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# Adoption of Improved Fisheries Technologies among Fish Farmers in Ogun State, Nigeria

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## ABSTRACT

*This study investigated the adoption of improved fisheries technologies (IFT) among fish farmers in Ogun State. One hundred and twenty fish farmers were sampled from the four agricultural zones (Abeokuta, Ikenne, Ijebu-Ode and Ilaro) of Ogun State Agricultural Development Programme using the multistage sampling technique. Data were analysed with both descriptive and regression analysis. Results revealed that the fish farmers had good contacts with extension workers and therefore positively perceived the extension services on fish farming. The fish farmers positively perceived the adoption of IFT. The different disseminated IFT received varied levels of adoption depending on the extent to which each of the technologies benefited the fish farmers after adopting them. Results of regression analysis revealed that fish farmers' secondary occupation (β=-0.324, p=0.003), annual income level (β=-0.471, p=0.035), cost of pond construction (β=0.477, p=0.018) and total profit realized (β=-0.466, p=0.023) were significant predictors of the fish farmers' adoption of IFT with an R2 implying that 46.0% of the variability in the fish farmers' adoption of improved aquaculture technologies is explained by the socio-economic and production characteristics of the fish farmers. In conclusion, the adoption of IFT was highly depended on the fish farmers' socio-economic characteristics, the quality of extension workers and the effectiveness of extension services disseminated to fish farmers, characteristics of IFT as well as institutional factors. It is therefore recommended that extension agencies should take the fish farmers' socio-economic characteristics into consideration while disseminating IFTs through a more effective extension service delivery in order to raise the adoption and continued use of IFTs.*

**Key words**: Artisanal, Aquaculture, Discontinued, Fisheries, Fish gears

## INTRODUCTION

The role played by artisanal fishery is highly remarkable which has been asserted by some research findings such as those of Olaoye (2010) and Federal Department of Fisheries – FDF (2008) which noted that the Nigerian artisanal fishing contributed 81.9% - 89.5% of local supply of fish while aquaculture and industrial sub-sectors only contributed 5.5% - 13.8% and 4.3% - 5.0% respectively. Yet, the gap between the demand for and supply of fish in Nigeria is getting wider on a yearly basis despite increasing local fish production attributed to development projects such as National Fadama Development Projects II and III (Tiamiyu *et al.,* 2015). Based on a per capita fish consumption of 13.5 kg, the fish supply gap deficit continues to increase based on the report of Nakazawa *et al.* (2013) despite the increasing domestic fish production between 2005 and 2015. The present condition of the fishery sector cannot guarantee the sustainable supply of fish to the nation and hence require that efforts be made at encouraging fish farmers in taking up the modern means of fish production through the use of improved fisheries and aquaculture technologies. Before new technologies could be used by fish farmers, it has to go through some series of systematic innovation diffusion processes (Rogers, 2003). On this basis, researchers, international and national governmental and non-governmental agencies have introduced several improved technologies to fish farmers in Nigeria. These technologies were also replicated at state levels through the extension service departments/units of the Ministries of Agriculture in each state as well as research institutes, religion/charitable organizations, Universities and colleges of agriculture.

In Ogun State where this study was conducted, several IFTs have been disseminated to the fish farmers over time through the Ogun State Agricultural Development Project (OGADEP), the Agricultural Media Resources and Extension Centre (AMREC) of the Federal University of Agriculture, Abeokuta (FUNAAB) and Justice and Peace Development Commission (JDPC) among others (Oloruntoba and Adegbite, 2006). It is therefore important

to assess the adoption rates of the different IFTs in Ogun State. This then serves as a basis for determining the extents to which technologies have been adopted, rejected or even discontinued after adoption. The specific objectives of this study were to describe the socio-economic characteristics of the fish farmers in Ogun State, determine the fish farmers' access to credit facilities, determine the production costs and returns of fish farming, assess the effectiveness of extension services on fish farming, determine the fish farmers' attitudes towards the adoption of IFTs and determine the adoption rates of IFTs among the fish farmers. The study also tested a hypothesis to know whether socio-economic characteristics are predictors of fish farmers' adoption of IFTs.

## METHODOLOGY

### The Study area

The study was conducted in Ogun State, Nigeria. The state is primarily agrarian and lies within longitude 20º45'E and 3º55'E and latitudes 7º01'N and 7º58'N in the tropics. It is bounded to the west by the Benin Republic, to the south by Lagos State and the Atlantic Ocean, to the east by Ondo State, and to the north by Oyo and Osun States (Olaoye *et al.,* 2007). Ogun State covers an estimated land area of 16,409.28 km$^2$, representing 1.77% of Nigeria's total land area, with population of 3,728,098 people and a growth rate estimated at 3 per cent annually, making the state to have one of the highest rates of population growth in Nigeria (National Population Commission - NPC, 2006).

