to Food and Agriculture Organization (FAO, 2011) is defined as "the farming of aquatic creatures, including fish, crustaceans, molluscs, and aquatic plants". The last ten years have seen advancement in aquaculture productivity and has currently increased global food fish production by almost 12 times, on average, at an annual rate of 8.8%. In a range of facilities with varied input intensities and technological sophistication, using fresh, brackish, and marine water, more than 300 aquatic species are raised for food on a global scale (FAO, 2011). The swift expansion of the world's population has triggered a substantial upsurge in the desire for animal protein which is fundamentally of superior quality when compared to plant based protein sources. The nutritional requirements are especially important in a developing country like Nigeria, where malnutrition and starvation are severe problems. The low protein intake indicates lack of high quality protein food in the Nigerian's diet. The protein intake in Nigeria, which is about 19.38 g per day, falls well below the FAO requirements of 65 g per day.

According to Dağtekin et al. (2017), fish farming provides significant services such as promoting nutritional health, supplying feedstock for the industrial sector, supporting rural development, increasing export opportunities, more effectively managing natural resources, and preserving biological diversity. A productive way to produce animal protein is through fish culture. It feeds nearly one billion people with vital nutrition, including at least 50% of animal protein for 400 million individuals from the world's poorest countries (WBG, 2011). Fish will continue to be the most dependable source of protein for many people in developing nations, according to Akpan (2006). However, in spite of ever increasing biological activity, inadequate attention has been devoted to the viability or efficiency of the business itself. According to Mwangi (2017) aquaculture production involves more than the biological processes of fish growth it also includes paying critical attention to the level of efficiency of However, resource productivity can be defined in terms of either a mix of resources or in terms of a single resource input. As observed by (Ajao,

2012), many African farmers are still using low-yielding agricultural strategy, which lead to low productivity.

In general, the fishing inputs (fingerlings and feed) and trawling operation costs are rising, there is insufficient production of fingerlings of cultivable fish species, and there is not enough of the least expensive feed for fish culture, among other issues. There is still a gap of 1.2 million metric tonnes in domestic fish production despite the current fish demand being around 2.66 million metric tonnes and estimated domestic production in Nigeria being around 800,000 metric tonnes. This inability of the fish farming industry to expand fast enough in the supply of the required quantities of fish being demanded for has been linked to low production efficiency among the Nigeria farmers (Inoni, 2007).

Despite the projected steady rise in demand for growing fish owing to population expansion, the country has seen a sharp decline in the availability and consumption of animal proteins. The growth in demand and investment in fisheries in Nigeria is due to the fish's improved performance in terms of quality and quantity of nutrients. However, the higher demand has not been met by the supply of the product because most fish farm could not operate due to some inefficiency in production strategy that exists among the fish farmers in the state.

Considering the points mentioned above, it is crucial to access production efficiency of catfish farms in Delta state, Nigeria in order to enhance productivity catfish towards economic growth and development and also attaining the food security goal of the Sustainable Development Goal project in Nigeria in particular and World over is apt. With this context in mind, the study was initiated to answer the following research inquires:

a) What are the socio economic characteristic of the small scale fish farmer in Delta State?
b) What is the level of efficiency in cat fish farm in the study area?
c) What are the strategies for enhancing efficiency among the small scale catfish farmer in Delta State?
d) Does a socio-economic and institutional characteristic of catfish farmers affect their production efficiency and profitability?

1.1. Objective of the Study

The broad objective of the study was to evaluate the efficiency and profitability of catfish farms in Delta State, Nigeria.

The specific objectives are to:

a) evaluate the level of efficiency in catfish farms in the study area,
b) ascertain the profitability of catfish farms in Delta State,
c) identify the strategies for enhancing efficiency among small scale fish farmer,
d) determine the effect of socio-economic and institutional characteristics on the efficiency of cat fish farmers.

1.2. Hypothesis of the Study

The following null hypothesis guided the study;

$H_0$1; socio-economic characteristics and other institutional variables have no significant effect on the profitability of catfish farms in the study area.

1.3. Theoretical Framework

It is well known that every research is based on the assumption that explanation is not dependent on immediate data and so I present the theoretical basis of my study in this chapter. The theory will be explained under production function.

