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Adoption of improved hatchery production technologies of *Clarias gariepinus* among fish farmers in Southwest Nigeria

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ABSTRACT

Fish farming has appreciative return on investment, driving more investors into the enterprise. This has made demand for fish seed to increase significantly resulting in scarcity and this could be prevented by developing and adopting improved fish hatchery production technologies. This study investigated level of adoption of improved fish hatchery production technologies of *Clarias gariepinus* among fish farmers in Southwest Nigeria. The study employed simple random sampling technique to select 440 fish hatchery farmers. Data obtained were analysed using descriptive statistics and regression model. The findings indicated that research institutes (2.60) were the main source of information on improved fish hatchery production technologies. The result further revealed that awareness, trial and adoption of improved fish hatchery production technologies were high unfortunately some farmers discontinued some of the technologies after adoption. Results from regression analysis show that sex (0.46211), educational qualification (0.04953), number of worker/labour (0.07584), number of fish enclosure units (0.18647) and years of experience (0.04584) had positive and significant influence on adoption of improve fish hatchery production technologies. The study concludes that technology with high level of adoption had high discontinuance rate after some time. Therefore, technology with high level of discontinuance or with low level of adoption should be improved upon and disseminated appropriately.

Keywords: Awareness, *Clarias gariepinus*, Hatchery production, Improved technlogies, Information dessemination.

INTRODUCTION

Adoption of improved technologies is characterized as either slow or low adding to researcher's frustration, provoking donors and policy makers, but this attribute is peculiar with developing nations (Yigezu *et al*., 2018). Improved technologies comprise opportunities and risks; farmers in developing nations cultivate habit of trying out new technologies with reduced risk but of high projected benefit (Pannell *et al*., 2006). Yigezu *et al*. (2018) opined that adoption of improved technologies face serious challenges resulting to low adoption rate especially when huge initial capitals are involved. Series of studies had been carried out to establish underlying factors that affect adoption rate. Factors such as government policies, change in technology, market forces, environmental concerns, social factors, institutional factors and delivery mechanism were identified (Caswell *et al.,* 2001).

Adoption process is sequential in nature and categorized into four; awareness, trial, adoption and intensity of adoption (full/partial adoption/discontinuance) (Astebro, 2004; Rogers, 1995; Rogers and Shoemaker, 1973). Also, Zentner and Lindwall (1978) and Malhi *et al*. (1988) stated that technology compatibility influences adoption rate. Adoption of improved technologies geared towards increased farmed produce for food security, sustainability and economic development is of importance to Nigeria for her to meet up with her food demand.

Nigeria is a nation with vast expanse of water bodies (fresh, brackish and marine), with supposed sufficient fish production for her citizen. However, stock from these water bodies has drastically diminished due to over reliance and poor management strategies forcing her to import fish from other countries (Digun-Aweto and Oladele 2017). To salvage this condition, the country has to embrace and give adequate attention to fish farming through development and dissemination of improved fish farming technologies. Fish farming has gain popularity from what it used to be in the last century from homestead to commercialised fish production. It is practiced all over the country because of its acceptability by all tribes (Ashley-Dejo and Adelaja, 2022). It is considered as the cheapest source of animal protein with unsaturated fatty acid (Omotoyin, 2007).

Clarias gariepinus (Catfish) is one of the most culturable fish species in Nigeria. This could be attributed to hardy nature of the fish species, readiness to breed in captivity, acceptability of formulated feed, tolerance to wide range of water quality parameters and disease resistance. The aforementioned characteristics of *C. gariepinus* have attracted numerous individuals to invest in the enterprise. At present, the enterprise has appreciative return on investment of almost 40% (Digun-Aweto and Oladele 2017), making demand for fish seed to significantly increased, and thereby creating scarcity across the nation. This study considered fish seed production because this is the heart of the enterprise but faced with inadequate supply of fish seed (fingerlings/juvenile) (Ashley-Dejo *et al*., 2020a). If not given adequate attention, the future of the enterprise is bleak. This problem could be addressed by developing and

adopting improved fish hatchery production technologies by concerned stakeholders. Thus, it is a must to develop technology that will improve fish hatchery production to meet up with the current demand and projected for future need.