### Sampling procedure and sample size

Multi-stage sampling technique was used for the selection of 120 fish farmers throughout the four agricultural extension zones in Ogun State. Stage 1 involves the random selection of three agricultural extension blocks from each of the four zones to give a total of twelve out of the twenty blocks in the state. Stage 2 involves the random selection of four cells from each of the blocks to give a total of 48 out of the 126 cells. Stage 3 followed the convenient sampling of any three fish farmers from each cell to give a total of 144 fish farmers. Hence, the sample size for the study was 120 fish farmers.

### Data collection instrument

Data were collected with the aid of validated interview guide which was found to be reliable through the test-re-test technique. The interview guide was divided into 5 sections on the fish farmers' socio-economic characteristics, access to credit facilities, production costs and returns of fish farming, effectiveness of extension services, fish farmers' attitudes towards the adoption of IFTs and adoption of IFTs.

### Data analysis and presentation

Collected data were subjected to both descriptive and inferential statistics. The descriptive statistics used were frequency count, percentage and mean while regression analysis was used to inferentially analyse the hypothesis of the study. The results from this study were presented in frequency tables.

## RESULTS AND DISCUSSION

### Socio-economic characteristics of fish farmers in Ogun State

Table 1 shows that only about 1.7% of the fish farmers were between 21 and 30 years and the same proportion (1.7%) were older than 60 years old while 20.0%, 46.7% and 30.0% were in the 31-40, 41-50 and 51-60 years age brackets respectively. The mean age of the fish farmers was calculated to be 46.43±9.25 years and is an indication that majority of the fish farmers are adults in the active labour force of Ogun State. The result is similar to that of Olasunkanmi and Yusuf (2014) who reported close to two-thirds of their respondents to be in the age range of 31-50 years. According to the arguments of Olaoye (2010), 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.

Almost all (91.7%) of the fish farmers were male and implies that fish farming in the State is male - dominated. Male dominance in fish farming was also previously reported in studies by Olasunkanmi and Yusuf (2014), Olawumi *et al.* (2010) and Agbebi (2012). Male dominance in fish farming was attributed to the laborious nature of the enterprise which the females could not handle (Agbebi, 2012). Almost all (95.8%) of the fish farmers were also shown in Table 1 to be married which is an indication that marriage is highly cherished and has placed familial responsibilities on the fish farmers. It is therefore expected that the fish farmers are likely to adopt technologies that have the potential to increase their income in order to ensure the survival of their households. Only about 9.2% of the fish farmers had no formal form of education at all while about 3.3% only went through the adult education. Also, Table 1 reveals that more than one-third (34.2%) were educated up to tertiary level while 29.2% and 24.2% only had primary and secondary levels of education respectively. This result is similar to those of Agbebi (2012) and Apata (2012) who 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 improved fisheries technologies once proven to be able to improve their productivity could be enhanced.

**Table 1:** Socio-economic characteristics of fish farmers in Ogun State (n = 120)

| Socio-economic variables | Frequency | Percentage | Mean |
|---|---|---|---|
| **Age (Years)** | | | |
| 21-30 | 2 | 1.7 | 46.43±9.25 years |
| 31-40 | 24 | 20 | |
| 41-50 | 56 | 46.7 | |
| 51-60 | 36 | 30 | |
| >60 | 2 | 1.7 | |
| **Sex** | | | |
| Male | 110 | 91.7 | |
| Female | 10 | 8.3 | |
| **Marital status** | | | |
| Single | 2 | 1.7 | |
| Married | 115 | 95.8 | |
| Widowed | 3 | 2.5 | |
| **Highest educational attainment** | | | |
| No formal education | 11 | 9.2 | |
| Elementary/primary education | 35 | 29.2 | |
| Secondary education | 29 | 24.2 | |
| Tertiary education | 41 | 34.2 | |
| Adult education | 4 | 3.3 | |
| **Fish Training** | | | |
| Acquired | 61 | 50.8 | |
| Not acquired | 59 | 49.2 | |
| **Fish farming experience (Years)** | | | |
| 1-5 | 70 | 58.3 | 5.54±2.47 years |
| 6-10 | 39 | 32.5 | |
| >10 | 11 | 9.2 | |
| **Mode of fish farming** | | | |
| Part time | 21 | 17.5 | |
| Full time | 99 | 82.5 | |
| **Secondary occupation** | | | |
| Trading | 29 | 24.2 | |
| Farming | 66 | 55 | |
| Artisan/vocational | 10 | 8.3 | |
| None | 15 | 12.5 | |
| **Membership of fish farmers' association/cooperative** | | | |
| Members | 69 | 57.5 | |
| Non-members | 51 | 42.5 | |