A production function serves as a description of how inputs are transformed into outputs within a production process, establishing a connection between the quantity of inputs and the resulting quantity of output. It shows the relationship between a firm's inputs and its outputs (Akpan, 2006). The production frontier characterizes the minimum number of the necessary combinations of inputs for the production of diverse products, or the maximum output with various input combinations and a given technology (Constantin et al., 2016). It indicates, in either short-run input elasticity and the marginal rate of technical substitution in mathematical or graphical form; what outputs can be obtained from various amounts and combinations of factor inputs in catfish production. In particular, it shows the maximum possible amount of output in catfish production that can be produced per unit of time with all combinations of factor inputs, given the current factor endowments and the state of available technology that will improve catfish production.

Unique production functions can be constructed for every production technology and this work extends this to include districts because production of fish is not restricted to one area especially catfish production; in other words, different production functions could exist for different districts due to likely differences in technology or micro-climates. The connection is non - monetary indicating that a production function associates physical inputs with physical outputs, without considering monetary values or financial aspects. Prices and costs are not considered (Mohaddes and Mazhari, 2008).

The production function represents a purely technical connection that explains how business converts inputs into outputs. It presupposes the existence of a relationship between inputs and outputs that can be expressed conveniently in mathematical terms:

$$Y(z) = 0 \quad (1)$$

where z is a real-valued m-dimensional vector containing both inputs used and outputs produced in catfish production over a given time period. Equation (1) can be re-written to separate inputs and outputs of catfish production into separate categories to improve its intuitive appeal as follows:

$$Y(y,x) = 0 \quad (2)$$

where the vectors x and y consist of nonnegative inputs and outputs in catfish production.

In the context of this analysis, (Equation 2) can be

rewritten as follows for the analysis case of an individual output:

$$Y(fx) = 0 \quad (3)$$

where $f(x)$ is single valued; in other words, the production function assumes that the output realized from a set of inputs is the maximum as prescribed by the technological relationship between inputs and outputs.

2. Materials and Methods

2.1. Area of the Study and Sampling Procedure

This study was conducted in Delta State, Nigeria. A multi stage random sampling procedure was used in selecting the respondents. The first stage involved a random selection of three local government areas each from the three agricultural zones, stage two involved a random selection of ten communities based o catfish production level from each LGAs. Stage three involved a random selection of twenty catfish farms making a total of six hundred catfish farms for the study.

2.2. Data Collection

Primary data were collected using structured questionnaire which was administered on the respondents. Data were collected on the socioeconomic characteristics such as age, gender, household size, fish pond size, farming experience, income, and level of education. Additionally, data were collected regarding the efficiency of fish farming and methods employed by catfish farmers to improve their efficiency, cost and returns on production and constraints faced by the farms.

2.3. Data Analysis

Data analysis was done on the objectives using descriptive and inferential statistical techniques as follows:

Objective 1, evaluate the level of efficiency in catfish farms in the study area was realized using frequency, percentage, mean and efficiency strategy index,

Objective 2, ascertain the profitability of catfish farms in Delta State was analyzed using mean, percentage, gross margin, benefit-cost-ratio and internal rate of return,

Objective 3, identify the strategies for enhancing efficiency among small scale fish farmer was achieved using frequency, percentage, mean and Likert scale rating,

Objective 4, determine the effect of socio-economic and institutional characteristics on the efficiency of cat fish farmers was analyzed using the multiple regression analysis.

2.4. Model specification

2.4.1. Efficiency strategy index

This index indicate the percentage of efficiency level of factors of production used in the production process, this index was realized with the formula given in Equation 4.

$$\text{Efficiency Strategy Index} = 100\frac{x}{IES} \quad (4)$$

where X= output and IES= input efficiency score.

2.4.2. The regression model

The multiple regression model will be employed to determine the influence of socioeconomic factors on the level of efficiency in catfish farm. The choice of the multiple regression model was based on the fact that the dependent variable is numerical and categorical in nature which does not required classification that can lead to the usage of other analytical tools (Kurnaz et al., 2021). The specific formulation of the regression model is as given in Equation 5:

$$ECFP = b_0 + b_1FG + b_2YFE + b_3HHS + b_4NYSS + b_5PSM + b_6MSA + b_7QLU + b_8SD + b_9PS + ei \quad (5)$$

where:

b_0 = regression constant

bi = slope of the linear regression

ei= error term

ECFP = Efficiency of catfish farm (Levels of efficiency)