According to Dlamini (2003), transfer of improved technology becomes effective when cordial relationship exists between researchers, extension agents and farmers. This makes dissemination of improved technology to be productive. Dissemination of improved technology involves circulating information to targeted audience with sole aim of bridging knowledge gap, change of attitude and skill improvement.

Technology development is a process driven by demand from end users to arrest unpleasant condition. In Nigeria, shortage of fish seed and table size fish production had been noticed and effort to combat this shortfall had been put in place (Ashley-Dejo *et al*., 2020a). Nigeria has six geological zones namely; South west, South east, South south, North central, North east and North west. States within Southwest Nigeria developed a package tagged 'improved breeding and hatchery management practices' which comprises improved broodstocks, hormonal treatment and fish hatchery management practices. The package was developed to arrest the shortfall. Despite the development, introduction and adoption of this package of fish seed is still inadequate. However, this study seeks to investigate level of adoption of improved hatchery production technologies of *Clarias gariepinus* among fish farmers in Southwest Nigeria.

MATERIAL AND METHODS

Southwest is one of the geopolitical zones in Nigeria, comprising six states namely Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States. This zone recorded significant increase in fish production in the last decade compared to other zones in Nigeria (National Agricultural Extension and Research Liaison Services (NAERLS) and National Programme on Agriculture and Food Security (NPAFS), 2010).

However, two states were purposely selected for this study namely Oyo and Osun States. The states experience steady increase in aquaculture production in the last decade (NAERLS and NPAFS, 2010). Oyo State lies between $2^0$38.66'N and $4^0$38.325'N longitude and latitude $9^0$8.74'E and $7^0$1.68'E while Osun State lies between $4^0$1.52'N and $5^0$3.26'N longitude and $8^0$3.66'E and $7^0$0'25'E latitude. Both states share boundaries with Ogun State in the south, Kwara State in the north, the Republic of Benin in the west and in the east, it is bounded by Ekiti and Ondo States respectively. Also, 20 local government areas (LGAs) each were purposively selected. The choice of selected LGAs was guided by extension agents.

For the purpose of this study, 11 respondents from each of the 40 LGAs were selected using simple random sampling technique to arrive at a total number of 440 fish hatchery farmers. Selected fish hatchery farmers were interviewed with the aid of structure questionnaire which were sectioned based on the objective of the study. Questionnaires were administered by trained enumerators within the months of June to September, 2018, however, 17 questionnaires were discarded due to inadequate information and data from 423 questioners were used for this study. Data from the field were subjected to descriptive statistics and regression model.

Ordinary least square multiple regression analysis was used to determine the determinants of the adoption of improved fish hatchery production technologies as described in equation 1

$$Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + £ \quad \text{.....} \quad (1)$$

Where: Y = adoption of improved fish hatchery production technologies

X_1 = age (years);

X_2 = sex (dummy: 1 for male, 0 for female);

X_3 = educational qualification (years of formal schooling/education);

X_4 = household size (number of members of the household);

X_5 = number of worker/labour (number of labours);

X_6 = number of fish enclosure units (number of hatchery rearing units);

X_7 = years of experience (years);

β_o = constant term;

$\beta_1 – \beta_8$ = coefficients of the independent variables;

£ = error term.

Five-point Likert type scale was also used to elicit data on perception of fish hatchery farmers towards the use of improved fish hatchery production technologies. This was achieved by weighing the score and critical mean 3.0 was adopted as baseline for this study. Mean weight score greater or equal to 3.0 is taken as positive perception while mean weight score lesser than 3.0 is taken as negative perception which needs to be addressed.