***multiple responses**

Table 1 further reveals that just about half (50.8%) of the fish farmers had trainings in fish farming. This is likely to be linked to their level of education which made them to want to acquire more knowledge about what they do. With the acquired trainings, the fish farmers are likely to adopt IFTs since they must have been aware of these during their trainings. Also found from this study is that more than half (58.3%) of the fish farmers had fish farming experience of 1-5 years, close to one-third (32.5%) had 6-10 years of fish farming while the fish farming experience for less than 10 percent of the fish farmers was more than 10 years. The mean fish farming experience of 5.54±2.47 years indicated that majority of the fish farmers have not been in the business for a very long time. Agbebi (2012) and Salau *et al.* (2014) also recorded that more than half of the fish farmers had a few years of fish farming of less than 5 years. It can then be inferred that the introduction of National Fadama Development Projects must have been the reason for the participation of most of the fish farmers in fish farming and may also explain why a higher proportion of the fish farmers had tertiary level of education.

As presented in Table 1, fish farming was practiced by majority (82.5%) of the fish farmers on a full-time basis while more than half (55.0%) of the fish farmers took fish farming as a secondary occupation. Other secondary occupation that the fish farmers were involved in include trading and artisanal/vocational such as tailoring, welding. More than half (57.5%) of the fish farmers also belonged to fish farmers' associations and cooperative societies. This could then serve as a good platform for raising awareness and demonstrating IFTs to a large number of fish farmers through their respective groups/associations. It is also a means through which fish farmers could obtain loan to expand their fish farming business in the face of improved fisheries technologies.

## Fish farmers' access to credit facilities

Table 2 shows that more than half (55.8%) of the fish farmers obtained credits from cooperative societies. Other important sources of credit facilities to the fish farmers were *Esusu* (35.8%), loans from agricultural banks (12.5%) and non-governmental organizations – NGOs (6.8%) and loan from money lenders (0.8%). This is contradictory to the findings of Adewuyi *et al.* (2010) and Adegbite *et al.* (2007) which reported that personal savings was the main source of credit to majority of the fish farmers in Ogun State. Adewuyi *et al.* (2010) however supported the non-use of bank loans by the fish farmers. This implies that most of the fish farmers had chosen to rely on their cooperative societies and the traditional *Esusu* to fund their businesses rather than depended on agricultural loans which are not easily accessible to fish farmers and other categories of farmers operating at subsistence level. Table 2 also reported that majority (70.8%) of the fish farmers took a loan of more than ₦20,000.00 for their business while the remaining took loans ranging from ₦6,000.00 to ₦20,000.00 Table 2 further shows that the fish farmers had borrowed an average of ₦21,616.67±8,534.22 in the past per production season. This amount is observed to be too

small for an expansion in fish farming and accounts for the fish farmers' operation at subsistence level.

Table 2 also reveals that close to two-thirds (64.2%) of the fish farmers took their loans at interest rates of 10.0% or less while 35.8% borrowed at interest rates of 11-20%. This implies that the loans available to the fish farmers were relatively easy and convenient to pay back. Almost all the fish farmers (90.8%) were able to pay back their loans within one year (6-12 months) while some 8.3% could only pay back their loans between 2 and 3 years.

**Table 2:** Fish farmers' access to credit facilities

| Access to credit facilities | Frequency | Percentage | Mean ± SD |
|---|---|---|---|
| **Sources of credit*** | | | |
| Agricultural banks | 15 | 12.5 | |
| Cooperative societies | 67 | 55.8 | |
| Local money lenders | 1 | 0.8 | |
| NGO | 8 | 6.7 | |
| Esusu | 43 | 35.8 | |
| Personal savings | 0 | 0 | |
| **Amount of credits obtained (₦)** | | | |
| ≤10000 | 8 | 6.7 | 21616.67±8534.22 |
| 10001-20000 | 27 | 22.5 | |
| >20000 | 85 | 70.8 | |
| **Interest rates (%)** | | | |
| ≤10 | 77 | 64.2 | |
| 11-20 | 43 | 35.8 | |
| **Payback period (Months)** | | | |
| 6 | 8 | 6.7 | |
| 12 | 101 | 84.2 | |
| 24 | 9 | 7.5 | |
| 36 | 1 | 0.8 | |

***multiple responses used**

The fish farmers' ability to pay back their loan within short period is attributed to the low interest rates as well as the profitability nature of fish farming. Similar findings were reported by Olaoye *et al.* (2012) who found that loans were obtained by most fish farmers in Remo zone as a result of low interest rate. This has a positive impact on fish production in Ogun state as the fish farmers are likely to continue in their fish farming business. This also means that sustainable production of fish can be ensured thereby making fish available to many citizens of the State.

## Production costs and returns from fish farming in Ogun State

As shown in Table 3, the mean fish output was 115.08±33.12 kg per production cycle while the mean selling price for fish was estimated at ₦340±54.36/kg implying that the fish farmers were producing on small-scale which is an indication that adopting IFTs will go a long way in increasing their production output in both quality and quantity thereby commanding higher prices and increasing the profitability of fish farming.

