ANALYSIS OF INNOVATION SYSTEM OF FISH MARKETING AMONG PRODUCERS IN ADAMAWA STATE, NIGERIA

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ABSTRACT

*This study analyzed the innovation system of fish marketing among producers in Adamawa state, Nigeria. The study was carried out in Adamawa state which is located at the Northeastern part of Nigeria. Data were collected from primary sources. The data were collected from 200 respondent using structural questionnaire. The data collected were analysed using descriptive and inferential statistics. The results reveal actors in innovation system which include: fish marketers, fish producer/farmer, fish feed miller, and fish drug seller. The result reveals that about 49.5%, of respondents" were within the age ranging from 41-50 years, while those at the range of 31-40 years had 33%, those range of 21-30 years had 10% respectively. The study also reveals that about 65% of the respondent were male while the remaining percentages (35%) were female. The study revealed that about 26.0% of respondent in the study area. The result reveal majority of respondent 94% had formal education and also the result reveal that majority of respondent belong to membership association and about 97% of the respondent agree if new innovation brought to them, they will adopt and Implement an Innovation in Fish production. The result of linear regression reveals that there were significant in R^2, were 89.75% and F- value (*40728.70*) which influencing linkage/interaction of respondent in the study area. This indicate that any increase in the value of any of the aforementioned variables will have high influence in the innovation system. Furthermore, the coefficient of* age, *household size, Experience, level of education, quantity of fish membership of association, quantity of fish produced, and spread of innovation, were found to be significant at 1% and 5% while, marital status and extension contact were found to be not significant. Improving fish marketing innovation in Adamawa State requires better infrastructure, stronger producer associations, and enhanced stakeholder training.*

Keyword: *Actor, Producer, Collaboration, effectiveness, Innovation system, Linkages/Interaction*

INTRODUCTION

Fish production is an important constituent of global food security and aquatic ecosystem management while fish farming, on the other hand, is considered as key to agricultural sector of food production all over the world FAO (2020). It is viewed as a crucial agricultural activity that can reduce nutritional deficiencies considerably on a global scale and therefore reduce poverty effectively (Kallem and Sabi 2021).

From the historical perspective, modern fish culture in Nigeria started during the period of the Second World War (1939-1945) when the colonial masters (Britain) initiated a study to evaluate aquatic resources in Nigeria. It is estimated that annual fish production has reached 1 million metric tons. Aquaculture contributes 275,645 metric tons while 805,210 metric tons originates from fisheries (Adewumi and Fagbenro 2021; Babatunde *et al.*, 2021).

Nigeria is ranked as the leading aquaculture-producing nation in Sub-Saharan Africa Kaleem, and Sabi (2021). Aquaculture production in Nigeria rose from about 2000 tone in 1960 to more than 300,000 tone by 2015. This rate dropped in 2019 to 290,000tones and furthermore decreased to 260,000 tons in 2020 due to the COVID-19 impact. By the year 2022, the production figures obtained was 275,645 tones (Kallem and Sabi, 2021). Nigeria dominated the global aquaculture production of bonytongues (Osteoglossiformes), with nearly 80%. Catfish was the largest aquaculture product nationally at 65.61%, but globally, it contributed only 2.85%. The contribution of characins to world aquaculture production is only at 4.6% (FAO 2022).

Fish accounts for nearly 40% of Nigeria's protein intake, as fish consumption hovers between 11.2 and 13.3 kg/person/per annum (Adeleke *et al.,* 2020; Ajayi *et al*., 2022). However, Nigeria's per capita protein intake is still lower than the Sub-Saharan African average even though fish is cheaper than other sources of animal protein (Babatunde *et al.,* 2021). Thus, the Nigerian production level of 1.04 million tons (fisheries 75%, aquaculture 25%), a deficit of about 2.5 million tons must be supplemented by importation (Kallem and Sabi, 2021). This shows that Nigeria is far from self-sufficiency as envisioned in the National Aquaculture Strategy (NAS). Despite this, the fisheries sub-sector has supported the development of a strong distribution value chain by local businesses. This made it possible for SMEs to undertake the delivery of live or frozen catfish and tilapia products to their destinations (Adelesi and Baruwa 2022; NT, 2023; PUNCH, 2022 and TEKN, 2019;).

