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Analysis of the factors influencing catfish production in Jos metropolis, Plateau State, Nigeria

A.O. Ojumu[1], M.O. Komolafe[2] and T.O. Obalola[3]

[1]Department of Agribusiness Management, Federal College of Land Resources Technology, Kuru, Jos, Nigeria
[2]Department of Business Administration, Nassarawa State University, Keffi, Nigeria
[3]Department of Agricultural Economics, Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria

ABSTRACT

Catfish production is a significant contributor to the aquaculture industry with a growing demand in domestic and international markets. This study therefore examined the factors influencing catfish production in Plateau State. A stratified sampling procedure was utilized to select catfish farmers, ensuring a representative sample. Data collection was facilitated through a questionnaire, and subsequent analysis employed a combination of descriptive statistics, marginal value product analysis, and regression analysis. The study found that most respondents were aged 36-45 (42.5%), with the next largest group being 46-55 (25%). Households of 4-6 members were most common (45%), while those with fewer than 3 members were least common (7.5%). Additionally, frequent visits or contacts from extension agents positively influenced catfish production outcomes. The results of the regression analysis of the factors affecting catfish production in the study area shows that the model had an R^2 value of 0.933, which implies that about 93.3% of the variation in catfish production was explained by variables included in the model while the remaining 6.7% was as a result of the non – inclusion of other important explanatory variables as well as errors in estimation. The F ratio (45.109) was statistically significant ($p<0.01$). This implies that the explanatory variables adequately explained the model. The study recommends establishing cooperative unions among catfish farmers to facilitate collective access to credit and essential inputs.

Keywords: Fingerlings; marginal value product; optimal profit; productivity

INTRODUCTION

Among the culture-able species of food fish in Nigeria is (carp, tilapia and catfish), catfish is the most sought-after species, very popular with fish farmers and commands a very good commercial value in Nigerian markets (Adeleke *et al.*, 2020). Nigerian aquaculture now produces the majority of the nation's aquaculture products, with catfish emerging as the leading fish culture (FAO, 2017). In recent time, there has been a drastic increase in price of

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correspondence: obalola.oyeyode@udusok.edu.ng
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catfish due to high demand (Maria Alice *et al.,* 2020; Adebayo & Daramola, 2013). Catfish are one of the most widely farmed freshwater fish species with a growing demand in the global market, thus in tandem with the position of the Food and Agriculture Organization of the United Nations which reported aquaculture as the fastest growing food production sector (FAO, 2016). The most popular catfish are the African catfish (*Clarias gariepinus*), Amur catfish (*Silurus asotus*), Striped catfish (*Pangasius hypophthalmus*), and Channel catfish (*Ictalurus puncuatus*). At the end of 2014, their contribution to fish production was 0.33%, 0.62%, 0.52%, and 0.53% (FAO, 2014), and at the end of 2018, it was 5.1%, 0.49%, 4.3%, and 0.91% respectively (FAO, 2020). According to Ezewudo *et al.* (2015), African catfish helped Nigeria carve out a place for itself in the world's aquaculture output. As of now, Nigeria is the continent's second-largest producer of aquaculture goods and the world's largest producer of African catfish (FAO, 2017). Catfish production is a thriving livelihood activity in Jos, with many residents engaging in its farming, taking advantage of the state's favourable climate and abundant water resources (Folorunsho *et al.,* 2024). The activity provides a source of income and employment for farmers, processors, and marketers. Catfish production has become a significant contributor to the aquaculture industry, providing a source of income for millions of people worldwide (Chukwu *et al.,* 2023; FAO, 2016). According to official records from the FAO, the total amount of African catfish produced in 2015 was 246,476 tons (FAO, 2017) and in 2020 it was 1249 thousand metric tons, or almost 2.5% of the entire amount of finfish produced (Chukwu *et al.,* 2023). Nonetheless, a number of African nations, like Egypt, South Africa, and Ghana, also produce a large number of African fish. As a result, the total amount of catfish produced in Africa can be overreported.