FA = Farmer age (years),

YFE = Farming experience (years),

HHS = Household size (number),

NYSS = Educational level (no of years spent school),

PSM = Pond size (square meters)

MSA = Membership of association (dummy; yes =1, 0 = otherwise)

QLU = Quantity of labor used (man/hour)

SD = Stocking density (number of fishes stocked)

PS = Production system (type of pond)

3. Results and Discussion

3.1. Socioeconomic Characteristics of the Respondents

3.1.1. Distribution of respondents by age

Table 1 show that the mean age of catfish farmers was 47years. Majority 36.3% of the respondents have age range 41- 60years while 31.3% had above 60years and 26.9% have age range of 21- 40 years. Only 5.6% of catfish farmers/producers have age range of 1-20 years. This is in line with the findings of Ugwumba (2010), who in separate studies observed that farmers between age group of 41-50 years are the most active catfish farmers and this implies that these farmers are mature and of productive and innovative age and may adopt new efficient strategy for increased level of production. This is expected to result in a positive influence in catfish production level.

3.1.2. Distribution of respondents by gender

Table 1, shows that majority 67.5% of the catfish farmers were males while 32.5% were females. The results obtained here suggest that males were involved more in catfish farming. This result agrees with those of Tsue, Lawal and Ayuba, (2013) who in their study in Oyo State, found that more males were involved in catfish production than their female counterparts.

3.1.3. Distribution of respondents according to marital status

Table 1 shows that majority 53.1% of the catfish producers respectively were married while 22.2% were

single. About 24.4% of the farmers were divorced, widowed or separated. It implies that majority of the population are married. This finding is in consonance with Mwachiro and Gakure (2011) who found that marital status is a factor that suggests a high level of responsibility and great capability for sound decision making among farmers.

3.1.4. Distribution of Respondents by their Level of Education

Table 1 show that most 32.5% of the respondents attained secondary education while 24.4% had primary education. 21.3% had tertiary education while 21.9% had no formal education. The implication of this finding is that most of the catfish producers in the study area were moderately educated with different educational background. This finding is line with Kareem et.al. (2013), who found that farmers with more years of schooling tend to be technically efficient than the farmers with no education.

Table 1. Socioeconomic characteristics of the respondents

Variables	Frequency	Percentage	Mean
Sex			
Male	108	67.5	
Female	52	32.5	
Age			
1-20	9	5.6	
21-40	43	26.9	47.3
31-60	58	36.3	
>61	50	31.3	
Marital status			
Single	36	22.2	
Married	85	53.1	
Divorced	14	8.8	
Widowed	17	10.6	
Separated	8	5.0	
Level of education			
No formal education	35	21. 9	
Primary education	39	24.4	
Secondary education	52	32.5	
Tertiary education	34	21.3	
Size of House Hold			
1.00-3.00	51	31.87	
4.00-6.00	67	41.87	4.53
7.00-9.00	42	26.25	
Fish farming experience			
1-10yrs	17	10.6	13.4
11-20 Yrs	143	89.4	
Purpose of catfish farming			
Commercial purpose	24	15.0	
Domestic consumption	36	22.5	
Both commercial and domestic purpose	100	62.5	
Extension Agent Visit			
00	143	89.4	
2.00	8	5.0	
3.00	9	5.6	
Membership of Association			
Yes	119	74.37	
No	42	26.25	2.55
Source of credit			
Personal savings	67	6.3	
Money lenders	23	14.4	
Cooperatives	10	41.9	
Friends and relative	43	26.9	
Others specify	17	10.60	

3.1.5. Distribution of respondents by household size

The mean household size of the respondents was 5 persons per household. Majority 41.9% of the farmers had household size ranging between 4 – 6 persons while 31.9% had household size ranging between 1 – 3 persons. Only 26.3% of the respondents had household size ranging between 7 – 9 persons. This implies that enough hands were engaged in carrying out catfish farming operations for efficient production. This result agrees with Idowu et al. (2012) who found that family size can serve as source of free and cheap labor as children of different sexes engage in helping their parents or guardians to market different forms of fish.

3.1.6. Distribution of respondents by source of credit

Various sources of credit/capital are available for the catfish farmers. Table 1, shows that majority 41.9% of the respondents source of capital was cooperative societies while 26.9% were from friends and family. About 14.4% were from money lenders while 10.6% source credit from other sources such as banks and only 6.3% of the farmers sourced their capital from their personal savings. The result indicated that majority of the respondents sourced their capital from outside their personal savings.