Innovation is the process by which social actors create value from knowledge, it does not as a rule result from research and development activities as has often been thought, rather, farmers, artisans, small scale food processors can do innovation about their processes and products based upon several/diverse sources of knowledge and information often streaming from everyday activities (Subasinghe *et al)*. While innovation systems are complex, open and dynamic activity systems in which actors (individuals, groups, and organizations) apply their minds, energies and resources to innovation in a particular area of human activity (Abdullahi *et al*,. 2022). Agricultural innovation system are a set of agents that jointly and /or individually contribute to the development, diffusion and use of agriculture-related new technologies which directly or indirectly influences the process of technological change in agriculture by improving its productivity. Innovation systems makes it possible to assess system performance which is useful in comparative studies since actors maybe uncoupled from what happens in the system (Nwuba, 2022; Subasinghe *et al.*, 2021; Tran *et. al*., 2021).

In Adamawa State, marketing of fresh fish passes through several market linkages and exchange points before getting to the final consumers. It is a chain of different systems involved in the marketing from production to consumer with intra and inter-linkages (Alam *et al.*, 2022). At various stages in the marketing chain, fish has to be packed and un-packed, loaded and un-loaded to meet consumer demand. Each handling cost will not amount so much but the sum total of all can be significant, depending on the length of chain (Ali *et al.*, 2018).

Adamawa state is a fish production and marketing area; lots of actors are involved in fish marketing. These actors relate and interact through links and networks; however, the type of links and networks as well as the roles played by each of these actors seems not to be clearly defined and ascertained. Innovation system study identifies the actors involved in fish marketing, determines their roles and gives an understanding of how they interact to generate, share, transfer knowledge and adopt new ideas so as to improve marketing performance. Innovation system brings about social interaction where different actors collectively introduce a new idea or improve on an existing idea. However, in Adamawa state, such collective interaction among actors particularly in the fisheries sub-sector has not been identified, rather, focus of previous studies has been on the economic aspect of fish productivity and marketing, hence, the need for this study.

Addressing the food and agricultural needs of current and future generations presents significant challenges. The necessity for increased and more efficient agricultural production on a sustainable basis cannot be overstated. To ensure the continuous availability of fish for human consumption, nutrition, and overall well-being, it is crucial to conduct effective and efficient analyses of innovation systems in fish marketing, particularly in Adamawa State, Nigeria.
The findings from this study will be valuable for the government by guiding the development of policies aimed at enhancing the fisheries sector. This research will also serve as a bridge between fish farmers, marketers, and consumers, revealing the specific roles of each actor and fostering collaboration to improve fish production and marketing in the region.
Extension service providers will benefit from the study's insights, which will enable them to collaborate with researchers and other stakeholders in planning targeted intervention programs for fish marketing innovation systems.

For the private sector, including NGOs and business investors, the study's results will offer guidance on participating in the innovation process. They will be able to contribute ideas, make informed decisions, and implement innovations effectively. Fish farmers and marketers will be encouraged to form networks and share information to enhance the performance of the innovation system. This includes improving marketing functions such as production (through the use of improved and disease-resistant species, proper feeding, and medication), transportation (short distances, cold vans), and processing (modern drying, smoking, and cold storage facilities).
Additionally, the study will provide baseline data for future researchers and serve as a reference for students and academics in related fields.