The mean weight score was determined using equation below:

$$X_s = {}^{\Sigma X}/_{n} \quad \text{.....} \quad (2)$$

Where X_s was computed by finding the product of each response pattern with its appropriate nominal value and dividing same by number of respondents to the items. This can be summarized mathematically as

$$X_s = {}^{\Sigma fn}/_{n_r} \quad \text{.....} \quad (3)$$

Where;
X_s denote mean weight score
Σ denote summation
f denote frequency
n denote likert nominal value
n_r denote number of respondents

$$Xs = \frac{1+2+3+4+5}{5} = \frac{15}{5} = 3$$

RESULTS

Tables 1. shows the demographic characteristics of respondents. On average, the respondents were 46 years old having male as majority (84.87%). Educational qualifications ranged between primary to tertiary education. Majority (89.83%) of the respondents were married with mean household size of 7 persons. Numbers of workers ranged between 2 to 13 persons with mean workers of 9 persons. Number of fish hatchery enclosure ranged between 4 - 17 rearing units. Fish hatchery farmers in the study area had mean farming experience of 8 years while majority (88.42%) belong to cooperative society. Both genders were involved in fish hatchery operation with aim of increasing fish production, ensuring food security and also add to family income but dominated by male (84.87%). Farmers in the study area were educated (63.12%).

Tables 1. future revealed that majority (89.83%) of fish hatchery farmers in southwest Nigeria were married. Experience is characterized with number of years spent in engaging in a particular vocation thus, having direct influence on decision making. The study revealed that 43.97% had more than 10 years of fish farming experience, 31.21% had between 5 – 10 years of experience. The mean years of fish hatchery experience was 11 years which suggested that respondents in the study area had considerable good years of fish farming experience.

Table 1. Demographic characteristics of fish hatchery farmers.

Socioeconomic characteristic	Frequency	%	Mean
Age (year)			
Less than 31	16	3.78	
31 – 40	63	14.89	
41 – 50	206	48.70	46 years
51 – 60	112	26.48	
Above 60	26	6.15	
Sex			
Male	359	84.87	
Female	64	15.13	
Educational qualification			
Primary education	45	10.64	
Secondary education	111	26.24	
Tertiary education	267	63.12	
Marital Status			
Single	24	5.67	
Married	380	89.83	
Divorced	19	4.49	
Household size (number of persons)			
Less than 4	94	22.22	
4 – 6	165	39.01	7 persons
Above 6	164	38.77	
Number of workers/labour			
Less than 4	107	25.30	
4 – 6	124	29.31	9 persons
Above 6	192	45.39	
Number of hatchery rearing units			
Less than 5	95	22.46	
5 – 10	145	34.28	12 rearing units
Above 10	183	43.26	
Years of experience			
Less than 5	105	24.82	
5 – 10	132	31.21	11 years
Above 10	186	43.97	
Membership of cooperative society			
Yes	374	88.42	
No	49	11.58	

Source: Computed from Field Survey Data, 2018

As presented in Tables 2. eleven (11) sources of information were evaluated, this study was able to establish the most preferred information source available to fish hatchery farmers in the study area. It was revealed that research institutes were ranked most effective source of information followed by contact with extension agents while information from fellow farmers (fish farmers association) was ranked third. However, information from agricultural show and family/friend/relatives were ranked 11th and 10th respectively.

Table 2. Frequency distribution showing sources of information for fish hatchery farmers.

Agencies	Always used	Occasionally used	Don't use	Decision	Ranking
	Freq (%)	Freq (%)	Freq (%)		
Extension publications	224 (53.0)	114 (27.0)	85 (20.1)	2.33	5th
Research Institutes	273 (64.5)	131 (31.0)	19 (4.5)	2.60	1st
University/Academic Journals	163 (38.5)	246 (58.2)	14 (3.3)	2.35	4th
Federal Department of Fisheries	148 (35.0)	221 (52.2)	54 (12.8)	2.22	7th
Ministry of Agriculture	172 (40.7)	173 (40.9)	78 (18.4)	2.22	7th
Agricultural show	122 (28.8)	182 (43.0)	119 (28.1)	2.01	11th
Cooperative society	172 (40.7)	178 (42.1)	73 (17.3)	2.23	6th
Television/Radio	107 (25.3)	278 (65.7)	38 (9.0)	2.16	9th
Family/Friends/Relatives	111 (26.2)	247 (58.4)	65 (15.4)	2.11	10th
Fish Farmers Association	230 (54.4)	165 (39.0)	28 (6.6)	2.48	3rd
Extension agents	300 (70.9)	111 (26.2)	12 (2.8)	2.68	2nd