3.1.7. Distribution of respondents by farming experience

Table 1 shows that majority 89.4% of the catfish farmers had an experience of between 11 - 20 years in catfish farming while only 10.6% of the farmers had experience of between 1 – 10 years. This suggests that all the respondents interviewed have different years of valuable experience in catfish production. This is expected to have a positive influence on catfish production in the area. This result is in consonance with the findings of Wadud (2011) and Olagunju et al. (2007) who in their study of brackish water aquaculture status found that the ability to manage fish pond efficiently depends on the years of experience.

3.1.8. Distribution of respondents by purpose of farming

On the purpose of farming Table 1 indicated that majority of the farmers 62.5% are into farming for both commercial and domestic purposes while 22.5% were for domestic purpose. Only 15.0% of the respondents are into commercial production. The results of the study confirmed that farmers had divergent reasons for going into catfish production.

3.1.9. Distribution of respondents by extension visit

On the basis of extension service delivery, majority of the respondents 89.4% ad zero or no extension agent visitation while 5.0% had twice extension visit . Only 5.6% of the farmers were visited three times by an extension agent. The results revealed that catfish farmers had little or no access to extension services.

3.1.10. Distribution of respondents by membership of association

Based on membership of association, majority of the farmers 74.4% belong to an association while only 25.6% do not. The results indicated that most catfish farmers in the study area belong to one form of association or the other. This result conform to study by Enimu and Edet (2019), who reported that group membership had a positive effect on catfish production efficiency.

3.2. Catfish Production Efficiency

Table 2 shows the production efficiency of catfish farmers in the study area. The Table 2 indicated that majority 54.4% of the catfish farmers ha average efficiency level at 0.22 – 0.25 while 28.8% of the catfish farmers had 0.26 – 0.29 efficiency level which is high. Only about 18.9% of the respondents had production efficiency level ranging between 0.00 – 0.21 which is low. The result revealed that majority of the catfish farmers in the study area had some levels of production efficiencies. The result supports study by Lawal (2002).

Table 2. Efficiency of catfish production

Item	Frequency	Percentage
Efficiency		
0.00-0.21	27	16.87
0.22-0.25	87	54.38
0.26-0.29	46	28.75

3.3. Strategies for Enhancing Catfish Production Efficiency

The mean result presented in Table 3, indicate that most of the strategies: buying of Fingerlings from reputable farm (3.0), use of modern technology (3.0), hatching of my own fingerlings to reduce cost (3.21), used of commercial feed (3.09), Regular Medication (2.5), used of recommended stocking density to avoid overcrowding/cannibalism (3.09), regular feeding (3.8), good water quality control (3.12) avoidance of excessive use of organic manure (2.8), personal labor to reduce cost (3.0) and consultant visitation (3.25) were very efficient in the study area.

3.4. Socio-Economic Determinants of Catfish Farmers on Production Efficiency

The study employs the ordinary least squares (OLS) estimation techniques to determine cause and effects of the relationship of the decision variables. This was done to establish how well the resulting model reflects the system it is intended to replicate. This thus, provided the study insight into the nature of the data in terms of their stationary or otherwise. This procedure intended to help the study to take a decision whether or not the coefficients of the estimated variables are significant.

Of the four functional model tried, (linear, semi-log, double-log and exponential) the ordinary linear function was preferred due to its abilities. It proved higher number of variables that were significant at 1%, 5%, and 10% levels of probabilities based on their t-test, f-ratio and R2 coefficients and also it has higher conformity with a priori expectations as compared to others. The analysis of the findings is therefore presented on Table 4.

