Assessment of Adoption of Improved Hatchery Management Practices among Fish Farmers in Lagos State

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Abstract
Nigeria has continued to import fish products to augment the deficit in domestic production. Among the problems confronting the nation's fish production is inadequate fish seed supply from hatcheries. This has not only limited the availability of fish fry and fingerlings, it has also constrained the attainment of maximum production of commonly raised African catfish in Nigeria. This study assessed the adoption of improved hatchery management practices among fish farmers in Lagos State. One hundred and fifty fish farmers, which were randomly selected from 12 local government areas of Lagos State and were interviewed using structured questionnaires. Majority of the respondents were male (68%) of between 41-50 years of age (55.3%), married (76.7%) with a household size of at least five members (90.6%). All the respondents (100%) had at least primary school education while 68% had 5-10 years farming experience. Majority of the hatchery technologies were widely adopted by the respondents except few technologies, such as use of graders (16%), ovaprim (30.7%), HCG hormone (16.7%), kakaban (25.3%), re-circulatory water system (17.3%) and use of hammock for brood stock transportation (12.0%). This study also revealed that there was an increase in fingerling production which may be attributed to high adoption pattern of various improved hatchery management practices techniques among the farmers.

Keywords: Aquaculture, Fish seed, Hatchery management, Innovation, Lagos.

Introduction

Nigeria is a maritime country blessed with large stretch of fresh, brackish and marine waters. However, the country is not producing enough fish for her domestic consumption from both capture and culture fisheries (Tunde *et al*., 2015). In addition to the declining output from captured fisheries, Nigerian aquaculture sector has not attained its full potential owing to problems such as poor quality seeds, lack of cost effective fish feed, lack of capital, poaching, poor marketing structure as well as unstable government and defective government policies (Omitoyin, 2007). Based on this, the country became popular as one of the largest importers of fish among developing countries (Adewuyi *et al*., 2010; Tunde *et al*., 2015). Recognizing the huge potential of aquaculture in contributing towards food security, elevating socio-economic status of rural communities and generating foreign exchange, Nigerian government has given great priority to aquaculture in its development plans (FDF, 2007; Olaoye *et al*., 2016).

Continuous importation of fish products foretells a massive loss of foreign exchange to Nigeria especially at this period when the country is going through economic recession. Present scarcity of foreign exchange requires immediate conservative measures which will reduce the amount of foreign exchange incurred on importation of food products among other materials. Sufficient domestic fish production through aquaculture can serve this purpose (Fregene and Digun-Aweto, 2008; Osawe and Salman, 2016). In order to bridge the demand-supply gap, an aquaculture transformation agenda was laid down by the federal government in 2011 to increase annual fish production with the aim of achieving self-sufficiency in fish production and supply by the year 2015 (Tijani, 2011). The transformation agenda was to be achieved through fish farm development program, fish seeds and feed mill development program, fish pen and cage culture development program and fish post-harvest management and marketing program (Oyakhilomen and Zibah, 2013). In spite of this effort, Nigeria has continued to import fish products in order to augment the deficit in local production. Nigeria has an actual annual fish demand of 2.68 million metric tonnes, annual domestic production of 0.78 million metric tons with a demand-supply gap of 1.8 million metric tons (Olaifa, 2015), which are supplemented by importation of fish products. This wide gap plays a major role in the volume of fish products imported. To bridge this gap, the need to boost fish seed production have been identified since inadequate fish seed supply from hatcheries contributes to the shortfall in Nigeria's aquaculture production (Omitoyin, 2007; Ozigbo *et al*., 2014). This problem has not only limited the availability of fish seeds, it has also constrained the attainment of maximum production of commonly raised fish species such as African catfish (*Clarias gariepinus*) in Nigeria.