Source: Computed from Field Survey Data, 2018

Tables 3. reveals fish hatchery farmer's perception towards improved fish hatchery production technologies. Thirteen (13) perceptional statements were examined in this study, out of which nine (9) were found to be positive while the remaining five (5) were negative. High positive perception could be related to their age, educational qualification and farming experience.

Table 3. Fish hatchery farmer's perception towards improved fish hatchery production technologies.

Perceptional statements	Mean Value
Give higher yields	4.31**
Increase income	3.65**
Save time	3.89**
Improve social status	2.69*
Improved production technologies are not better	2.01*
Tedious and labour intensive	3.09**
Expensive to manage	3.73**
Requires trained man power	3.65**
Skills required cannot be easily acquired	2.45*
Meant for educated farmers	2.12**
Meant for the wealthy farmers	3.63**
Requires regular contact with extension workers	2.17*
Increases production cost	3.31**

Note: ** positive perception, * negative perception

Source: Computed from Field Survey Data, 2018.

Tables 4 reveals level of adoption of improved fish hatchery production technologies. It was shown that 88.9% of fish hatchery farmers were aware of wooden trough as hatchling enclosure. Out of this, 82.4% and 55.5% tried and adopted the technology respectively unfortunately, 26.9% of the 55.5% that adopted the technology discontinued the use. Furthermore, awareness, trial and adoption of fiber glass were 70.7%, 44.1% and 35.6% respectively but 53.2% out of 35.6% that adopted the practice discontinued its use. As for plastic tanks, 93.9% were aware out of which 61.5% and 38.5% tried and adopted the technology respectively while about one third (34.0%) of adopters discontinued the use. All fish hatchery farmers were aware of concrete tank as hatchlings enclosure, meanwhile 98.6% and 96.6% tried and adopted the technology respectively, but surprisingly 1.2% discontinued its use. Awareness, trial and adoption of hatchling jar were 29.1%, 61.0% and 42.7% respectively but 43.8% discontinued its use.

As shown in Tables 4 all the fish hatchery farmers were aware of natural and synthetic hormones. For natural hormones 53.4% out of 100.0% tried the technology while 82.3% out of 53.4% adopted the practice but 12.9% discontinued its use. Synthetic hormone had 97.6% trial and 99.5% adoption rate. Unfortunately, 3.2% of adopters discontinued the practice.

Tables 4 further revealed that all the fish hatchery farmers were aware of intramuscular injection method, 97.6% tried the practice, out of which 98.8% adopted the practice unfortunately, 0.7% discontinued its use. Interperitoral injection method has 74.7% awareness, 50.0% trial and 31.0% adoption percentage, surprisingly 53.1% out of 31.0% that adopted the practice discontinued with the use of the technology. High adoption rate of intramuscular injection method might be due to inadequate technical know-how. Also, all the fish hatchery farmers were aware of the under listed water quality parameters pH, temperature, dissolved oxygen, nitrate, nitrite, ammonia and water hardness, but