Table 3. Strategies for enhancing catfish production efficiency

Strategies	NVE	NE	E	VE	Mean
Buying of Fingerlings from reputable farm	20 (12.5)	30 (18.75)	40 (25)	70 (43.75)	3.0
Buying of Fingerlings from road side/market	70 (43.75)	40 (25)	30 (18.75)	20 (12.5)	1.60
Hatching of my own fingerlings to reduce cost	10 (6.25)	20 (12.5)	55 (34.37)	75 (46.87)	3.21
Use of commercial feed	15 (9.37)	25 (12.5)	50 (31.25)	70 (43.75)	3.09
Use of maggot as supplement	70 (43.75)	50 (31.25)	25 (15.62)	15 (9.37)	1.09
Stocking of catfish with tilapia which serve as alternate protein source	80 (50)	45 (28.12)	25 (15.62)	10 (6.25)	2.53
Regular Medication	10 (6.25)	20 (12.5)	50 (31.25)	80 (50)	3.25
Use of recommended stocking density to avoid overcrowding/cannibalism	15 (9.37)	25 (15.62)	50 (31.25)	70 (43.75)	3.09
Use of modern technology	15 (43.75)	25 (31.25)	50 (15.62)	70 (9.37)	3.09
Regular feeding	5 (3.12)	25 (15.62)	50 (31.25)	80 (50)	3.28
Good water quality control	15 (9.37)	25 (15.62)	45 (28.12)	75 (45.87)	3.12
Avoidance of excessive use of organic manure	20 (12.5)	40 (25)	45 (28.12)	55 (34.37)	2.84
Personal labour to reduce cost	15 (9.37)	35 (21.87)	45 (28.12)	65 (40.62)	3.0
Consultant visitation	10 (6.25)	20 (12.5)	50 (31.25)	80 (50)	3.25

Table 4. Socio-economic determinants of catfish farmers on production efficiency

Variables	Linear +.	Semi-log	Double-log	Exponential
Intercept	4008247.178	-16.346	1.290	3747515.553
	(9.067)***	(2.343)**	(2.382)**	(16.431)***
Age	15566.686	0.046	0.362	17846.075
	(1.041)	(0.846)	(1.509)	(1.101)
Education	50947.225 (1.615)***	1.708	-1.728	-51311.916
		(3.431)**	(2.692)**	(1.183)
Household size	-145026.835	4.548	3.288	-4938.956
	(5.188)***	(10.311)***	(6.386)***	(0.142)
Production system	25870.041	-522	0.196	9331.686
	(3.486)	(1.899)*	(.818)	(0.576)
Quantity of labor	-72284.154 (3.669)***	1.044	1.212	-104163.387
		(3.359***	(3.703)***	(4.710)***
Pond size	336431.069 (2.054)**	-4.340	-2.729	206464.5923
		(1.679)*	(1.151)	(1.289)
Membership of group	-.827	7.670E-6	0.227	-13634.479
	(5.938)***	(3.489)**	(6.208)***	(5.520)***
Farming experience	1.001	-4.288E-6	-0.009	-5899.812
	(2.400)**	(.652)	(.287)	(2.726)**
Stocking density	-343828.056 (2.203)**	-2.172	2.860	219747.655
		(1.002)**	(1.419)	(1.614)
R^2 =	0.818	0.794	0.809	0.598
Adj. R^2 =	0.807	0.788	0.804	0.587
F-ratio =	55.77	132.979	146.330	51.288
Std-error =	1101.630	17.382	16.729	11298.896

Source= computation from field survey 2018, Reject the null hypothesis at one percent level, Figures in brackets are the t-values, ***, **, * significant at 1%, 5% and 10% level respectively, += the lead equation.

The results of the ordinary least square regression in which the production efficiency of catfish farmers was set as the dependent variable and the rest of the variables were defined as the explanatory variables.

The detailed results obtained from the regression are shown on Table 4. An evaluation of the model shows that, it performed relatively well based on the values of R^2, adjusted R^2 and F-ratio. The value of R^2 and adjusted R^2 are 0.818 (82%) and 0.807 (81%). This indicates that approximately 81% of the variation in the dependent variables (income) was due to the variables captured in the model. The values of R^2, adjusted R^2 and F-test thus provided reliable measures of the overall explanatory power of the regression model.

Using the two-tail test at 1% level of significance, the F-computed is 55.770 and the F-table is 2.58, since the calculated F is greater than the corresponding table value, we rejected the null hypothesis (H_0, at $P<0.01$; b's =0) which states that there is no significant relationship between production efficiency of catfish farmers and socioeconomic/agricultural/institutional characteristics; and accept the alternative hypothesis. Seven of the nine parameters included in the model affected the amount of income realized by production contract producers significantly. These parameters include educational level, household size, farm credit, sex, membership of group, extension training and distance.