Fish farming is an aqua-cultural activity that involves rearing of fish in a controlled environment such as ponds (concrete or earthen), vats (wooden or fibre glass) and plastics from which social and economic gains are realized (Adebayo & Daramola, 2013). Despite catfish being the most sought-after species with high commercial value in Nigeria, factors affecting catfish production persist, particularly in areas with few catfish farmers. High demand has led to price increases, yet production challenges remain. These include inadequate infrastructure, limited access to quality inputs, and lack of technical expertise, which hinder the growth of catfish farming. Understanding these issues is crucial for enhancing production efficiency and meeting market demands. This study therefore is aimed to examine the factors influencing catfish production in Jos metropolis of Plateau State, Nigeria.

METHODOLOGY

Study Area

Jos metropolis is located between latitudes $9^0$54' and $10^0$10' N and longitudes $8^0$48' and $9^0$30'E (Andesikuteb *et al.,* 2020). Jos metropolis is composed of two Local Government Areas, Jos North and Jos South, with their headquarters located in Bukuru and Jos, respectively. Situated within the northern senatorial zone of Plateau State, Jos metropolis is bordered to the east by Barkin-Ladi and Jos East, to the south by Riyom, and to the west by Bassa local government areas. The projected population of Jos metropolis as of 2024 is 1,159,961 people at a 3.2% annual growth rate (NPC, 2021). At an elevation of 1,250 meters above sea level, Jos Metropolis spans 104 km from north to south and 80 km from east to west. The tallest peak, Shere Hills, is located at 1,777 m above sea level and covers an area of 1002.19 km (Andesikuteb *et al.*, 2020; Mohammed *et al.*, 2010). Although situated in the tropical zone, the higher altitude gives the state a near-temperate climate, with an average temperature between 13 and 22 °C (Adamu *et al.*, 2022; Climate-data.org, 2021). Harmattan winds cause the coldest weather between December and February, with the warmest temperatures usually in the dry season months of March and April. The mean annual rainfall varies between 1,317 mm (52 in) in the southern part to 1,460 mm (57 in) on the plateau, with the highest rainfall during the wet season in July and August.

Sampling Procedure

The study employed a stratified sampling procedure, where Jos metropolis was initially divided into two distinct strata based on Local Government Areas (LGAs), namely Jos North and Jos South. To ensure representativeness, the sample was then proportionally allocated to each stratum according to population density. Consequently, 35 questionnaires were administered in Jos North LGA, which is more densely populated, and 28 questionnaires were administered in Jos South LGA, which is less densely populated. This systematic allocation resulted in a total of 63 questionnaires being administered, out of which 57 were successfully retrieved.

Method of Data Collection

Primary data were used in the study. This was collected with the aid of a structure questionnaire designed to elicit relevant information such as the socioeconomic characteristics of the catfish farmers such as age, sex, marital status, household sizes, experience in catfish production and their educational levels. Others were the surface area of the catfish ponds, the input costs, this includes costs on quantity of feed, quantity of fingerling, quantity of drugs and chemical, and quantity of labour as well the output accruing from production. Data collection lasted from January to March, 2024.

Analytical Techniques

Descriptive and inferential statistics were employed in achieving the objective of the study. These included the use frequency and percentage to describe the socioeconomic characteristics of the catfish farmers. In examining the factors influencing catfish production, ordinary least square (OLS) regression model was employed. Ensuing the work of Obalola and Tanko (2016), the implicit form of the model was specified thus:

$$Y = f\ (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, e_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Four functional forms were fitted to the data and the lead model was chosen based on statistical and econometric criteria such as R^2 value, consonance with *apriori* expectations, level of significance of the variables. The explicit forms of the models fitted to the data are specified as follows:

Linear:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + U_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Cobb – Douglas:

$$InY = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \beta_6 InX_6 + \beta_7 InX_7 + \beta_8 InX_8 + \beta_9 InX_9 + \beta_{10} InX_{10} + \beta_{11} InX_{11} + \beta_{12} InX_{12} + \beta_{13} InX_{13} + U_i \text{ ………… (3)}$$

