Awareness and Level of Adoption of Aquaculture Management Techniques in Igabi Local Government Area of Kaduna State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AAI, ONO and BFI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JTA and UFY managed the analyses of the study, proof read the article and co-type the manuscript. Authors SO and OO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study investigated the awareness and level of adoption of aquaculture management techniques in Igabi Local Government Area of Kaduna State, Nigeria. Purposive and random sampling techniques were adopted to select 60 fish farmers from the study area and data were collected from the fish farmers with the aid of well structured questionnaire administered to them face to face by the researchers and some trained enumerators. The data collected were analyzed using descriptive statistics such as means score, percentage, tables, Likert scale and multiple regression analysis. The findings indicated that majority (60.00%) of the respondents were male, while 95.00% of the farmers were between the age of 21-60 years with 91.67% of the fish farmers educated and 61.67% of fish farmer are highly experienced with 6 years and above. The findings also revealed that majority of the farmers are aware of aquaculture management techniques in the study area with 70.00% getting information on these techniques from extension agents followed by

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55.00% who relied on other fish farmers for relevant information about fish farming. The Likert scale result revealed that thirteen out of twenty – one aquaculture management techniques postulated were adopted while eight were not adopted implying that 61.90% of the postulated techniques were adopted by the fish farmers in the study area. The result of the regression analysis showed that level of awareness of techniques; access to credit facility and number of contact with extension agent were the three factors influencing adoption of aquaculture management techniques by the fish farmers in the study area. Lack of credits/ fund to adopt improved practice (75.00%), expensiveness of techniques (55.00%), complexity of techniques (55.00%), and lack of support from the government (51.67%), lack of adequate and proper information on these techniques (50.00%), lack of training (45.00%) and lack of awareness (33.33%) were identified as constraints affecting adoption of aquaculture management techniques in the study area. In conclusion, the study revealed that the farmers were aware and adopted good numbers of the aquaculture management techniques introduced to them The study recommends that farmers should establish cooperative society so that they can pool their resources and knowledge together in solving most of the problems identified.

1. INTRODUCTION

Awareness and adoption of aquaculture management techniques by fish farmers is critical to the development of aquaculture in Nigeria because fishery continues to maintain its crucial position through its contribution to the agriculture's share of gross domestic product (GDP) in Nigeria. Fisheries are also an enviable subsector which provides employment to a large proportion of the nation's population (about 65-70%), especially those in riverine and other fishing communities [1]. Fish is also important in the provision of protein to the teaming populace. Yucel and Daalen [2], identified the importance of adoption studies to include; to quantify the number of technology use over time, determine extension requirements, enhance further research, provide information for technology reform and provide a basis for measuring the impact of such innovation on the adopters.

Nigeria is not producing enough fish for consumption. According to FDF [3], there is huge supply- demand gap for fish and fisheries products in Nigeria. Increase in demand for fish in Nigeria could not be met by artisanal fishing. FDF [3], gave a projected fish demand of 3,850,000 metric tonnes by the year 2020 in Nigeria with a corresponding projected fish supply of 2,251,797.71 metric tonnes resulting into a projected demand – supply gap of 1,598,252.29 metric tonnes. This can be attributed to intense fishing pressure arising from increase in number of fishermen that greatly reduced fish stock in coastal areas. According to Offor and Okpara [4], expensive fish feed also contribute to the failure of aquaculture in Nigeria.

The adoption of aquaculture technologies is therefore one way to boost fish production and contribute to food security in Nigeria. However adoption of new innovation is hampered by factors such as economic status, age, scale of production, educational level and socio-cultural situation. Availability of credit facilities to fish farmers also serves as constraints to level of adoption.

Technology, economic benefit and efficient extension delivery are responsible for the rapid growth and development of aquaculture experience around the world. This is evidence in its increase in monetary value and high in quality supply. According to FAO [5], the total world aquaculture production in 2018 is 82.1 million tonnes valued at US $ 250 billion. Dada [6], pointed out that aquaculture *potential output* of the country have not undergone the degree of development as expected because less than 1% of potential is utilized. Fish output from pond is the amount of fish gained at harvest and is dependent on the farmers' management and system of practice. Aquaculture practice is the adoption of fish farming in an enclosure. The sustainability of aquaculture practice depends on the economic disposition and value it adds to the welfare of the farmer. Bolorunduro and Falaye [7], agreed that characteristics of farmers have a key role to play in adoption decision of improved technologies, and are therefore important consideration in adoption studies.

[Roger and Shoemaker [8], described the adoption process as a mental process through which an individual passes from learning of new innovations to decide to adopt or reject the new

innovations. Peace Corps [9], postulate that farmers must pass through five stages of adoption before the idea is accepted. Awareness, interest, evaluation of its usefulness, trying and adopting the process is inseparable as a link of a chain. Adoption takes place after people have successfully passed through the five stages. Williams [10], explained the adoption process with the following steps awareness, interest, action, desire, conviction and satisfaction. Adoption was also viewed to consists of five processes which are; having knowledge of the new innovation or idea, persuasion of the farmers which involves farmers attitudinal changes, taking decision by the farmers on whether to adopt or reject the new innovation or idea, implementation of the new innovation or idea and the last stage is the confirmation of the new idea to be working and better than old one. However, the adoption process according to Roger [11],does not always follow this sequence in practice because to him decision taking in practice may often be made in less rational and systematic manner compared with the ways it was outlined and there is evidence that "knowledge" and "decision" stages exist, but evidence for other stages is not clear. Roger and Shoemaker [8], identified five general factors affecting adoption of improved techniques by farmer. These include; attitude of adopters, aspects of technology, government policies, features of the environment, risk and uncertainty. Overall, adoption by farmers might not be worthwhile unless the new practices are culturally appropriate in agreement with self-interest, respectful of tradition, clearly beneficial and not economically risky [9]. The rate of adoption of an innovation depends to a great deal upon its characteristics. It can be explained by such economic variables such as ability (relative advantage) and social variables such as compatibility [12]. The most economically logical reason for farmer's adoption of a particular innovation or new farm practices would definitely be the expectation of higher yields and consequently increased income [12].