The coefficient of education was significant at 1% and positively related to production efficiency. This implies that, the higher the educational attainment of the producer, the higher the production efficiency, vice versa. This result is in conformity with a priori expectation which state that the more educated people are the more likely they are to make higher income, since the more years spent to obtain formal education is believed to cumulate in better skills, which assist them do better in their chosen business comparatively. This report is in line with the work done by Ajao, (2012) and Ekunwe and Emokaro (2009).

The coefficient of household size was directly related to production efficiency by catfish producers and significant at1% probability level. The implication is that the more people there are in a household, the more efficient the household will be in production of catfish all things being equal vice versa. This finding agrees with a priori expectation further implying that if there are many people living under one roof, they act as farm labor that are easily available and manageable leading to higher income and savings. This is in conformity with work by Enimu and Edet (2019), Inoni (2007).

In conformity with a priori expectation, the coefficient of quantity of labor was significant at 1% probability level and positively related to production efficiency of catfish producers. The implication is that, the higher the quantity of labor, the higher the production efficiency. The number of available labor helps to increase productivity and scale of operation and if well managed especially by small scale farmers can increase the farmer's efficiency and income. The result is in line with work done by Lawal (2002), who noted that availability of labor is a very important determinant of production especially catfish as it leverage operations and increases the scale of production. The report agrees with Lawal (2002).

The coefficient of pond size was significant at 5% probability level and positively related to production efficiency. This implies that the size of the pond which invariably determines stocking density is a crucial variable in production efficiency vice versa. The result is in line with a priori signs and work done by Ume and Ochiaka (2018), Tsue et al. (2013), who reported that pond size management, is a veritable input in the production of catfish. They ascertain that pond size and stocking mix management determine input used which cumulates in output and income. These reports also conform to Dagtekin and Emeksiz (2007).

Membership of a group was significant at 1% probability level and was positively related to production efficiency. The result of the study was in conformity with a priori sign which means that belonging to producers groups will leads to increase in the production efficiency and output. The likelihood of the group insurance serving as collateral and moral suasion for adopting and networking towards better management strategies is apt. the report is in line with work done by Enimu and Edet (2019), who opined that membership homogeneity create a social bond which guarantee increase income for optimal production efficiency

Stocking density was significant at 5% probability level and positively related to production efficiency, the result is in conformity with a priori expectation which implies that the higher the number of catfish stock in a pond, the higher the management practices leading to production efficiency and output. Stocking density was found to influence income positively, indicating that as the number fishes stock increases the likelihood of mobilizing income. This result is in conformity with the findings of Olgunju et al. (2007) and Mwachiro and Gakure (2011), who found that the higher the stocking densities with optimum mix the more productive the farmer.

The coefficient of farming experience was significant at 5% probability level and was positively related to production efficiency of catfish farmers. This result is conformity to a priori expectation and implies that experience affect the efficiency of catfish production in the study area. This is not a surprise because experience they say is the best teacher as it has a positive effect on production, output income, savings and investment. Income and savings are expected to increase with experience (Nkamigbo et al., 2014).

4. Conclusion

The study focused on the socio-economic features of catfish farmers and their use of various tactics to increase production efficiency. The findings indicated that

measures involving optimal nutrition, disease control alongside stocking practices were more efficient in increasing the output of catfish farmers. Furthermore, factors ranging from education, household size, quantity of labor used, stocking density, membership of association, farming experience, pond size and production system all had a vital effect in determining efficiency.

Based on the findings from the study, the following recommendations were suggested to improve the production efficiency of catfish in the Delta State, Nigeria.

1) Encourage farmers with lower education levels to participate in training programs that focus on modern and efficient farming techniques.
2) Advocating for a variety of income sources among catfish farmers can enhance its stability such as creating value added products or offering fish related services.
3) Encourage more farmers to join cooperative associations to benefit from collective bargaining power and resource sharing.
4) Educate farmers about modern farming methods such as advanced pond/tank/tarpaulin management techniques and automated feeding systems. Promote the use of technology to enhance productivity and efficiency in various aspects of catfish farming

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	S.E.	O.L.O.	O.G.E.
C	34	33	33
D	34	33	33
S	34	33	33
DCP	34	33	33
DAI	34	33	33
L	34	33	33
W	34	33	33
CR	34	33	33
SR	34	33	33
PM	34	33	33
FA	34	33	33

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. Permission to conduct the study was obtained with the decision of the Delta State University Research Ethics Committee (approval date: January 15, 2023, protocol code: 23/05).

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