Exponential:

$$InY = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + U_i \text{ ……………… (4)}$$

Semi – log:

$$Y = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \beta_6 InX_6 + \beta_7 InX_7 + \beta_8 InX_8 + \beta_9 InX_9 + \beta_{10} InX_{10} + \beta_{11} InX_{11} + \beta_{12} InX_{12} + \beta_{13} InX_{13} + U_i \text{ …….. (5)}$$

Where:
Y= dependent variable (output of catfish in kg)
X’s = independent variables
β’s = regression coefficients to be estimated,
Y = Quantity of catfish harvested (Kg),
X_1 = Age of the farmer (Years),
X_2= Sex of the farmers (1 if male, 0, otherwise),
X_3 = Level of education (Years spent in school),
X_4 = Pond size (Square meters),
X_5 = Quantity of feed (Kg),
X_6 = Number of fingerlings (Number),
X_7 = Cost of drugs and medication (₦),
X_8 = Labour input (Man-days),
X_9 = Experience in catfish production (Years)
X_{10} = Household size (Number)
X_{11} = Amount of credit accessed (₦),
X_{12} = Extension contact (Number of visits),
X_{13} = Membership of cooperative (1 if member; 0, otherwise)
U_i = error term.

The resource use efficiency of the catfish farmers was evaluated using the linear programming model, through the respective shadow prices.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Catfish Farmers

The socioeconomic characteristics of catfish farmers are presented in Table 1. The results show that the majority of catfish farmers in the study area were within the age range of 36-45 years, followed by those between 46-55 years at 40.40% and 22.80%, respectively. A total of 14.0% were below 35 years of age, while 12.3% fell within the age range of 56-65 years.

Table 1: Socioeconomic characteristics of catfish farmers

Socioeconomic Variables	Frequency	Percent
Age (years)		
26-35	8	14.0
36-45	23	40.4
46-55	13	22.8
56-65	7	12.3
> 65	6	10.5
Sex		
Male	50	87.7
Female	7	12.3
Marital Status		
Married	48	84.2
Single	9	15.8
Education		
No formal education	1	1.8
Primary education	4	7.0
Secondary education	5	8.8
Tertiary education	47	82.5
Experience (years)		
≤ 5	39	68.4
6-10	15	29.3
11-15	2	3.5
16-20	1	1.8
Household Size (persons)		
≤ 3	8	14.0
4-6	23	40.0
7-10	14	24.6
> 10	12	21.1
Cooperative Membership		
Non-member	44	77.2
Member	18	22.8
Sources of Finance		
Personal savings	47	82.5
Friends/Relatives	8	14.0
Commercial banks	1	1.8
Local money lender	1	1.8

Source: Field Survey, 2024

The fish farmers were predominantly in their prime, making them productive and economically active, which corroborates the work of Oluwasola and Ige (2015). Gender plays a significant role in catfish farming, as in other agricultural practices concerning property acquisition, such as fixed assets like land and machinery. The majority of respondents involved in catfish production in the study area were males, constituting 87.7%, while 12.3% were females. This supports the findings of Olagunju *et al.* (2022) and Oluwasola and Ige (2015), which indicate that fisheries activities are predominantly male dominated. The male dominance in this sector could be attributed to several factors, including their access to water points and land, which is typically acquired through male lineage. Women can only access such land resources through purchase or rent. Additionally, the physical demands of fish farming may deter female participation.

The majority of respondents were married, constituting 84.2%, while 15.8% were single, as shown in Table 1. Marital status allows them to easily utilize family labor for performing critical farm tasks. However, it also implies that they may incur higher household expenditures, reducing the amount of income realizable from the enterprise. This observation is consistent with the positions of Oluwasola and Ige (2015) and Nwosu *et al.* (2012).