Nweke and Akorhe, [13], reported that social-economic, socio-cultural and socio-political variables are amo factors that affect adoption of new technology. They further suggest that before a technology transfer programme is embarked upon, the technology must be tested not only for its financial profitability but also for its suitability to farmer's circumstances and needs. Socio cultural variables such as friends, neighbours, family/village structures tend to influence

individual adopters in that they serve as consultants in farmer's decision to either adopt or reject farm innovation [14]. Other reasons given for farmers non-adopting of agricultural practices is reluctance to give up their old ways, and favourable producers prices. Ridd [15], found that farmers did not adopt certain agricultural innovations because they lack credit facilities. Extension contact and credit facilities are positively and significantly related to awareness, adoption and gross farm output of farmers. Onyewaku and Inbuba [16], found that profitability of enterprises was the major reason for adoption, while lack of awareness of the technology was the limiting factor to adoption. This study therefore aimed at investigating the level of awareness and adoption of aquaculture management techniques and also to identify constraints limiting the adoption of these management techniques among fish farmers in Igabi Local Government Area of Kaduna State, Nigeria.

2. METHODOLOGY

2.1 Study Area

The study was conducted in Igabi Local Government Area of Kaduna state, Nigeria. Igabi is one of the four local government areas which constitute Kaduna metropolitan city, an important commercial and administrative centre in Northern Nigeria and comprises of different sets of people with diversified socio-cultural characteristics. Igabi local government is located in guinea savannah of Nigeria on latitude 10° 47'0"N and longitude $7^o46'$ 0" E. Turunku is the headquarter of Igabi Local Government Area. The population of Igabi Local Government Area according to 2006 population census was estimated at 430,753 people and projected population of 581,500 people by 2016 [17]. Annual rainfall is between 250 mm-1000 mm and usually begins early May and ends in October and the dry season is between October-April. The major crops produced in the area are cowpea, yam, cassava, maize, millet, guinea corn, sugarcane and cocoyam. Livestock/animals that are reared in the Local Government Area are poultry, cattle, goat and sheep and fish. It covers 3727 square kilometres of land.

2.2 Sampling Techniques

Multi stage procedure was employed for this study. The first stage was the selection of the Igabi Local Government Area because the

researchers reside in this local government area. The second stage is the selection of two villages each from the three main districts which are Igabi district (Igabi and Turunku); Rigasa district (Afaka and Rigasa) and Rigachikun district (Rigachikun and Mararraban Jos).The six villages were selected purposively for the study due to good numbers of fish farmers identified in this village during a recognizance survey carried out by the researchers before the study was carried out. The recognizance survey revealed that the six villages selected for this study had adequate fish farming activities compared to the rest villages and average of 20 fish farmers were identified in each village giving a sum total of 120 fish farmers. 50 % of these fish farmers were randomly selected for the study since there was no comprehensive list of fish farmers in the villages. All the fish farmers in these villages constituted the sampling frame for this study. Random sampling was them employed in the third stage to select ten (10) fish farmers each from the six villages giving a total of 60 fish farmers that were used for this study. The cultural practices of the fish farmers is the use of dug out pit as an earthen pond, use of concrete ponds that are not constructed to standard specification, absent of re-circulatory pond system, poor pond management such as not checking oxygen content and pH, crude harvesting method that lead to death of fish and non usage of harvesting gears. So the new package introduced to the farmers for adoption include improve method of construction of both earthen and concrete pond with standard specifications and structures, introduction of re-circulatory pond system, improve management such as provision of equipment for oxygen check, pH check and thermometer for checking water temperature, use of fish harvesting gears and method of harvesting fish through total drainage.

2.3 Data Collection

Data were collected by administering questionnaire to the fish farmers in the study area. Data were collected on method of rearing fish, adoption of pond construction techniques, adoption of stocking method, adoption of pond management technique, adoption of harvesting technique, source of information and socio-economic characteristics of the farmers. Information and socio - economic characteristics includes age, gender, education level, fishing experience, income level, number of fish ponds owned, type of fish pond, contact with extension agent, household size, and information on constraints to adoption of aquaculture technologies were also collected. The questionnaires were administered to the respondents face to face by the researchers and some enumerators employed and trained by the researchers. The questionnaire comprise both multiple choices and open ended questions.