The broad objective of the study was to analyze the effectiveness of the innovation system of fish marketing in Adamawa state, Nigeria. Specifically, the study intends to:

i. Describe the socio-economic characteristics of fish producers in the innovation system.
ii. Identify the actors in fisheries innovation system of Adamawa State.
iii. Examine the linkages/interactions among actors of fisheries innovation system

The study analysis of innovation system of fish marketing among producers in Adamawa State Nigeria was limited to three Local Government Areas (LGAs), Mubi north, Yola north and Numan LGAs states. This is due to the fact that the majority of fish farmers are concentrated in the urban centers of these LGAs and a few artisanal fish farmers are also found in and around these regions. Additionally, the threat posed by insurgents, particularly Boko Haram, has hindered access to other areas of the state, making it challenging to conduct research in those regions.

METHODOLOGY

The Study Area

This study was carried out in Adamawa state which is located at the Northeastern part of Nigeria. It lies between latitudes $7^o – 11^o$ N of the equator and between longitudes $11^o – 14^o$E of the Greenwich meridian (Adebayo and Tukur, 2020). The State consists of twenty-one Local Government Areas (LGAs). These are further divided into four agricultural development projects (ADP) zones: zone 1, 2, 3 and 4. It shares a common boundary with Taraba State in the south and west, Gombe State in the Northwest and Borno State in the North; it also has an international boundary with Cameroon Republic along its eastern borders (Adebayo *et al.,* 2012; Adamawa State Diary, 2020).

The State covers a land area of about 39,741km^2 and has a total population of 3,100,000 persons out of which 1,800,000 (58.06%) are males while 1,300,000 (41.94%) are females (NPC, 2006). This figure according to United Nations (UN) projection brings the total population to 4,902,100 persons in 2022, and projected to 6,617,835 at 2.7% annual growth rate (NBS, 2023). Annual rainfall in the state ranges from 900 to 1600mm while annual maximum temperature ranges between 39^oc and 45^oc. Majority of the populace are farmers; others are fishermen, civil-servants, marketers and people of various trades. Adamawa State is one of the leading producers of crops like Maize, Rice, Cowpea, Sorghum, groundnuts and cotton (Adebayo and Tukur, 2020) while major animals produced include cattle, other small ruminants and monogastric birds (Babale, *et al.,* 2012). Infrastructure such as road network, electricity, hospitals, schools and research institutions are found in the State. Figure 3.1 shows the map of Adamawa State and the selected area of study.

Method of data Collection

Data for this study was obtained from primary source; this was collected with the aid of structured questionnaire which was administered to the respondents in the study area via the use of Kobo Collect. This procedure is in line with that of Khan, *et al.,* (2017), Hamisu, *et al.,* (2024) and Madugu *et al.,* (2024).

Sample Size and Sampling Procedure

A multistage simple random sampling and snow ball sampling techniques was employed for this study. In the first stage, three Local Government Areas (LGAs) was purposively selected (on the basis of the size of fish production and marketing activities). The three LGAs make up the largest fish production and marketing locations in the state (Numan, Yola North and Mubi North) The second stage involved the random selection of two wards from each of the LGAs while the final stage will involve the selection of two hundred (200) respondents (fish producers/marketers) via snow ball sampling which was in proportion to population size of the sampling frame (Table 3.1). The sampling frame was obtained from the agricultural development programmes (ADPs) and fish producers/marketers association at each of the locations from where the sample was drawn.

Data Analysis

i. Non-inferential statistics such as frequency distribution, means and percentage was used to achieved objectives i, ii,
ii. Regression analysis was used to determine objective iii. It is given by the function implicitly as: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, \ldots\ldots\ldots\ldots\ldots X_n)$.