**Table 3:** Mean production costs and returns of fish farming in Ogun State

| Cost and return variables | Mean | Standard deviation |
|---|---|---|
| Fish output/cycle (kg) | 115.08 | 33.12 |
| Fish price/kg (₦) | 340 | 54.36 |
| Cost of pond construction/annum (₦) | 41,833.33 | 22,345.43 |
| Cost of pond management/annum (₦) | 28,829.17 | 15,783.80 |
| Cost of fingerlings stocked/cycle (₦) | 33,000.00 | 19,236.54 |
| Profit from fisheries activities per annum (₦) | 41,275.00 | 11,500.46 |
| Annual income (₦) | 46,654.17 | 14,925.52 |

The mean costs for pond construction and pond maintenance were estimated at ₦41,833.33±22,345.43 and ₦28,829.17±15,783.80 per annum respectively. Fingerlings worth an average of ₦33,000±19,236.54 were stocked by the fish farmers per production cycle. The findings indicated that the fish farmers incurred highly on fingerlings, pond construction and maintenance and is in consonance with the observation of Olaoye *et al.* (2011) which reported that costs of fish seeds and feed made up the lion share of the cost of production. Table 3 also reveals that the fish farmers earned an average income of ₦46,654.17 per annum while the exact profit earned from fish farming by the fish farmers was an average of ₦41,275.00 per year. This implies that despite the small-scale level of production, fish farming in was a profitable enterprise among the fish farmers in Ogun State. This is in agreement with the position of Bolarinwa (2014) who observed that the Nigerian fishery industry is profitable. It then means that any IFTs that have the tendency of increasing the fish farmers' income are likely to be adopted by them.

## Effectiveness of extension services on fish farming in Ogun State

Table 4 reveals that almost all (98.3%) of the fish farmers were aware of the existence of extension agents and the services offered by them in the study area.

**Table 4:** Perceived effectiveness of extension services by fish farmers in Ogun State (n=120)

| Extension service variables | Frequency | Percentage |
|---|---|---|
| **Awareness of extension agents** | | |
| Aware | 118 | 98.3 |
| **Period of extension agent's visit** | | |
| Forth nightly | 101 | 84.2 |
| Monthly | 16 | 13.3 |
| Quarterly | 1 | 0.8 |
| Never | 2 | 1.7 |
| **Extension agent's contact** | | |
| Very regular | 36 | 30 |
| Regular | 78 | 65 |
| Not regular | 4 | 3.3 |
| Never | 2 | 1.7 |
| **Extent of extension agent's teaching ability** | | |
| Very good | 52 | 43.3 |
| Good | 61 | 50.8 |
| Poor | 7 | 5.8 |
| **Assessment of extension service** | | |
| Very Good | 56 | 46.7 |
| Good | 53 | 44.2 |
| Fair | 7 | 5.8 |
| Very Poor | 4 | 3.3 |
| **Characteristic of extension service*** | | |
| Easy to understand | 117 | 97.5 |
| Easy to implement | 110 | 91.7 |
| **Degree of extension agents' interest in small scale fishers' welfare** | | |
| Highly interested | 87 | 72.5 |
| Interested | 9 | 7.5 |
| Slightly interested | 22 | 18.3 |
| Not interested | 2 | 1.7 |

***multiple responses used**

Extension workers usually visit majority (84.2%) of the fish farmers on a forth night basis, 13.3% and 0.8% were visited on monthly and quarterly basis. This showed that extension workers do visit the fish farmers on a more or less frequent basis in line with the basic principle of the Training and Visit System. Table 4 further reveals that 95.0% of the fish farmers assessed the extension agents' contact with them in relation to fisheries technologies as either very regular (30.0%) or regular (65.0%) while 5.0% claimed that their contacts with extension agents were not regular. This is an indication that majority of the fish farmers had access to extension services which is contradictory to the report of Agbebi (2012) which stated that most of the fish farmers had no access to extension services. This therefore implies that most of the fish farmers are likely to have sound knowledge of IFTs that could enable them adopt the technologies with little or no stress.

As shown in Table 4, the teaching ability of the fish farmers was assessed to be very good by 43.3% and good by about half (50.8%) of the fish farmers while only a few (5.8%) assessed the teaching ability of the extension agents as poor. This implies that with the good teaching ability of the extension agents, improved fisheries technologies could easily pass through the awareness, trial and adoption stages as fast as possible. This contradicts the findings of Agbebi (2012) which perceived extension officers poorly. This is also attributed to the frequent contact and regular visits that the extension agents had with the fish farmers on IFTs.

Almost an equal proportion of the fish farmers assessed the extension services delivered by the extension agents as very good (46.7%) and good (44.2%). This is in line with the fish farmers' assessment of the personality and teaching ability of extension agents and implies that only extension agents with good personality and adequate knowledge of his/her profession could deliver good extension services. This good assessment of the extension services by the fish farmers is an indication that extension services is not a constraint to them as against the report of Olasunkanmi and Yusuf (2014) which ranked extension officers' services first among the major constraints of fish farmers.