2.4 Analytical Tools

The following under listed analytical tools were used to analyze the data generated:

i. Descriptive statistics
ii. Multiple regression analysis

2.4.1 Descriptive statistics

Descriptive statistic such as percentage, frequency distribution, table, mean and Likert-scale were used to describe the socio economic characteristics of the fish farmers, level of awareness, source of information, level of adoption of aquaculture management techniques and constraints affecting rate of adoption. Three points Liikert- scale was used to evaluate the rate and extent of adoption of aquaculture management techniques among the fish farmers in the study area specified as Not- adopted =1, Tried = 2 and Adopted = 3. The Likert scaling type measuring instrument is represented by the formula [18]:

$$X = \sum Fx / N$$

Where,

X = mean score
$\sum$ = summation sign F = frequency
N = number of respondents.
x = no of nominal value of each response category (3 + 2 + 1) / 3 = 2 for rate/level of adoption of aquaculture management techniques. Therefore, 2 is the weighed mean of the scaling statement for rate/level of adoption of aquaculture management techniques among the fish farmers in the study area.

Decision rule: Any mean value greater than or equal to 2 is positive (adopted) while mean value less than 2 are negative (not – adopted).

2.4.2 Multiple regression analysis

Multiple regression analysis was used to achieve factors influencing the adoption of aquaculture

management techniques by the fish farmers in the study area.

The multiple regression equation is express implicitly as:

$Y = f (X_1 X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, U)$

Where,

Y = Numbers of aquaculture techniques adopted by a farmer:

X1	=	Age (years)
X2	=	Gender (Male = 1, Female = 2)
X3	=	Educational Level (No Formal = 1, Primary= 2, Secondary= 3, Tertiary = 4)
X4	=	Household size (Number)
X5	=	Income Level (Naira)
X6	=	Fish farming experience (Years)
X7	=	Contact with extension agent (Number)
X8	=	Number of fish pond owned
X9	=	Access to credit (Yes =2, No =1)
X10	=	Level of awareness (Aware =2, Not aware =1)
U	=	Error term

The explicit forms of the multiple regressions are given below:

2.4.2.1 Linear model

$Y = b_0 + b_1X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_s + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9X_9 + b_{10} X_{10} + U$ (1)

2.4.2.2 Semi –log model

$Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_s + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + b_9 \log X_9 + b_{10} \log X_{10} + U$ (2)

2.4.2.3 Double log model

$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_s + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + b_9 \log X_9 + b_{10} \log X_{10} + U$.   (3)

Where,

Log	=	Natural logarithm
Y	=	as specified above
$X_1 – X_{10}$	=	as specified above
b_0	=	Intercept
$b_1 – b_{10}$	=	Parameters that were measured
U	=	as specified above

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Characteristics of Fish Farmers in the Study Area

3.1.1 Distribution of respondents by age, gender status, educational level and household size

The results of the distribution of the fish farmers based on age, gender status, educational level and household size are presented in Table 1. The result shows that 30% of the respondents fall within the age of 21-30 years. 26.67% were between the ages of 41-50years, 25% were 31-40 years, 13.33% fall within the age range of 51-60 years while 5% were 61 years and above. This implies that most of the fish farmers in the study area are youth which makes them to be strong and capable of carrying out the fish farming actively. According to Olaoye et al. [19], age is a factor through which farmers gain more experience and acquaintance with new technologies and are hence expected to have higher ability to use new technologies more efficiently. Results in Table 1 also show that 60% of the respondents are male while 40.00% are female. It shows that males are more than females in the fish farming in the study area. Females are also engaged in household activities. This may also be a reason of their less involvement. Olaoye [20], reported that (91.70%) of the fish farmers in their study were male. Male dominance in fish farming was attributed to the laborious nature of the enterprise which the females could not handle [21]. Table 1 revealed that 40.00% of the respondents are tertiary certificate holders, 35.00% of the respondents are secondary school certificate holders while 16.67% have primary education while 8.33% of the farmers had no formal education. Majority of the fish farmers in the study area are educated with 91.67% having one form of education or others and 75.00 % having secondary education and above. The fact that majority of the fish farmers in the study area had one form of education implies that adoption of new innovations by them will be easier because they will have good knowledge and understanding of such innovations before adoption. This result is similar to the work of [22] who reported that 90.80% of fish farmers are educated. This result is also similar to those of [21] and [23] that reported that higher proportions of the fish farmers in southwestern Nigeria are highly educated even up to tertiary level. This therefore

implies that the rate of fish farmers' adoption of aquaculture management techniques once proven to be able to improve their productivity could be enhanced as coined out from the study of [20]. The results in Table 1 also shows that (31.67%) of the respondent household size fall within 6-10 people, 28.33% of the respondents have a family size of 1-5 and 25.00% of the farmers have 11-15 household size, while 15.00 % of the respondents have a family size of 16-20 people. This implies that most of the fish farmers in the study area have a large family size of 6 persons and above which is of great importance in the area of supplying family labour. The finding in this study differs from the study of [18], who reported that majority of farmers, in Igabi Local Government Area had family size that ranged between 1-5 persons.

3.1.2 Fish farming experience

Table 2 shows that 38.33% of respondents had 1-5 years of fish farming experience, 30.00% of respondents had 6-10 years experience in fish farming, 21.67 % of respondents had 11-15 years fish farming experience while 10.00% of respondents had been into fish farming for 16 years and above. This means the respondents had experience in fish farming which also implies that majority of the fish farmers are highly experienced which serves as an advantage in the area of identifying problems militating against fish farming and way of proffering solutions to these problems. This is in line with the study of [22], in which they reported average fishing experience of 7 years for fish farmers in Delta State.