Therefore, the linear model explicit specification is as below:

$$Y=ß_0+ß_1X_1+ß_2X_2+ß_3X_3+ß_4X_4+ß_5X_5+ß_6X_6+ß_7X_7+ß_8X_8+ß_9X_9+ß_{10}X_{10}+ß_{11}X_{11}+\mu$$

Where:
The dependent variable, Y = Number of Linkage/interactions (frequency of collaboration/continuous variable), while the various independent variables are as follows:
X_1 =Average income (₦) (continous variable)
X_2 = Age (in years)
X_3 = Level of education (in years)
X_4 = Experience (in years)
X_5 = Marital status (Binary)
X_6= Household size (continous variable)
X_7 = Quantity of fish sold (in Kg)
X_8 = Quantity of fish produced (in Kg)
X_9 = Membership in association (Binary)
X_{10} = Extension Contact (in Numbers)
X_{11} = Farmer- Farmer contact (in Numbers)

Criteria used for selecting the lead equation was based on the apriori expected economic criteria for the signs of coefficients, significance and size of coefficients of multiple determinations (R^2) as well as F and t- ratios. Average income, Age, educational status, experience, size of household, quantity of fish produced, volume of fish sold, membership in association and are expected to be positive and thus positively influence frequency of interaction or networking. Four functional forms was fitted into the analysis, the models being: linear, exponential, double- log and semi-log functional forms. The equations of the functional forms are specified as follows:

Linear: $Y = bo + biXi + b_2X_2 + b_3X_3 ...+ + b_9X_9 + e$…….(4)

Semi-log: $Y= \log bo + bi \log Xi + b_2 \log X_2 + b_3 \log X_3… + b_{11} \log X_{11} + \log e$ ……..……(5)

Exponential: $\log Y = bo + biXi + b_2X_2 + b_3X_3 .+ + b_{11}X_{11} + \log e$……..……(6)

Double-log: $\log Y= \log bo + bi \log Xi + b_2 \log X_2 + b_3 \log X_3 + + b_{11} \log X_{11} + \log e$ …….……(7)

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Fish Producers

The purpose of investigating the fish producers' characteristics is to provide valuable information on them. The socioeconomic characteristics of the fish producers that were analyzed using descriptive statistics include sex, marital status, age, level of education, household size, and years of production experience of the fish producers. Table presents the socioeconomic characteristics of fish producers in the study area, providing insight into the demographic and human capital attributes that shape participation and performance within the fisheries innovation system.

Age distribution of fish producers

The age distribution from the results below showed that 49.5% of producers are adults, 33.5% are youth, and 17% are senior citizens. This indicates a relatively balanced age structure, with a dominance of economically active individuals. The presence of youth suggests potential for long-term sustainability of the fisheries sector, while adult and senior producers contribute experience and stability. Similar age distributions have been reported by Aderolu *et al. (*2020) in aquaculture studies across Nigeria, where middle-aged farmers dominate production activities.

Sex of Fish Producers

The results below indicated that male fish producers constitute 65%, while females account for 35% of fish producers. This suggests that although fish production remains male-dominated, female participation is substantial. The relatively high involvement of women reflects increasing inclusiveness in aquaculture activities, particularly in small-scale fish farming, processing, and marketing. This finding is consistent with FAO (2022), which reported growing female participation in aquaculture across sub-Saharan Africa, and with Adeyemo *et al.* (2020), who observed narrowing gender gaps in Nigerian aquaculture systems.

Marital status of the fish producers

The results revealed that most of the fish producers were married (62%), followed closely by single individuals (30%), while divorced (5.5%) and widowed (2.5%) fish producers constituted smaller proportions. The dominance of married producers suggests household stability, which may enhance access to family labor and support for production activities. According to Olagunju *et al.* (2021), married farmers often exhibit higher production capacity due to shared responsibilities and labor availability, although marital status alone does not necessarily determine innovation adoption.

Household size of the fish producers

The results reveal in Table 4.1 showed that about 18.5% of actors had a household ≤ 5 size, 41.5% had household size between 6-10 members, 24% had household size range between 11-15 members, 10.50% had family household size range between 16-20 and about 5.5% had family size between ≥ 21 persons respectively. The implication of this is that, the larger the household size the better the marketing innovation efficiency. The house hold members may help in providing some marketing functions at a reduce cost which is an incentive to an efficient marketing system. This agrees with World Bank (2019), household labor availability positively influences engagement in agricultural production and innovation activities, particularly in labor-intensive systems such as aquaculture.