with varying level of trial, adoption and discontinuation. High level of awareness could be attributed to their educational status which informs them about factors that influence hatchability, survival and growth of hatchlings.
All the fish hatchery farmers were aware and tried wet fertilization, out of which 91.5% adopted the practice while 5.1% out of the adopters discontinued the practice. Percentage of awareness for dry fertilization was 100.0%. Out of this, 67.6% tried the technology and 43.7% out of 67.7% adopted the technology. Unfortunately, 55.2% of 43.7% discontinued the practice. Awareness, trial and adoption of flow through water system were 100.0%, surprisingly 12.3% discontinued the practice. All the fish hatchery farmers were aware of recirculatory aquaculture system, 39.0% and 53.9% tried and adopted the practice respectively. However, 30.0% out of 53.9% discontinued the practice.
Fish hatchery farmers had varying level of awareness, trial, adoption and discontinuance of the under listed feeding practices as shown in Tables 4. Awareness, trial, adoption and discontinuation of the use aerator/air stones were 100.0%, 70.4%, 72.8% and 21.1% respectively. All the fish hatchery farmers were aware, tried and adopted the use of sorting tray with no discontinuation. Awareness of early sorting of fry was 100.0%, with trial and adoption percentage of 88.9% and 86.4% respectively however no single fish hatchery farmer abandoned the technology.
In addition, all the fish hatchery farmers were aware of air tight bag as means of transporting fish seed, 47.5% tried the practice, 81.6% out of the farmer that tried the practice adopted the practice while 25.5% out of the adopters discontinued the practice. All the farmers were aware, tried and adopted use of jerican as means of transporting fish seed.

Table 4. Distribution of the level of adoption of improved fish hatchery production technologies.

Fish hatchery production technologies	Awareness Freq (%)	Tried Freq (%)	Adoption Freq (%)	Discontinued Freq (%)
Hatching enclosure				
Wooden trough	376 (88.9)	310 (82.4)	234 (75.5)	63 (26.9)
Fiber glass tanks	299 (70.7)	132 (44.1)	47 (35.6)	25 (53.2)
Plastic tanks	397 (93.9)	244 (61.5)	94 (38.5)	32 (34.0)
Concrete tanks	423 (100.0)	417 (98.6)	403 (96.6)	5 (1.2)
Hatchling jars	123 (29.1)	75 (61.0)	32 (42.7)	14 (43.8)
Hormone				
Natural hormone (Catfish, Tilapia, Carp pituitary etc)	423 (100.0)	226 (53.4)	186 (82.3)	24 (12.9)
Synthetic hormones (Ovaprim, ovatide, Ovulin etc)	423 (100.0)	413 (97.6)	411 (99.5)	13 (3.2)
Injection methods				
Intra muscular	423 (100.0)	413 (97.6)	408 (98.8)	3 (0.7)
Inter peritoral	316 (74.7)	158 (50.0)	49 (31.0)	26 (53.1)
Water Quality Monitoring				
pH	423 (100.0)	391 (92.4)	354 (90.5)	13 (3.7)
Temperature (^{0}C)	423 (100.0)	366 (86.5)	301 (82.2)	9 (3.0)
Dissolved Oxygen	423 (100.0)	417 (98.6)	339 (81.3)	26 (7.7)
Nitrate	423 (100.0)	281 (66.4)	142 (50.5)	49 (34.5)
Nitrite	423 (100.0)	211 (49.9)	153 (72.5)	63 (41.2)
Ammonia	423 (100.0)	328 (77.5)	110 (33.5)	73 (66.4)
Water hardness	423 (100.0)	271 (64.1)	151 (55.7)	38 (25.2)
Incubation procedure				
Wet fertilization	423 (100.0)	423 (100.0)	387 (91.5)	21 (5.4)
Dry fertilization	423 (100.0)	286 (67.6)	125 (43.7)	69 (55.2)
Flow through water system	423 (100.0)	423 (100.0)	423 (100.0)	52 (12.3)
Recirculatory water system	423 (100.0)	165 (39.0)	89 (53.9)	27 (30.3)
Siphon off un-hatched eggs/dead larva after hatching	423 (100.0)	423 (100.0)	423 (100.0)	423 (100.0)
Feeding practices				
Feeding with live/shell free Artemia	423 (100.0)	413 (97.6)	394 (95.4)	21 (5.3)
Feeding with Daphnia	322 (76.1)	209 (64.9)	189 (90.4)	5 (2.6)
Feeding at hours interval	423 (100.0)	423 (100.0)	365 (86.3)	36 (9.9)
Feeding with combination of Artemia and Daphia	423 (100.0)	265 (62.6)	204 (77.0)	56 (27.5)
Siphon off un-hatched eggs/dead larva after hatching and uneaten feeds	423 (100.0)	423 (100.0)	423 (100.0)	423 (100.0)
Stock Management				
Use of aerator/air stones	423 (100.0)	298 (70.4)	217 (72.8)	46 (21.2)
Use of sorting tray	423 (100.0)	423 (100.0)	423 (100.0)	0 (0.0)
Early (after two weeks) sorting of fry	423 (100.0)	376 (88.9)	325 (86.4)	0 (0.0)
Transportation of fish seed				
Air tight bag	423 (100.0)	201 (47.5)	164 (81.6)	42 (25.6)
Kegs (25 or 50 litre Jerican)	423 (100.0)	423 (100.0)	423 (100.0)	0 (0.0)