Table 1. Age, gender status, educational level and household size of respondents

Characteristic	Frequency (n =60)	Percentage (%)
Age(years)		
21 -30	18	30.00
31 – 40	15	25.00
41 -50	16	26.67
51 – 60	8	13.33
61 and above	3	05.00
Gender		
Male	36	60.00
Female	24	40.00
Educational Level		
No Formal Education	05	08.33
Primary Education	10	16.67
Secondary Education	21	35.00
Tertiary Education	24	40.00
Household Size		
1 -5	17	28.33
6 -10	19	31.67
11 – 15	15	25.00
16 – 20	9	15.00

Table 2. Frequency distribution of respondents according to their experience

Fish Farming Experience	Frequency	Percentage (%)
1-5 years	23	38.33
6-10 years	18	30.00
11-15 years	13	21.67
16 years and above	6	10.00
Total	60	100.00

Table 3. Frequency distribution of respondents according to the type of fish pond owned

Types of Fish Pond Owned	Frequency	Percentage (%)
Earthen pond	24	40.00
Concrete pond	30	50.00
Re- circulatory pond system	6	10.00
Tank / Basin	20	33.33

Table 4. Frequency distribution based on the number of fish ponds owned

Number of Fish Pond Owned	Frequency	Percentage (%)
1 – 4 ponds	27	45.00
5 – 8 ponds	16	26.67
9 – 12 ponds	17	28.33
Total	60	100.00

3.1.3 Type of fish ponds owned

Table 3 shows that 50.00% of the respondent owned concrete pond type, 40.00% have earthen pond type and 33.33% of the respondents reared their fish in plastic tank and basin while 10.00% of the fish farmers own a re-circulatory system of pond. This implies that most of the fish farmers have concrete pond which also was in line with the finding of [22] in which 55% of the farmer have concrete pond. The result obtained for the type of pond owned by the fish farmers was tagged multiple responses because some of the farmers possessed two or more types of pond on their farms. Re- circulatory system is more expensive than other types of pond but give more yield per unit area compare to others. The concrete pond construction is costlier than the earthen pond system but it is easier to manage than the earthen pond and also give better output in term of kilogramme of fish harvested per metre square. The earthen pond gives the fish natural habitat compared to the other pond type, so if manage well will give optimum yield of fish cropped per unit area.

3.1.4 Number of fish ponds owned

Table 4 shows that 45% of the respondents have between 1-4 ponds, 28.33% of the respondents have a range of 9-12 ponds while 26.67% of the fish farmers owned between 5-8 ponds. This implies that most fish farmers have an average pond that is above 4 ponds.

3.1.5 Number of fish stocked

The result of the number of fish possessed by the farmers is presented in Table 5. The table revealed that 30.00 % of the farmers possessed fish that is less or equal to 500, 23.33 % have a range of 501 -1000 fishes, 16.67 % have 1001 - 1500 and 2001 and above fishes respectively and 13.33 % have fish that ranged between 1501- 2000. The result implies that most or majority of the farmers in the study area are small scale producers. As extracted from Salau ES et al. [24], the present result agrees with the findings of [25] and [26], they observed that fish farming in Nigeria was mainly at a small subsistence level and that, small- scale producers find it difficult to adopt technologies that are capital – intensive.

3.1.6 Sources of finance to the fish farmers

The result in Table 6 shows that the major source of finance to the fish farmers was from personal savings (66.67 %). Other sources of finance were relatives and friends and bank loans which were 10.00% respectively, cooperative society (8.33 %), while money lender contributed 5.00% capital to the fish farmers as source of finance. This implies that most of the fish farmers got their initial capital for rearing fish from their personal savings which will help them to be able to withstand any losses that might arise as a result of poor management, mortality or poor sales. This is in agreement with the findings of [27] and [28], which reported that personal savings was the main source of credit to majority of the fish farmers in Ogun State.

3.1.7 Annual income level

Table 7 shows that 36.67% of the respondents falls within 80,001- 200,000 naira (222.23 – 555.56 United State Dollar{USD} annual income which is a low annual income level, 33.33% of the respondent were within 200,001 - 320,000 naira (555.56 – 888.89 USD) annual income which is moderate income 18.33% of the respondents fall within the range of 320,001 - 440,000 naira (888.89 – 1,222.22 USD) annual income which is a good income level but the percentage of the fish farmers is low, 11.67% of the respondent fall between the range of 440,001- 560,000 naira (1,222.22 – 1,555.56 USD) annual income which is the highest income level. This is to say that majority of farmers in the study area are low income earners which in time may affect their standard of living. The gross mean annual income of ₦ 30,420.00 (84.50 USD) was reported by [24] which is a low annual income compared to the moderate annual income obtained in this study. Agbamu JU [29] and Agwu AE [30], have reported that high

income levels positively influence the adoption of agricultural technologies.

3.1.8 Contact with extension agent

Table 8a revealed that 76.67 % of the fish farmers were privileged to have contact with extension agents while 23.33 % never had contact with extension agent and Table 8b shows that 33.33% of the fish farmers had between 1-6 contacts with extension agents

per annum, 26.67% had contact with extension agents within a range of 7-12times per annum, 23.33 % had no contact with extension agents at all, while 16.67% met with extension agents for about 13- 18times per year. It is evident that dissemination of new innovations in aquaculture was fair in the study area. This finding corroborates the report of [24], who reported that the fish farmers had a mean of 6 contacts per annum with extension agents.