Years of experience of fish producers

The result showed that the majority of the Producers 40.50% of respondent had a marketing experience between 6-10 years, followed by 20.50% of producers had a marketing experience ≥ 5years, and the lowest are producers that had a marketing experience of ≤ 16years. These results implied that marketers in the study area have sufficient experience in fish marketing. Dossou-Yovo et al. (2022) reported that experienced farmers are more likely to engage in innovation networks and adopt improved technologies due to accumulated knowledge and confidence.

Educational level of the fish producers

The results below revealed that educational level of fish producers revealed a relatively high-level formal education, with 51.5% having tertiary education and 28.5% having secondary education. This implies strong human capital among fish producers, which enhances their ability to understand and adopt improved technologies, management practices, and market information. This finding aligns with Anderson and Feder (2020) and Bernard and Spielman (2019), who emphasized education as a critical driver of innovation adoption and effective participation in agricultural innovation systems. The small proportion of fish producers without formal education (4%) further suggests a literate producer base conducive to innovation diffusion.

Table 1: Distribution of Socio-Economic Status of Respondent

Variable	Frequency	Percentage (%)
Age of Respondent		
21-30	21	10.50
31-40	46	23.00
41-50	99	49.50
≥ 51	34	17.00
Total:	**200**	**100**
Sex of Respondent		
Male	130	65.00
Female	70	35.00
Total:	**200**	**100**
Marital Status		
Single	60	30.00
Married	124	62.00
Divorced	11	5.50
Widowed	5	2.50
Total:	**200**	**100**
Household Size		
≤ 5	37	18.50
6-10	83	41.50
11-15	48	24.00
16-20	21	10.50
≥ 21	11	5.50
Total:	**200**	**100**
Years of Experience		
≤ 5	26	13.00
6-10	81	40.50
11-15	61	30.50
≥ 16	32	16.00
Total:	**200**	**100**
Educational level of Respondent		
Informal Education	12	6.00
Primary School	28	14.00
Secondary School	57	28.50
Tertiary Education	103	51.50
Total:	**200**	**100**

Field survey, 2026

The actors in fisheries innovation system of Adamawa State

The results revealed that the actors involved in the fisheries innovation system, reflecting the structural composition and relative participation of stakeholders across the fish value chain. The results showed that fish rearers/breeders constitute the largest proportion of actors (46.5%), followed by fish marketers (34.5%), while other supporting and institutional actors such as feed millers, research institutions, extension agents, transporters, and government agencies are relatively underrepresented.

The dominance of fish rearers/breeders indicated that the fisheries innovation system is primarily producer-driven, with innovation activities largely centered on production. This is typical of smallholder-dominated aquaculture systems in developing economies, where primary producers form the backbone of the sector (FAO, 2022). Their numerical strength underscores their critical role as the main adopters of innovations related to production technologies, feeding regimes, and disease management. Similar distributions have been reported in Nigeria and other sub-Saharan African countries, where aquaculture systems are characterized by a high concentration of small-scale producers (Aderolu *et al.,* 2020).

Fish marketers, representing 34.5% of the actors, form the second-largest group, highlighting the importance of market-oriented activities within the innovation system. Their significant presence reflects strong downstream linkages aimed at ensuring fish distribution, price formation, and market access. According to Reardon *et al.* (2020), the active participation of market actors enhances value chain coordination and strengthens incentives for innovation adoption among producers.