Table 4 also presents that majority (97.5% and 91.7%) of the fish farmers characterized extension services as easy to understand and implement respectively. Table 4 reveals that majority (72.5%) of the fish farmers assessed the extension agents to be highly interested in the welfare condition of the small-scale fish farmers. All these indicated that adoption of IFTs is likely to be rapid among the fish farmers due to the good rapport that has been built between the fish farmers and the extension agents in Ogun State over the years.

## Fish farmers' attitude towards the adoption of IFTs

As shown in Table 5, majority of the fish farmers were in the agreement continuum for all the positively worded statements. Instances are as follows: at least seventy percent of the fish farmers either agreed or strongly agreed with the facts that IFTs save time (73.3%), conserve fish farmers' energy and finance (70.0%), increase profit through higher yield (75.0%), reduced drudgery (70.0%), improve the quality and quantity of fish harvest (73.3%), improved

technologies are easier to handle and operate (70.0%) and fish farmers derived a sense of satisfaction by adopting improved fisheries technologies (72.5%).

The fish farmers however disagreed with all the negatively worded attitudinal statements with the exception of gender insensitivity of IFTs. This is an indication that the introduced IFTs have not taken the sensitivity of gender into consideration. With the mean values in Table 5, most of the fish farmers had positive attitudes toward all the attitudinal statements with the exception of gender sensitivity of IFTs with a mean value of less than 3.0 (mean = 2.88).

## Fish farmers' level of adoption of improved fisheries technologies in Ogun State

Table 6 explains the different stages of adoption of the different improved fisheries technologies that have been introduced under the following fish stock management, fish nutrition, integration, pond bottom excavation, fish culture system, fish species selectivity, fish marketing gear system and drainage system sub-headings. Therefore, the results and discussion for this section are presented as follows.

## Fish stock management

As shown in Table 6, all (100.0%) of the fish farmers were aware of the sorted fish stock while 95.0% were aware of the unsorted fish stock. About 99.2% and 90.0% of the fish farmers have tried the sorted and unsorted fish stocks respectively while 91.7% and 81.7% also adopted the sorted and unsorted fish stocks respectively. Surprisingly, about 40.0% and 51.7% of the fish farmers have discontinued the use of sorted and unsorted fish stocks respectively. This implies that although both methods have been adopted by majority of the fish farmers, the two methods have also been discontinued by most of the fish farmers. Still, continued use of sorted fish stock is higher than that of the unsorted and further implies that the sorted fish stock has proven to be better than the unsorted fish stock

**Table 5:** Fish farmers' attitude towards the adoption of IFTs

| S/N | Attitudinal statements about fish farmers | SA | A | U | D | SD | Mean |
|---|---|---|---|---|---|---|---|
| 1 | Using IFTs save time | 44 (36.7)* | 44 (36.7) | 1 (0.8) | 1 (0.8) | 30 (25.0) | 4.52 |
| 2 | IFTs conserves farmers' energy human, material & finance | 34 (28.3) | 50 (41.7) | 1 (0.8) | 5 (4.2) | 30 (25.0) | 4.35 |
| 3 | Lazy fish farmers use improved technologies | 3 (2.5) | 6 (5.0) | 1 (0.8) | 41 (34.2) | 69 (57.5) | 4.34 |
| 4 | Using IFTs lead to high product losses | 9 (7.5) | 5 (4.2) | 13 (10.8) | 31 (25.8) | 62 (51.7) | 4.36 |
| 5 | Large family size discourages fish farmers' use of improved technologies | 6 (5.0) | 3 (2.5) | 6 (5.0) | 46 (38.3) | 59 (49.2) | 4.24 |
| 6 | Fish farmers use of improved technologies increases profit/improved income via higher yield/harvest | 58 (48.3) | 32 (26.7) | 0 (0.0) | 1 (0.8) | 29 (24.2) | 4.67 |
| 7 | IFTs are not gender sensitive | 26 (21.7) | 44 (36.7) | 0 (0.0) | 18 (15.0) | 32 (26.7) | 2.88 |
| 8 | Using improved technologies help to reduce drudgery | 37 (30.8) | 47 (39.2) | 16 (13.3) | 5 (4.2) | 15 (12.5) | 4.18 |
| 9 | IFTs improve the quantity and quality of fish harvest | 49 (40.8) | 39 (32.5) | 2 (1.7) | 3 (2.5) | 27 (22.5) | 4.6 |
| 10 | The improved technologies are easier to handle and operate | 31 (25.8) | 53 (44.2) | 3 (2.5) | 3 (2.5) | 30 (25.0) | 4.29 |
| 11 | Skills required for the use of the improved technologies can be easily acquired | 16 (13.3) | 45 (37.5) | 24 (20.0) | 12 (10.0) | 23 (19.2) | 3.65 |
| 12 | Adopting the improved technologies gives me a sense of satisfaction | 30 (25.0) | 57 (47.5) | 0 (0.0) | 6 (5.0) | 27 (22.5) | 4.31 |
| 13 | Improved technologies fit well into existing fisheries systems | 28 (23.3) | 53 (44.2) | 4 (3.3) | 3 (2.5) | 32 (26.7) | 4.17 |
| 14 | Government policy changes have positive impact on adoption and discontinuance of IFTs | 20 (16.7) | 30 (25.0) | 25 (20.8) | 16 (13.3) | 29 (24.2) | 3.32 |