Table 5. Frequency distribution of respondents based on numbers of fish stocked

Flock Size	Frequency	Percentage %
<=500	18	30.00
501 – 1000	14	23.33
1001 -1500	10	16.67
1501– 2000	8	13.33
2001 fish and above	10	16.67
Total	60	100

Table 6. Frequency distribution of respondents based on sources of finance

Source of Finance	Frequency	Percentage %
Personal Savings	40	66.67
Cooperative Societies	5	8.33
Money Lenders	3	5.00
Bank Loans	6	10.00
Relatives/ Friends	6	10.00
Total	60	100.00

Table 7. Frequency distribution of respondents according to their annual income

Income Level (Naira)*	Frequency	Percentage (%)
80, 001- 200, 000	22	36.67
200.001 - 320.000	20	33.33
320, 001 - 440, 000	11	18.33
440, 001 - 560, 000	7	11.67
Total	60	100.00

* 360 Naira is equivalent of 1 USD

Table 8a. Distribution of respondents based on contact with extension agents

Contact with Extension Agents	Frequency	Percentage %
Yes	46	76.67
No	14	23.33
Total	60	100

Table 8b. Frequency distribution of respondents according to number of contacts per annum with extension agents

Contact with Agent	Frequency	Percentage (%)
13-18 contacts/year	10	16.67
7-12 contacts/year	16	26.67
1-6 contacts / year	20	33.33
Zero contact	14	23.33
Total	60	100

Table 9. Distribution of the fish farmers based on level of awareness of each aquaculture management techniques

Management Techniques	Aware (%)	Not aware(%)
Earthen pond construction	51(85.00)	09(15.00)
Concrete pond construction	51(85.00)	09(15.00)
Re- circulatory system	12(20.00)	48(80.00)
Use of tank/basin	51(85.00)	09(15.00)
Sealing of pond bottom	27(45.00)	33(55.00)
Monoculture practices	51(85.00)	09(15.00)
Polyculture practice	24(40.00)	36(60.00)
Appropriate stocking density	48(80.00)	12(20.00)
Fertilization of pond	51(85.00)	09(15.00)
Liming of pond	51(85.00)	09(15.00)
pH check	15(25.00)	45(75.00)
Weed control	50(83.33)	10(16.67)
Supplementary feeding	51(85.00)	09(15.00)
Diseases and pests control	49(81.67)	11(18.33)
Repairs of leakage in pond	49(81.67)	11(18.33)
Check of water temperature	33(55.00)	27(45.00)
Check of oxygen content of the pond	30(50.00)	30(50.00)
Fish harvesting using hook	45(75.00)	15(25.00)
Fish harvesting using basket	22(36.67)	38(63.33)
Fish harvesting using nets	44(73.33)	16(26.67)
Total fish harvesting by draining water	36(60.00)	24(40.00)

Figures in parenthesis are in Percentage

3.2 Level of Awareness of Aquaculture Management Techniques

Farmers were asked to indicate their awareness of aquaculture management techniques. About 21 recommended aquaculture techniques were made available for the farmers to indicate their level of awareness out of two options of aware or not aware for each of the recommended techniques. The result of the analysis presented in Table 9 shows that farmers have high awareness for all the recommended management techniques. The result shows that 85.00% claimed the awareness of construction of earthen pond, construction of concrete pond, use of plastic tank/basin, practicing of monoculture, fertilization of pond, liming of pond and supplementary feeding respectively. 83.33% of the fish farmers carried out weed control in the pond, 81.67% of the farmers are aware of diseases/pest control and repair of pond leakage, respectively. Level of awareness of other techniques by the farmers include; appropriate stocking density (80.00%), harvesting of fish using hook(75.00%), harvesting of fish using net(73.33%), total fish cropping by draining the pond (60.00%), check of pond temperature (55.00%), check of pond oxygen content (50.00%), sealing of pond bottom (45.00%), practicing of polyculture (40.00%), pH check (25.00%) and 20.00 % of the fish farmers were aware of the use of re- circulatory pond system. Although the result of this study revealed that there is high level of awareness of aquaculture management techniques among the fish farmers in the study area but [8] however cautioned on the use of awareness to determine adoption of innovation in that it is not always certain that farmers who are aware of innovation will adopt it. The high level of awareness of these techniques among the fish farmers in this study corroborates the study of [30], which reported that more than 72% of farmers were aware of the eight fish farming technologies under study. The high percentage of awareness recorded in this study may be an indication of a functional and effective agricultural extension system. However, efforts are needed to bring aquaculture management techniques to the knowledge of the 15 % fish farmers in the study area who are still ignorant of these aquaculture management techniques. The high rate of awareness of these techniques by the fish farmers is an indication that good number of them will adopt these techniques which in turn may boost the rate of fish production for them bringing more income for the fish farmers as well as addressing the inadequate protein level observed in the communities and the nation at large.