Artificial propagation, through improved breeding and fish seed production and management under controlled hatchery environment, becomes a necessity to ensure mass production of fry and fingerlings of various culturable fish species. Hormonal inducement of broodstock, using pituitary gland, deoxycorticosteroneacetate (DOCA), human chronic gonadosterone (HCG), fresh catfish pituitary and synthetic hormone such as ovaprim, has been used to hasten the ripening of matured eggs in female broodstock. Protection against predators and monitoring of water quality parameters are some of the benefits accruable from raising fish seeds in nursery tanks. Nursery facilities can be small, medium or large scaled depending on the extent of the hatchery operations.

In Nigeria, most hatcheries breed and culture seeds of African Catfish, *Clarias gariepinus*. In these hatcheries, the brine shrimp, *Artemia salina,* is popularly used as the first food for frys. Dry cycts are commercially and readily available, although it is relatively more expensive than locally raised zooplanktons. Nutritionally, there may be better live food than Artemia but the ease and speed with which the cysts can be hatched make their use very convenient in catfish hatcheries. Fry rearing is the most critical stage in catfish seed production. In most hatcheries, 70-90 percent fry population is lost before reaching fingerling stage (Digun-Aweto, 2011). As such fry rearing and management require training and expertise.

Improved breeding and hatchery management practices have been introduced to fish farmers in Lagos State through extension agents since 2005. Lagos State Agricultural Development Authority (LASADA), which is in charge of disseminating aquaculture and other agricultural related information to the farmers through its extension unit, introduced many improved fisheries and aquaculture technologies to the fish farmers (Olaoye *et al*., 2016). Some of the improved management practices in the package include introduction of improved broodstocks aimed at increasing fish seed quality and quantity; hormonal induction of broodstocks to improve fecundity rates; early sorting of fry, use of hatching troughs, and use of graders were introduced to improve survival rates; flow through systems and the use of air stones which were introduced to improved the water quality (Ofuoku *et al*., 2008) among others. The adoption of these technologies largely depends on the innovation source, medium of passage as well as the target recipients. The decision to adopt innovations involves risk on the part of the farmers (Ogunremi and Oladele, 2012). High level of adoption of innovation is attainable when the farmers are able to obtain and replicate higher production per unit time, with cheaper costs under a minimal level of technical knowledge.

Previous studies by Nwachukwu and Onuegbu (2007), Ofuoku *et al.* (2008), Ogunremi and Oladele (2012) and Olaoye *et al*. (2016) have shown that adoption of improved aquaculture technology and management techniques have immense impact on fish production in Imo, Delta and Lagos States, Nigeria respectively. However, there has been paucity of information on the adoption level of improved hatchery technologies as well as its impact on fish production in Lagos State. Therefore, this study assessed the various levels of adoption of improved hatchery management practices among the farmers, and the effect of the adoption of these practices on fingerling production.

Materials and Methods

This study was carried out in Lagos State, south-western Nigeria. Lagos is the foremost manufacturing and port city in West Africa, and the hub of business and economic development in Nigeria (Jenyo-Oni and Adepoju, 2013). According to Heinrich-Boll-Stiftung (HBS) foundation research, Lagos is the 7th fastest growing city in the world with a population of 21 million (HBS, 2012). The state lies approximately within longitude 2°42'E and 3°42'E and stretches between latitude 6°22'N and 6°42'N, with 3,577 sq. km. size and a maritime shoreline of about 180km. About 30% of the total landmass of Lagos State is made up of a network of water bodies (Olaoye *et al*., 2016). Although, Lagos is endowed with 147,877 hectares of swamp land and large area of water bodies suitable for aquaculture and adequate to feed its ever increasing human population of about 21 million, only 61.28 hectares (about 0.04%) is used for aquaculture. Lagos has five administrative divisions which are further divided into 20 local government areas (LGAs).

For the purpose of this study, 12 out of the 20 LGAs were selected using simple random sampling technique. The 12 LGAs were selected across the 5 administrative divisions of Lagos State, with each having at least 2 LGAs. One hundred and fifty (150) fish farmers, out of a total of registered 1466, were randomly selected and interviewed, using structured questionnaire across the selected 12 LGAs. The distribution of the fish farmers across the LGAs are presented in Table 1. Primary data were obtained from the questionnaires administered to the respondents.