Figures in parentheses are percentages

**Table 6:** Percentage distribution of the level of adoption of IFTs by the fish farmers

| Improved fisheries technologies | Aware | Tried | Adopted | Discontinued |
|---|---|---|---|---|
| **Fish stock management** | | | | |
| Sorted fish stock | 100 | 99.2 | 91.7 | 40 |
| Unsorted fish stock | 95 | 90 | 81.7 | 51.7 |
| **Fish nutrition** | | | | |
| Maggots | 100 | 99.2 | 89.2 | 4.2 |
| Poultry waste | 100 | 87.5 | 85.8 | 37.5 |
| Grass paste/feed | 46.7 | 9.2 | 5.8 | 5.8 |
| Pulverized cereal | 45.8 | 5.8 | 4.2 | 2.5 |
| Kitchen waste | 97.5 | 95 | 95 | 95 |
| Compounded pelleted diet | 100 | 99.2 | 99.2 | 4.2 |
| Fish forage | 30 | 13.3 | 2.5 | 2.5 |
| **Integration** | | | | |
| Fish/poultry | 98.3 | 90.8 | 90.8 | 12.5 |
| Fish/piggery | 84.2 | 53.3 | 41.7 | 30.8 |
| Fish/crop | 90.8 | 88.3 | 85 | 1.7 |
| **Pond bottom excavation** | | | | |
| By using machines like bulldozers | 100 | 98.3 | 98.3 | 95.8 |
| By Manual digging | 100 | 100 | 95.8 | 0.8 |
| **Fish culture system** | | | | |
| Poly-specific culture | 97.5 | 84.2 | 80 | 14.2 |
| Poly-sex culture | 76.7 | 42.5 | 42.5 | 24.2 |
| Mono-specific culture | 100 | 87.5 | 87.5 | 16.7 |
| Mono-sex culture | 77.4 | 44.2 | 38.3 | 29.2 |
| **Fish species selectivity** | | | | |
| *Oreochromis niloticus* | 98.3 | 97.5 | 91.7 | 29.2 |
| *Heteroclarias* | 98.3 | 94.1 | 91.7 | 19.2 |
| *Clarias gariepinus* | 96.7 | 84.2 | 75 | 7.5 |
| *Heterotis niloticus* | 92.5 | 71.7 | 71.7 | 37.5 |
| *Gymnarchus niloticus* | 96.7 | 80 | 79.2 | 55 |
| *Heterobranchus bidorsalis* | 90.8 | 81.6 | 78.2 | 48.3 |
| *Channa obscura* | 93.3 | 93.3 | 83.3 | 68.3 |
| **Fish harvesting gear system** | | | | |
| Drag net | 98.3 | 97.5 | 94.2 | 16.7 |
| Cast net | 95.8 | 74.2 | 69.2 | 44.2 |
| Gill net | 84.2 | 46.7 | 45.8 | 23.3 |
| Basket | 100 | 90 | 85.8 | 36.7 |
| Traps | 100 | 87.5 | 81.7 | 80.8 |
| **Drainage system /method** | | | | |
| Sluice | 77.5 | 65 | 62.5 | 42.5 |
| Monk | 97.5 | 97.5 | 92.5 | 71.7 |
| Drainage ditches | 79.2 | 53.3 | 47.5 | 34.2 |
| Siphon | 66.7 | 62.5 | 61.7 | 46.7 |
| Pump | 100 | 100 | 94.1 | 55 |

**Fish nutrition**: Table 6 shows that all (100.0%) of the fish farmers were aware of using maggots, poultry waste and compounded pelleted diets to feed their fishes. Majority (97.5%) of the fish farmers were aware of using kitchen wastes as fish nutrition. At the trial stage, Table 6 reveals that more than three-quarters of the fish farmers have tried the use of maggots (99.2%), poultry wastes (87.5%), kitchen wastes (95.0%) and compounded pelleted diet (99.2%). All the technologies that were tried by the fish farmers were also reported to have been adopted. For instance, Table 6 shows that all the fish farmers that tried compounded pelleted diet (99.2%) and kitchen waste (95.0) also adopted them as important fish nutrition while almost all those that tried maggots (89.2%), and poultry wastes (85.8%) also adopted their use as important sources of fish nutrition. Furthermore, most of the fish nutrition sources

that were previously adopted have been discontinued by most of the fish farmers with the exemption of maggots and compounded pelleted diets which were discontinued by only 4.2% of the fish farmers. This implies that the most commonly used fish nutrition sources among the fish farmers in Ogun State are compounded pelleted diets (95.0%) and maggots (85.0%).