3.3 Farmers Sources of Information on Aquaculture Management Techniques

The findings of this study as shown in Table 10 revealed that farmers obtained information on aquaculture management techniques from various sources ranging from interpersonal to mass media. About 70.00 % of the sampled fish farmers indicated extension agents and 55.00% identified other fish farmers as their major source of information on aquaculture management techniques; this is followed by inputs suppliers (48.33 %), fish buyers (46.67%), radio (35.00%), television (33.33%), fish farmers association (31.67%), internet/ social media and newspapers (16.67%) respectively while family/friends (13.33%). From this result it could be inferred that extension agents, other fish farmers, input suppliers and fish buyers serves as the four main sources of information to the farmers on aquaculture management techniques. This finding is similar to the findings of [24], that identified other fish farmers with a mean score of 3.04 as the second major source of information to fish farmers on awareness of improved fisheries technologies, although in their study they reported private consultant as the first major source of information to the fish farmers which was not considered in this present study that identified extension agents as the first major source of information to the fish farmers in the study area. This shows the effectiveness of extension service in the study area with 70.00% of the fish farmers getting information from them. The result of the current study corroborates the findings of [31],[that reported that information on fish farming was regularly sourced from extension agents by about two-thirds of the fish farmers.

3.4 Level of Adoption of Aquaculture Management Techniques by Fish Farmers in the Study Area

The level of adoption of each aquaculture management techniques is presented in Table 11a and b. The results in Table 11a showed that fish farmers have adopted and were using a number of techniques. Some of the techniques with high level of adoption ranged between 10.00% adoption rate for the use of re-circulatory system and pH check respectively to 50.00% adoption rate in concrete pond construction, practicing of monoculture, pond fertilization and harvesting of fish with hooks respectively. The mean score for adoption rate is 35.56% which implies that the rate of adoption of aquaculture

management techniques by the fish farmers is generally low. The aquaculture management techniques that were considered to be averagely adopted by the fish farmers are concrete pond construction, monoculture practices, fertilization of pond and fish harvesting with all having 50.00% adoption rate respectively. They were closely followed by adoption of weed control (48.33%), liming of the pond (45.00%) and supplementary feeding (45.00%). On the other hand some of the aquaculture management techniques were poorly adopted by the fish farmers which include; check of oxygen content of the pond (25.00%), sealing of pond bottom (20.00%), fish harvesting using basket (20.00%), use of re-circulatory pond system (10.00%) and checking of pond pH10.00%). The low rate of adoption of these techniques may be due to lack of knowledge about them by the farmers due to poor fish farming training. The result in Table 11b showed the Likert scale rating of adoption rate of aquaculture management techniques among the fish farmers in the study area. The result revealed that the average mean score for rate of adoption of all the aquaculture management techniques by the fish farmers stood at 2.02 which signifies that majority of the aquaculture management techniques were adopted by the farmers with only few of them not adopted. The table revealed that thirteen out of the twenty one postulated aquaculture management techniques were adopted because their adoption level mean score were above 2.0 while the other eight management techniques were rejected that is not adopted based on our decision rule because they are below 2.0. The result showed that 61.90% of the aquaculture management techniques were adopted by the fish farmers. The result of this study is in agreement with the study of [24] that reported 14 out of the 23 improved fisheries technologies disseminated by Nassarawa Agricultural Development Programme to fish farmers in southern agricultural zone of the state were adopted with an overall mean adoption index of 54.04%. Olaoye et al. [19] also observed that fish farmers in Lagos state, Nigeria adopted considerable numbers of improved aquaculture technologies introduced to them. Olatunji SO, Ogunremi JB [32]], also reported that fish farmers were aware and adopted many of the fish farming technologies introduced to them in Obio-Akpor Local Government Area of Rivers State, Nigeria. According to Bolorundoru PI, Adesehenwa AOK [33], the adoption of fisheries technologies by small – scale farmers depends on cost, availability of recommended inputs, and ease of handling. The level of adoption of the

management techniques by the fish farmers in the study area revealed that if these techniques are properly applied in their fish farming activities might resulted into bumper harvest of fish which translate to better living conditions for the fish farmers and their household and may also contribute to solving food insecurity and malnutrition within the society.

3.5 Factors Influencing Adoption of Aquaculture Management Techniques by the Fish Farmers

The contribution of ten (10) independent variables to adoption of aquaculture management techniques were determined by multiple regression analysis. the result of the multiple regression analysis is presented in Table 12. The result of the production function analysis shows that the double log regression model was chosen as the lead equation because it has the highest coefficient of multiple determination of 0.72, R^2 = 0.48,standard error of 0.27 with an F statistic of 3.52. The value of R^2 of 0.48 for the model implies that 48.00% of the variability in the fish farmer adoption of aquaculture management techniques in the study area is explained by the ten independent variables, while the remaining 52.00 % variation of the dependent variable was accounted for by disturbance term. This finding is in line with [23] that has R^2 of 46.00% in their study. The F–value (3.52) measures the joint significance of all the explanatory variables of the model which is not significant at 10 % level of probability. The t-values observed in the model were used to test the significance of each explanatory variable. The result reveals that fish farmers' adoption of aquaculture management techniques is significantly predicted by their level of awareness of these techniques (X_{10}) with positively signed coefficient value of 0.4563, access to credit facility by the fish farmers (X_9) also with positively signed coefficient of 0.3323 and number of fish farmers contact with extension agent (X_7), which is also positively signed and a coefficient value of 1.3651. Level of awareness and access to credit were significant at 5% level of probability respectively while number of contact with extension agents was significant at 10% level of probability. The implication of the findings is that fish farmers that have opportunity to access credit facility may adopt the new aquaculture management techniques better than those who do not have access to credit facility, Also the more the level of awareness of these techniques to fish farmers the more likely for them to adopt them. The result