Source: Computed from Field Survey Data, 2018

Tables 5 reveals the determinants of adoption of improved fish hatchery production technologies. It was shown that sex (P<0.01), educational qualification (P<0.05), number of worker/labour (P<0.10), fish enclosure (P<0.05) units and years of experience (P<0.01) was positive and significant (P<0.01). The model accounted for 76.5% of the variance in adoption of improved fish hatchery production technologies.

Table 5. Determinants of adoption of improved fish hatchery production technologies.

Variables	Coefficients	Standard error	t-Stat	Sig value
Constant	0.36370	0.11083	3.28165	0.0321
Age	0.00073	0.00230	0.31875	0.3118
Sex	0.46211	0.13480	3.42818	0.0000
Educational qualification	0.04953	0.00572	8.65375	0.0263
Household size	0.00895	0.00412	2.17435	0.7125
Number of workers/labour	0.07584	0.02017	3.76138	0.0752
Number of fish enclosure units	0.18647	0.04879	3.82214	0.0188
Years of experience	0.04584	0.00480	9.54421	0.0000
F-statistics	35.49174			
p-value	0.00115			
R-squared	0.76525			

Note: *, **, *** are the 10%, 5% and 1% significant levels respectively.

Source: Computed from Field Survey Data, 2018.

DISCUSSION

Age bracket recorded in this study indicated that farmers in the study area are within their youthful age, agile, willing to try out new innovations to boost their income. This is in line with the findings of Ashley-Dejo and Adelaja (2022); Oke and Kehinde (2019) who reported similar age bracket in a study carried out in Nigeria. Male dominance indicated that fish hatchery farming is gender sensitive and strenuous in nature. The finding agrees with the study of Oladimeji *et al*. (2017); Olaoye *et al*. (2017); Folayan and Folayan (2017) that fish farming operation is dominated by males. Educational attainment has been described as one of the key factors determining adoption rate Asiabaka (2008). It widens one's intellectual horizons and influences one's mind to new innovations (Ashley-Dejo and Adelaja 2022). Educational status of individual could be related to one's literacy level which is crucial for communication. The results on farmers educational qualification agrees with the findings of Ashley-Dejo *et al*. (2020a) that fish hatchery farmers in Osun State Nigeria are educated with majority having tertiary education. In African, marital status is often used to measure individual level of responsibility. The findings aggress with the study of Ashley-Dejo *et al.* (2017) who reported that most fish farmers in southwest Nigeria are married individuals. Study carried out by Ogunmefu and Achike (2018) in Lagos State, Nigeria corroborates the result observed from this study, who reported farming experience of 11.7 years.