In contrast, feed millers and research institutes/universities each account for only 1% of the actors, indicating weak upstream innovation support. Feed millers play a crucial role in supplying quality feed, which is a key determinant of aquaculture productivity. Their limited presence suggests dependence on external feed sources and limited local feed innovation, a constraint widely reported in African aquaculture systems (Tacon & Metian, 2020). Similarly, this is in concord with the findings of Klerkx *et al.* (2021) who reported the low participation of research institutions reflects weak research–producer linkages, which can limit the development and diffusion of context-specific technologies.

Extension agents, accounting for 5% of fish producers, represent an important but relatively small institutional presence. This suggests limited extension coverage, which may constrain effective knowledge transfer and innovation diffusion. Anderson and Feder (2020) observed that inadequate staffing and funding often weaken extension systems in developing countries, reducing their influence within agricultural innovation systems.

Transporters (7%) play a key role in linking producers and markets, particularly for perishable products such as fish. Their moderate representation reflects the importance of logistics in reducing post-harvest losses, although limited transport capacity can undermine value chain efficiency (FAO, 2023).

Government agencies (ADP) constitute 6.5% of the actors, highlighting the role of the public sector in regulation, policy implementation, and support services. While their presence is notable, the relatively small proportion suggests that government involvement may be more regulatory than operational. Spielman *et al.* (2021) emphasized that effective agricultural innovation systems require stronger public-sector coordination and facilitation.

Table 2: The actors in fisheries innovation state of Adamawa State.

Actors in Fisheries Innovation	Frequency	Percentage
Fish Rearers/Breeders	93	46.50
Fish Marketers	69	34.50

Feed Millers	2	1.00
Extension Agents	10	5.00
Reseacrh Institutes/Universities	2	1.00
Transporters	14	7.00
Government Agencies(ADP)	13	6.50
Total	**200**	**100**

Field survey, 2026

Relationship between Socio-Economic Characteristics of Producer and Effectiveness of Linkages/Interaction among Actors

The result of regression analysis was carried out to determine if there is relationship between socio-economic characteristics of producers in fish innovation system and the level of linkages/interaction among them. four functional form were tested (linear, exponential, semi log and double log), double log equation was selected as best fit based on the a priori economic criteria for the signs and significance of the coefficients, size and significance and the coefficients of multiple determination R^2, F and t-ratios as well as a very minimal standard error of the variable.

The result of the relationship between socio-economic characteristics of producers in fish innovation system and the level of linkages/interaction among actor revealed that 89.75% of variation on the linkage/interaction level of producers with other major actors toward fish innovation system could be explained by the explanatory variables in the equation. Furthermore, nine out of eleven explanatory variables were found to contribute significantly to the predictor variables, which were age, level of education, household size, marital status, and membership of association, quantity of fish produced etc. This implies that age, level of education, household size, membership of association, quantity of fish produced and Farmer- Farmer contact of fish producers made significant contribution to the level of linkage/interaction among fish producers in the innovation system. The overall regression result showed that there is a significant relationship F=40728.70 ($p<0.000$) between some socio-economic characteristics of the farmers and the level of linkage/interaction in fish innovation system.

The coefficient of multiple determination R^2 was found to be 0.8975, implying that 89.75% of the variation of effectiveness of linkages was accounted for by age, level of education, experience, marital status, household size, quantity of fish sold, quantity of fish produced, membership in association and farmer to farmer contact of the respondents while the remaining 10.25% is accounted for by variables not included in the model. This finding is in line with that of Madugu and Edward, (2011) who observed that age, marital status, household size and experience were all positive and significant at various level with a high R^2 (63.8%) in relationship between smoked and dried fish distribution and marketing in Adamawa State.

The coefficient of income and age is positive and significant at 1% level; the value of the coefficient was .3289881 indicating that 1% increase in income and age will lead to increase in effective linkage by .3289881. Also, the coefficient of Marital Status and extension contact of the respondents (0235718) (.0055042) was found to be positive and not significant. This implies that the absence of Marital Status and extension contact in innovation system may not have significant effect on effectiveness of linkages/interaction of actors in the innovation system. The coefficient of experience of respondents (.1792698) was found to be positive and significant at 5% level. This implies that 5% increase in years of experience in fish production will increase effectiveness of linkages/interaction between respondents by the value of the coefficient. It signifies that respondents will have more and better ideas to share with

the other actors in the system, by doing so might positively influence the decision of other actors to adopt new or upgraded technology that will improve the entire innovation system of fish marketing.