also signifies that the more the extension agents paid visits to the fish farmers the more the likelihood for them to be able to educate and convince the farmers to adopt the new techniques. In the study of [19] extension contact and credit facility do not significantly influenced the level of adoption of improved aquaculture technologies which the present findings negate. Income level, fish farming experience and number of pond owned have positive regression coefficient but not significant. These indicate that an increase in any of these variables will lead to increase in the level of adoption of aquaculture management techniques by the fish farmers. This finding is in harmony with the study of [19] who reported significant relationship between fish farmer's income and level of adoption of aquaculture technologies. This study has shown that the higher the income of a fish farmer, the more the willingness to adopt new techniques since he has the means to purchase such compared to his counterpart who earned less income from fish farming who might not be able to afford new techniques. This study also discovered that fish farmers with more number of ponds are more likely to adopt new techniques. However the result revealed that age, gender, ed Agbamu JU, Orhorhoro WC.ucation level and household size were all negatively signed and they do not make any significant contribution at 1%, 5% and 10% level of probabilities to adoption of aquaculture management techniques by the fish farmers in the study area. Agbamu JU, Orhorhoro WC..[22] reported that education at 5% level of probability significantly influenced the adoption of aquaculture techniques in Delta State.

3.6 Constraints Limiting the Adoption of Aquaculture Management Techniques by Fish Farmers in the Study Area

Table 13 presents the result of factors militating against the adoption of aquaculture management techniques. The ranking of the result revealed that adoption of aquaculture management techniques is been hampered by factors such as lack of credits/ fund to adopt improved practice (75.00%) which ranked as the first factor affecting level of adoption by the fish farmers followed by expensiveness of techniques (55.00%) and complexity of the management techniques (55.00%) that came second respectively. The fourth factor influencing the adoption of the aquaculture management techniques is lack of support from the government (51.67%), followed by lack of

adequate and proper information on these techniques (50.00%) which ranked 5th position. The result from this study signifies that majority of the fish farmers in the study area were resources poor fish farmers with no adequate financial resources to finance the acquisition of the aquaculture management practices and also lacking the required training and information on these techniques Others constraints hindering adoption of these techniques are lack of training (45.00%) and lack of awareness (33.33%) that

came 6th and 7th position respectively. If the techniques are expensive and the fish farmers do not have the fund or credit facility and not getting assistance from the government, they may not adopt them. These findings supported the findings of [34] in which they reported that improved practices are too expensive, lack of training, lack of credit/funds to adopt and lack of government support to be the serious constraints facing the adoption of poultry management practices in Ughelli of Delta State.

Table 10. Sources of information on awareness of aquaculture management techniques (n = 60)

Source of Information	Yes	Percentage (%)	No	Percentage (%)
Extension agents	42	70.00	18	30.00
Radio	21	35.00	39	65.00
Television	20	33.33	40	66.67
Friends/ families	8	13.33	52	86.67
Fish farmers association	19	31.67	41	68.33
Other fish farmers	33	55.00	27	45.00
Input suppliers	29	48.33	31	51,67
Internet/social media	10	16.67	50	83.67
Newspaper	10	16.67	50	83.67
Fish buyers	28	46.67	32	53.33

Field survey, 2019

Table 11a. Distribution of the fish farmers based on level of adoption of each aquaculture management techniques

Management Techniques	Not Adopted (%)	Tried (%)	Adopted (%)
Earthen pond construction	09(15.00)	27(45.00)	24(40.00)
Concrete pond construction	09(15.00)	21(35.00)	30(50.00)
Re- circulatory system	48(80.00)	06(10.00)	06(10.00)
Use of tank/basin	09(15.00)	31(51.67)	20(33.33)
Sealing of pond bottom	33(55.00)	15(25.00)	12(20.00)
Monoculture practices	09(15.00)	21(35.00)	30(50.00)
Polyculture practice	36(60.00)	12(20.00)	12(20.00)
Appropriate stocking density	12(20.00)	21(35.00)	27(45.00)
Fertilization of pond	09(15.00)	21(35.00)	30(50.00)
Liming of pond	09(15.00)	24(40.00)	27(45.00)
pH check	45(75.00)	09(15.00)	06(10.00)
Weed control	10(16.67)	21(35.00)	29(48.33)
Supplementary feeding	09(15.00)	24(40.00)	27(45.00)
Diseases and pests control	11(18.33)	24(40.00)	25(41.67)
Repairs of leakage in pond	11(18.33)	25(41.67)	24(40.00)
Check of water temperature	27(45.00)	12(20.00)	21(35.00)
Check of oxygen content of the pond	30(50.00)	15(25.00)	15(25.00)
Fish harvesting using hook	15(25.00)	15(25.00)	30(50.00)
Fish harvesting using basket	38(63.33)	10(16.67)	12(20.00)
Fish harvesting using nets	16(26.67)	21(35.00)	23(38.33)
Total fish harvesting by draining water	24(40.00)	18(30.00)	18(30.00)
Mean score (%)	33.25	31.19	35.56

Field survey, 2019. Figures in parenthesis are in Percentage

Table 11b. Likert scale rating of level of adoption of aquaculture management techniques among the fish farmers (n= 60)