**Fish integration:** Table 6 reveals that majority of the fish farmers were aware of the combination of fishery with poultry (98.3%), piggery (84.2%) and crops (90.8%). With respect to trying these different technologies, piggery was least tried by the fish farmers (53.3%) while the poultry and crops were combined with fish production by 90.8% and 88.3% of the fish farmers respectively. This implies that the practice of Islam by some of the fish farmers might have been responsible for low proportion of fish farmers combining piggery with fishery. About 90.8% and 85.0% of the fish farmers went ahead to adopt the integration of poultry and crops with fishery respectively while only about 41.7% adopt the integration into piggery into fishery. After trying the different integration methods over time, up to 30.8% of the fish farmers also discontinued the combination of piggery and fishery while only about 12.5% and 1.7% discontinued the integration of poultry and crops with fishery respectively. This implies that the combination of crops with fishery is the most common among the fish farmers in Ogun State followed by its combination with poultry production.

**Pond bottom excavation:** Table 6 reveals that use of machines and manual digging has been introduced to the fish farmers for pond bottom excavation. The results reveal that all (100% of) the fish farmers were aware of both methods. Also, 100% and 98.3% have tried the manual digging and use of machines for pond excavation respectively. All those that tried the use of machines (98.3%) adopted its use for pond excavation while 95.8% of the fish farmers had adopted the use of manual digging at a point after the trial stage. It is however surprising that almost all that adopted the use of machines (95.8%) discontinued its use while only 0.8% of the fish farmers discontinued the use of manual labour. This implies after using these technologies over time, the manual digging was preferred by majority of the fish farmers. The reasons adduced to this are that manual labour is cheaper and readily available than bulldozers and that lands for fish production are most often than not, not easily worked on by machines.

**Fish culture system:** more than three-quarters of the fish farmers were found to be aware of all the fish culture systems that were previously introduced as improved fisheries technologies in Ogun State. Poly-specific and mono-specific culture systems were shown in Table 6 to have been tried by majorities (84.2% and 87.5%) of the fish farmers respectively while higher proportions (57.5% and 55.8%) of the fish farmers did not even try the poly-sex and mono-sex culture systems.

**Table 7:** Result of regression analysis of the relationship between fish farmers' socio-economic and production characteristics and adoption of IFTs

| | Un- standardized Coefficients | | Standardized Coefficients | T | p-value |
|---|---|---|---|---|---|
| | β | Std. Error | Beta | | |
| (Constant) | 102.862 | 60.689 | | 1.695 | 0.451 |
| Age | 5.088 | 3.528 | 0.248 | 1.442 | 0.309 |
| Education status | 0.103 | 3.71 | 0.007 | 0.028 | 0.072 |
| Training acquired | -0.996 | 5.484 | -0.031 | -0.182 | 0.102 |
| Other occupation | -5.403 | 3.017 | -0.324 | -1.791* | 0.003 |
| Extension agents' visit | -2.442 | 2.334 | -0.192 | -1.046 | 0.268 |
| Income level per annum | -5.532 | 2.696 | -0.471 | -2.052** | 0.035 |
| Credits obtained | -0.004 | 2.9 | 0 | -0.001 | 0.421 |
| Interest rate | -3.628 | 3.384 | -0.179 | -1.072 | 0.285 |
| Payback period | -6.897 | 4.809 | -0.281 | -1.434 | 0.294 |
| Output last year | 6.256 | 5.969 | 0.29 | 1.048 | 0.248 |
| Cost of pond construction | 5.249 | 2.31 | 0.477 | 2.273** | 0.018 |
| Cost of pond management | -2.966 | 1.836 | -0.283 | -1.615 | 0.394 |
| Cost of fish fingerlings last year | 4.949 | 1.919 | 0.599 | 2.579 | 0.059 |
| Total profit realized last year | -4.59 | 2.291 | -0.466 | -2.004** | 0.023 |
| Fish farming experience | 1.893 | 3.325 | 0.086 | 0.569 | 0.417 |
| Extension contact | -1.368 | 2.94 | -0.089 | -0.465 | 0.405 |

* and ** significant at 1% and 5% levels of significance; R=0.678; $R^2$=0.460; Adjusted $R^2$=0.061

Table 6 further reveals that almost all that tried both poly-specific (80.0%) and mono-specific (87.5%) culture systems adopted their use. After discontinuation, it can be deduced from Table 6 that most of the fish farmers were still making using of the poly-specific (65.8%) and mono-specific (70.8%) culture systems.