The result reveals that the coefficient of Quantity of fish sold (.1946097) was found to be positive and significant at 1% level. This implies that the effectives of linkages/interaction increase by the value equal to that of the coefficient as Quantity of fish sold increase by 1%.
The result also reveals that coefficient of household size of respondents (.1372901) was found positive and significant at 5% level, this means that with 5% increase in household size, there will be an increase in effectiveness of linkages by a value equivalent to the coefficient. The implication is that household members will have a favourable attitude to words collaboration and ease of exchange of information with other actors in the innovation system.
Furthermore, the result reveal that coefficient of Quantity of fish produced (.2070522) was found to be positive and significant at 1%level. It was also observed that the result the coefficient of membership in association was found to be positive (.2142564) and significant at 5% level. The result also reveals that coefficient of farmer-farmer contact was positive and significant at 1% level. The value of the coefficient was (.1834616) indicating that with 5% unit increase in the Spread of innovation, there will be increase in effective linkages equivalent to the value of coefficient among respondents in the innovation system.

Based on the finding which revealed that all variables included in the model to be positive and significant at 1% and 5% level except for x_3 (marital status) and x_{10} (Extension contact), the null hypothesis which states that there is no significant relationship between socio economics characteristics of producers and effectiveness of was rejected. It was concluded that there is a positive and significant relationship between producer's socio economics characteristics and effectiveness of linkages among them.

Table 4. Relationship between Socio-Economic Characteristics of producers and Effectiveness of Linkages/Interaction among Actors

Variable	Coef	Std. Error	t-value
Average income	.3289881***	.0804826	4.09
Age (in years)	.0216777***	.0048549	4.47
Experience (in years)	.1792698**	.0073741	24.31
Marital status	.0235718	.0164252	1.44
Household size	.1372901**	.0151094	9.09
Quantity of fish sold (in Kg)	.1946097***	.000488	398.81
Level of education (in years)	.0889412***	.009865	9.02
Membership in association	.2142564**	.0746778	2.87
Farmer- Farmer contact (in Numbers)	.1834616**	.0148532	12.35
Extension Contact (in Numbers)	.0055042	.0235261	0.23
Quantity of fish produced (in Kg)	.2070522 ***	.0003852	537.46
_Cons			
Model Diagnostics			
Number of Obs	200		
F (11, 188)	40728.70		
Prob > F	0.0000		
Adjusted R-squared	89.75%		

Source: Field Survey, 2026

*, ** and *** Represents 10%, 5% and 1% Significant Level

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study it is concluded that there is a strong and positive relationship between socio-economic characteristics of fish producers and the effectiveness of linkages and interactions within the fish innovation system. Variables such as age, education, household size, experience, income, quantity of fish produced and sold, and membership in associations significantly influenced the level of interaction among actors, as indicated by the high coefficient of determination ($R^2 = 0.8975$). Therefore, the following recommendations were made:

1. In other to encourage fish marketing innovations system activities it is important that government focus on providing basic infrastructure such as electricity, good access roads, and good supply of water, school, and health facilities among others. Such infrastructure has an immense potential to facilitate improved fish farming and marketing.
2. All actors should develop and encourage fish producer association so that they can have easy access to new information's and innovations in order to improve their fish production and marketing.
3. To improve the overall effectiveness of the fish marketing innovation system in Adamawa State, government should ensure that skills and knowledge of the stakeholders in fish innovation system are improved through seminars, conferences, workshops and agricultural training programmes. This will go a long way to increase fish production.

COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

There is no conflict of interest.

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