Management Techniques	Likert scale rating			Total score	Mean score	Decision
	Not Adopted(1)	Tried(2)	Adopted(3)			
Earthen pond construction	09(09.00)	27(54.00)	24(72.00)	135	2.25	Adopted
Concrete pond construction	09(09.00)	21(42.00)	30(90.00)	141	2.35	Adopted
Re- circulatory system	48(48.00)	06(12.00)	06(18.00)	78	1.30	Not adopted
Use of tank/basin	09(09.00)	31(62.00)	20(60.33)	131	2.18	Adopted
Sealing of pond bottom	33(33.00)	15(30.00)	12(36.00)	99	1.65	Not adopted
Monoculture practices	09(09.00)	21(42.00)	30(90.00)	141	2.35	Adopted
Polyculture practice	36(36.00)	12(24.00)	12(36.00)	96	1.60	Not adopted
Appropriate stocking density	12(12.00)	21(42.00)	27(81.00)	135	2.25	Adopted
Fertilization of pond	09(09.00)	21(42.00)	30(90.00)	141	2.35	Adopted
Liming of pond	09(09.00)	24(48.00)	27(81.00)	138	2.30	Adopted
pH check	45(45.00)	09(18.00)	06(18.00)	81	1.35	Not adopted
Weed control	10(10.00)	21(42.00)	29(87.00)	139	2.32	Adopted
Supplementary feeding	09(09.00)	24(48.00)	27(81.00)	138	2.30	Adopted
Diseases and pests control	11(11.00)	24(48.00)	25(75.00)	134	2.23	Adopted
Repairs of leakage in pond	11(11.00)	25(50.00)	24(72.00)	133	2.22	Adopted
Check of water temperature	27(27.00)	12(24.00)	21(63.00)	114	1.90	Not adopted
Check of oxygen content of the pond	30(30.00)	15(30.00)	15(45.00)	105	1.75	Not adopted
Fish harvesting using hook	15(15.00)	15(30.00)	30(90.00)	135	2.25	Adopted
Fish harvesting using basket	38(38.00)	10(20.00)	12(36.00)	94	1.57	Not adopted
Fish harvesting using nets	16(16.00)	21(42.00)	23(69.00)	127	2.12	Adopted
Total fish harvesting by draining water	24(24.00)	18(36.00)	18(54.00)	114	1.90	Not adopted
Average mean score					2.02	Adopted

Field survey, 2019, Figures in parenthesis are Likert scale score

Table 12. Summary of multiple regression analysis (Double-log model)

Predictors	Regression Coefficient	T-Ratio	P- Value
Age (X_1)	-0.1071	-0.0606	0.932
Gender (X_2)	-0.0201	0.0115	0.981
Educational level (X_3)	- 0.2213	-0.1133	0.812
Household size (X_4)	-1.7370	-1.1550	0.240
Income level (X_5)	2.1866	1.3260	0.317
Fish farming experience (X_6)	1.8817	1.2440	0.271
Contac with extension agent (X_7)	1.3651**	0.6131	0.064
Number of ponds owned (X_8)	0.1075	0.0340	0.950
Access to credit (X_9)	0.3323*	0.1324	0.042
Level of awareness (X_{10})	0.4563*	0.5363	0.032
Constant	-5.5816	-0.7439	0.461
Coefficients of Multiple Determination (R)	=0.72		
R^2	=0.48		
Standard Error (SE)	=0. 27		
F –value	=3.52		

*Significant at 5% and ** Significant at 10 % probability levels

Table 13. Distribution of fish farmers based on constraints limiting the level of adoption of aquaculture management techniques in the study area

Management Techniques	Frequency	Percentage (%)	Ranking
Techniques are too complex	33	55.00	2nd
Lack of training	27	45.00	6th
Lack of credit/fund to adopt	45	75.00	1st
Lack of government support	31	51.67	4th
Lack of information	30	50.00	5th
Lack of awareness	20	33.33	7h
Tecniques are expensive	33	55.00	2nd

Multiple Responses

4. CONCLUSION

The result from this study revealed that that majority of the respondents are male and most of them had good years of experience in fish farming with an average fish farmers having good education. The result revealed that majority of the fish farmers are aware of the aquaculture management techniques and they obtained information on these techniques through extension agents and fellow fish farmers. The mean adoption percentage for all the aquaculture techniques stands at 35.56%. The Likert scale result also revealed that 13 out of the 21 aquaculture management techniques were adopted by the fish farmers in the study area which implies that 61.90% of the aquaculture management techniques were adopted. The result of the regression analysis showed that level of awareness of techniques; access to credit facility and number of contact with extension agent were the three factors influencing adoption of aquaculture management techniques by the fish farmers in the study area.

However, the adoption level of these techniques is hampered with constraints such as lack of credits/ fund to adopt improved practice (75.00%),expensiveness of techniques (55.00%) and complexity of the techniques(.55.00%). The fourth factor influencing the adoption of the aquaculture management techniques is lack of support from the government (51.67%), followed by lack of adequate and proper information on these techniques (50.00%), lack of training (45.00%) and lack of awareness (33.33%). The study therefore suggest that adequate training in fish farming procedures and management should be organize for the fish farmers especially covering those aquaculture management techniques that were poorly adopted by the farmers, there is also the need for government to address the issue of credit availability through an institutionalize frame work aimed at linking farmers to formal sources of credit, if the quantum of fish production is to keep pace with the protein requirement of the population. Fish farmers should be encouraged to form strong cooperative societies and pool their financial

resources together from where members can borrow for the purchase of new aquaculture management techniques as well as reinvestment and through cooperative societies they can also benefit from government sponsored micro credit scheme to boost aquaculture business.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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