Information dissemination play a significant role in technology adoption, the beauty of improved technology is to be appropriately delivered to target audience and this could only be achieved through effective communication channel. Fish hatchery farmers in the study area chose research institutes as the most preferred source of information on improved fish hatchery production technology. This shows that research institute was the most efficient source of information to fish hatchery farmers on improved technologies. This could be attributed to the fact that research institutes are mainly established to carry out research and the respondents could relate well due to their high literacy level which enhances effective and cordial relationship between researchers and farmers. The role played by extension agents in information dissemination to fish hatchery farmers in the study area shows how effective extension workers are discharging their duty. Extension workers serve as link between researchers and end users (Adebolu and Ikotun, 2001). Dominance of research institutes and extension agents has main information sources to fish hatchery farmers in the study area agrees with the findings of Asiabaka (2002) who affirmed that research institutes and extension arm are responsible for research development and dissemination of proven technologies. The findings from this study agree with the study of Digun-Aweto and Oladele (2017) who reported that extension agents and research institutes are the main sources of information to fish farmer in a study conducted in Lagos state, southwest Nigeria.

Age of farmer is anticipated to influence farmer's perception towards improved technologies. Most often, young farmers are always willing to try out new innovations showing positive perception to improved technology compared to older ones which are often reluctant to change. Young farmers have better access to information thorough various information outlets (internet, books, friend etc) which gives them edge and influences their perception towards new technologies. Experienced farmers are presumed to have acquired knowledge over time and in better position to evaluate improved technology. To a large extent, farming experience influences farmers managerial ability and decision making. This plays out in this study having positive perception of more than two third (2/3) of the perceptional statement evaluated. High literacy level is assumed to have greater influence on individual perception towards improved technology.

The study revealed that high level of adoption of concrete tanks could be attributed to its durability when compared to other enclosures although with relative high cost of construction. This finding agreed with the submission of Omitoyin (2007) who observed that fish farmers adopted concrete tank enclosure than other enclosures and is commonly used in peri-urban settings. Also, high adoption rate of synthetic hormones could be attributed to availability, high fertilization and hatching rate when compared with natural hormones Nwokoye *et al.* (2007) and Ashley-Dejo *et al*. (2020b). Sex was found to be positive and significant variable influences the adoption of improved fish hatchery production technologies in the study area indicating that the adoption of these technologies is gender sensitive. This finding agreed with the work of Folayan and Folayan (2017). Similarly, educational qualification had positive and significant influence on adoption of improved fish hatchery production technologies. This indicates that the more educated fish farmer was, the higher the probability of adopting improved technologies. Ability to acquire, process and utilize improved innovations by farmers is directly related to his/her educational qualification (Mignouna *et al*., 2011; Lavison, 2013). The result further shows that number of worker/labour and fish enclosure units has positive and significant influence on adoption of improved fish hatchery production technologies. This implies that fish hatchery farmers with high number of workers and fish enclosure units are more likely to adopt improved hatchery production technologies. In addition, years of experience had positive and significant influence on adoption of improved fish hatchery production technologies. This implies that as fish hatchery farmers advance in hatchery operation their adoption level increases. Experienced farmer will be able to assess the importance of improved innovations, lower the level of uncertainty about innovations, thereby positively influencing the adoption of the improved technologies.

CONCLUSION

The study revealed that fish hatchery production in southwest Nigeria is dominated by educated married male, with mean age and fish hatchery experience of 46 and 11 years respectively. Mean household size and fish enclosure units were 7 persons and 12 units respectively. It was also established that fish hatchery farmers in southwest were aware of improved fish hatchery production technologies through various agencies but research institutes reached out as the main source of knowledge to fish hatchery farmers on improved fish hatchery technologies. However, awareness, trial and adoption of improved fish hatchery production technologies were high; unfortunately, some farmers discontinued some of the technologies after adoption. Adoption of improved technologies was found to be attributed to various factors like sex, educational qualification, number of workers/labour, number of fish enclosure units and years of fish hatchery experience. Conclusively, adoption of improved fish hatchery production technologies in southwest Nigeria goes in line with rate of adoption of other technologies in a systematic manner which is mainly influenced by fish hatchery farmer's demographic characteristics. Therefore, technology with high level of discontinuance or with low level of adoption should be improved upon by researcher and disseminated appropriately.

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