**Fish species selectivity:** At least 90 percent of the fish farmers were aware of all the fish species previously introduced. About 97.5% of the fish farmers have tried culturing *Oreochromis niloticus* while 91.7% had adopted its culture. More than one-quarter (29.2%) however discontinued their choice of *Oreochromis niloticus* after some period of adoption. Also, *Hetero clarias* was tried by 94.1% and adopted by 91.7% of the fish farmers, although 19.2% of the fish farmers later discontinued its culture. Table 6 reveals that 84.2% and 75.0% have tried and adopted the culturing of *Clarias gariepinus* respectively while only 7.5% later discontinued their choice of *Clarias gariepinus.* Although, 71.7% of the fish farmers tried and adopted *Heterotis niloticus* as fish species to be cultured, up to 37.5% of the fish farmers later discontinued its choice. About 80.0% also tried *Gymnarchus niloticus* and 79.2% adopted its choice for culture while more than half of the fish farmers (55.0%) later discontinued culturing *Gymnarchus niloticus.* About 81.6% and 93.3% have tried culturing *Heterobranchus bidorsalis* and *Channa obscura* respectively. These two species were also adopted by 78.2% and 83.3% respectively and 48.3% of the fish farmers discontinued the choice of *Heterobranchus bidorsalis* while more than two-thirds (68.3%) of the fish farmers discontinued culturing *Channa obscura.* This implies that the fish species commonly cultured among the fish farmers in Ogun State are *Oreochromis niloticus, Heteroclarias and Clarias gariepinus.* This corroborates the findings of Olasunkanmi and Yusuf (2014) that identified *Clarias gariepinus* as the most common fish species cultured by fish farmers.

**Fish harvesting gear system:** As presented in Table 6, the least awareness of the fish harvesting gear systems was with the gill nets as only 84.2% of the fish farmers were aware of it as an important gear. The use of drag net, and baskets have been tried by 97.5%, and 90.0% of the fish farmers respectively and subsequently adopted by 94.2%, and 85.8% respectively. These technologies were later discontinued by 16.7% and 36.7% of the fish farmers respectively. Cast net was tried and adopted by 74.2% and 69.2% but discontinued by 44.2%. Traps were tried and adopted by 87.5% and 81.7% of the fish farmers respectively but discontinued by 80.8% of the fish farmers. This indicates that the fish harvesting gear system with the most continued adoption among the fish farmers in Ogun State was drag net.

**Drainage system/method:** Table 6 reveals that all the fish farmers were aware of the use of pumps to drain fish enclosures while 97.5% and 77.5% were aware of the use of monk and sluice respectively for the same purpose. Also, 79.2% and 66.7% of the fish farmers were aware of drainage ditches and siphon respectively. Table 6 further presents that pumps and monks were tried by all that have been were aware of them while 92.5% and 94.1% of the fish farmers adopted monks and pumps respectively. Monks and pumps were later discontinued by 71.7% and 55.0% of the fish farmers respectively. Sluice was tried by 65.0%, adopted by 62.5% and discontinued by 42.5% of the fish farmers while drainage ditches were tried by 53.3%, adopted by 47.5% and discontinued by 34.2% of the fish farmers. Siphon was tried and adopted by 62.5% and 61.7% of the fish farmers respectively while it was discontinued by 46.7% of the fish farmers.

### Determinants of adoption of improved aquaculture technologies

Table 7 reveals that fish farmers' adoption of improved fisheries technologies is significantly predicted by their secondary occupation (β=-0.324, p=0.003), annual income level (β=-0.471, p=0.035), cost of pond construction (β=0.477, p=0.018) and total profit realized (β=-0.466, p=0.023). The $R^2$ of 0.460 for the model implies that 46% of the variability in the fish farmers' adoption of improved aquaculture technologies is explained by the socio-economic and production characteristics of the fish farmers.

## CONCLUSION AND RECOMMENDATIONS

It can be concluded from this study that fish production in Ogun State is primarily at the subsistence level. It was also found that improved aquaculture technologies were adopted at a varying rate. It can therefore be concluded that the adoption of improved fisheries technologies highly depended on the fish farmers' socio-economic characteristics, the quality of extension workers and the effectiveness of extension services delivered to fish farmers, characteristics of improved fisheries technologies as well as institutional factors.

It is therefore recommended that extension agencies should continue to work on the training of extension agents so as to improve the effectiveness of extension services delivered to fish farmers and other farmers in rural areas. Fish farmers are also encouraged to try introduced fisheries technologies over a substantial period of time before adopting the technologies in order to reduce the incidences of discontinued adoption of technologies. The fish farmers should also be sensitized and trained on the adoption of improved fisheries technologies. Encouragement of women

fish farmers should be ensured for poverty and unemployment reduction among women.

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