According to Table 1, only 1.8% of respondents lacked formal education, while 82.5% had tertiary education. This indicates that fish farming is predominantly undertaken by individuals with higher educational qualifications. The high level of education among farmers enhances their capacity to understand and evaluate new production technologies, corroborating the findings of Olagunju *et al.* (2022), Oluwasola and Ige (2015), and Nwosu *et al.* (2012). The data also show that 68.4% of respondents had less than five years of experience in catfish farming, suggesting that many farmers are relatively new to the enterprise. This finding contrasts with Olagunju *et al.* (2022), which indicated more experienced farmers in the field. Household size positively influences technology adoption in catfish farming. Larger families provide a source of cheap labor, reducing the cost of executing production activities. The money saved can be invested in procuring improved production inputs, facilitating technology adoption. The table reveals that 64.6% of households had between four and ten members, indicating sufficient family labor to support fish farming operations. However, as noted by Adebayo and Daramola (2013), it is not just the size but the composition of the family that matters.

Furthermore, the result shows that 77.2% of respondents were not members of a cooperative society, with only 22.8% registered as members. This low membership rate might be due to a lack of awareness about the benefits of cooperative societies. Consequently, most respondents operated independently, missing out on government incentives and support provided through cooperatives. Cooperative societies play a crucial role in meeting the financial and resource needs of members, highlighting the importance for catfish farmers to join these organizations. Apata *et al.* (2018) found a contrary result, with 90.6% of the farmers belonging to one social group or the other. Non-members face the challenge of sourcing funds independently, often relying on personal savings or other means.

Factors Influencing Catfish Production in the Study Area

The factors influencing catfish production in the study area were examined using multiple regression analysis, with results detailed in Table 2. Among the four functional forms considered, the linear model was determined to be the best fit, explaining 93.3% of the variation in catfish production ($R^2 = 0.933$). The model's F ratio of 45.109 was statistically significant ($p<0.01$), indicating that the included variables sufficiently explained the model.

From the 13 variables initially tested, four were found to be statistically significant in explaining catfish production. These variables included the age of the farmer ($\beta = 132.27$, p

< 0.01), number of fingerlings reared (β = 1.16, $p < 0.01$), extension contact (β = 818.20, $p < 0.05$), and cooperativeness (β = -1963.97, $p < 0.05$).

Table 2: Factors influencing catfish production in the study area

Variables	Linear	Cobb - Douglas	Exponential	Semi – Log
Constant	-4665.058	-1.444	5.831	-58314.980
	(-2.157**)	(-1.461)	(9.186***)	(-3.369***)
Age	132.270	0.189	0.009	- 354.353
	(3.191***)	(1.585)	(0.725)	(- 0.169)
Sex	-63.751	-0.103	0.016	- 2587.334
	(-0.065)	(-0.871)	(0.057)	(- 1.245)
Education	43.387	0.004	- 0.012	1560.196
	(0.397)	(0.033)	(- 0.374)	(0.755)
Pond Size	2.134	0.023	0.003	-3649.209
	(0.601)	(0.174)	(2.563**)	(-1.574)
Feed	-0.001	0.041	- 2.438E – 007	1017.382
	(-1.231)	(0.874)	(-0.749)	(1.246)
Fingerlings	1.169	0.994	8.346E – 005	8091.712
	(6.004***)	(6.833***)	(1.461)	(3.174***)
Drugs and Medication	0.023	-0.027	9.634E – 006	- 257.516
	(0.921)	(-2.095***)	(1.304)	(-1.152)
Labour	0.007	0.022	2.335E – 006	351.224
	(1.540)	(0.376)	(1.725*)	(0.336)
Experience	-46.810	0.016	0.038	-1292.485
	(-0.471)	(0.242)	(1.295)	(-1.151)
Household	-554.902	0.043	0.155	-2300.032
	(-1.017)	(0.353)	(0.970)	(-1.071)
Credit	-1034.368	0.235	-0.043	1779.747
	(-0.560)	(1.095)	(-0.079)	(0.473)
Extension	818.198	-0.084	0.113	766.601
	(2.178**)	(-0.588)	(1.021)	(0.308)
Cooperative	-1963.971	0.031	- 0.089	1833.790
	(-2.286**)	(0.299)	(- 0.354)	(1.017)
R^2	0.933	0.913	0.773	0.715
R^2 adjusted	0.912	0.902	0.702	0.629
F – ratio	45.109***	86.917	10.968***	8.299***

Source: Author’s computation, 2024
Figures in parenthesis are t-values; *, **, *** denotes significance 10%, 5%, and 1% levels respectively

The positive coefficient for age suggests a direct relationship between the age of catfish farmers and production output. Older farmers tend to have more experience, enabling them to set realistic production targets and exhibit greater technical competence. Similarly, the positive coefficient for the number of fingerlings indicates that increasing the number of fingerlings reared correlates with higher catfish production. The significance of the extension contacts variable underscores the role of extension services in enhancing farm efficiency. Farmers who have regular contact with extension agents benefit from improved technical advice and innovation dissemination, aligning with findings from Apata *et al.* (2018) on the pivotal role of extension services in agricultural development. Conversely, the negative coefficient for cooperativeness suggests that catfish farmers who are members of cooperatives may experience decreased production efficiency. This could stem from potential challenges in cooperative operations or limited awareness among farmers regarding the benefits of cooperative membership in enhancing technical efficiency.

While age, fingerling numbers, and extension contact positively influence catfish production, cooperativeness among farmers requires further exploration to optimize its potential benefits in enhancing productivity. These findings highlight the nuanced interactions between socio-demographic factors and agricultural productivity, offering insights for policy and practice aimed at improving catfish farming efficiency in the study area.

Marginal Value Products of Resources

Table 3 summarizes the optimal resource allocation and usage patterns, highlighting surplus and shadow prices. Resources such as pond size, fingerlings, human labor, and capital were found to be in surplus supply, exceeding the required amounts for catfish farming in the study area. This indicates they were non-limiting factors. The marginal value products of resources demonstrate how much profit would increase with a unit increase in each resource. Only resources with positive shadow prices are limiting. For resources not fully utilized, the shadow price is zero, signifying they do not constrain achieving production goals.

In the optimized plans for catfish production, only feed showed a positive shadow price of N1,054.016. This suggests that increasing feed quantity by 1% or one unit (kg) would increase optimal profits by N1,054.16. The findings confirm that feed is the primary cost driver in catfish production, aligning with its significant impact on profitability, thus, corroborates the work of Oluwasola and Ige (2015).

This analysis underscores the efficient allocation of resources in maximizing catfish production, with feed identified as the critical limiting factor influencing profitability.

Table 3: Marginal value product of resources

Resource	Use Status	Slack/Surplus	Shadow Price (₦)
Pond Size (m^3)	Not fully utilized	224.908	0.000
Feed (kg)	Fully utilized	0.000	1,054.016
Fingerlings (No)	Not fully utilized	1,060.892	0.000
Human Labour	Not fully utilized	3.938	0.000
Capital(₦)	Not fully utilized	195, 295.800	0.000

Source: Field Survey, 2024

CONCLUSION

This study analysed the factors influencing catfish production in Plateau State, Nigeria. The findings indicate a positive correlation between the age of catfish farmers and production output, highlighting age as a significant factor influencing catfish production. Additionally, an increase in the number of fingerlings was found to correspond with higher catfish production. Moreover, frequent visits by extension agents positively influenced production outcomes. Conversely, membership in cooperatives showed an inverse relationship with catfish production in the study area.

Based on these findings, the study recommends establishing cooperative unions among catfish farmers to facilitate collective access to credit and essential inputs. Additionally, efforts should be focused on reducing the cost of feeds for catfish production. This can be achieved through research and development of alternative feed sources that are cost-effective and sustainable. These recommendations aim to foster a conducive environment for enhancing catfish production in Plateau State, thereby supporting food security and economic development in the region.

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