Table 1: Distribution of respondents across selected 12 local government areas of Lagos State

LGA	Frequency	Percentage (%)
Epe	14	9.3
Ibeju	12	8.0
Eredo	12	8.0
Ikorodu	14	9.3
Ojo	14	9.3
Amuro-odofin	12	8.0
Ikosi/ejinrin	12	8.0
Badagry	12	8.0
Surulere	12	8.0
Eti-osa	12	8.0
Alimoso	12	8.0
Ipaja	12	8.0
Total	**150**	**100**

Descriptive statistics mainly frequency counts and percentage were used to describe the distribution of various variables being quantified while inferential statistics such as chi-square was used to test the relationship between socio-economic characteristics of respondents and level of adoption of improved hatchery management practices.

Results

The personal characteristics of the respondents show that majority (55.3%) of the respondents were between the age of 41-50 years (Table 2). Also, they were mainly male (68%), married (76.7%), with at least primary school education (100%). Half of the respondents (50%) had 3-4 children in a household with at least 5 members (90.6%). Although 68% of the respondents had 5-10 years farming experience.

Table 2: Personal characteristics of respondents

Characteristics	Frequency	Percentage (%)
Age		
31-40	20	13.3
41-50	83	55.3
51-60	47	31.3
Sex		
Male	102	68.0
Female	48	32.0
Marital Status		
Single	35	23.3
Married	115	76.7
Educational level		
Primary	84	56.0
Secondary	42	28.0
Tertiary	24	16.0
Occupation		
Farmer	129	86.0
Trader	21	14.0
House Hold Size		
3-4	15	9.3
5-6	51	45.3
>7	51	45.3
Number of Children		
1-2	7	4.7
3-4	55	50.0
5-6	53	45.3
Farming Experience		
6 months	7	4.7
< 5 years	41	27.3
5-10 years	102	68.0
Establishment of Farm		
1990-1995	7	4.7
1996-2000	21	14.0
2001-2005	75	50.0
2006 and above	47	31.3
Farm Size		
Less than 1 acre	129	86.0
1-2 acre	14	9.3
2 acres and above	7	4.7

The majority of the hatchery technologies were widely adopted by the respondents except few technologies, such as use of graders (16.0%), pituitary hormone (20.7%), ovaprim (30.7%) and HCG hormones (16.7%), kakaban (25.3%), re-circulatory water system (17.3%) and use of hammock for brood stock transportation (12.0%) (Table 3). Among the technologies, the use of improved brood stock and hatching troughs, feeding with daphnia, early sorting of fry, use of sorting trays and flow through water system were widely adopted at levels greater than 80.0%. The mean adoption score (%) for adoption was 59.4 based on which each of the hatchery technologies were ranked high and low. Presented in Table 4 is the fingerlings production levels of the respondents before and after adoption of improved technology and management practices. The table shows that there was an increase in production of fingerlings as a result of adoption of improved hatchery management practices and technology. While the number of farmers

Table 3: Percentage distribution showing levels of adoption of various improved technologies and management practices

Hatchery Technologies	Adopted		Not Adopted		Adoption
	No.	%	No.	%	Level
Use of improved brood stock	143	95.3	7	4.7	High
Use of hatching troughs	144	96.0	6	4.0	High
Use of sieve cloth/glass jar incubators	102	68.0	48	32.0	High
Feeding with live Artemia	102	68.0	48	32.0	High
Feeding with Daphnia	124	82.7	26	17.3	High
Early sorting of fry	150	100.0	0	0.0	High
Use of sorting trays	136	90.7	14	9.3	High
Use of trash fish as substitute for fish meal	115	76.7	35	23.3	High
Use of graders	24	16.0	126	84.0	Low
Use of hatching jars	115	76.7	35	23.3	High
Siphoning of hatchlings	115	76.7	35	23.3	High
Use of pituitary hormone	31	20.7	119	79.3	Low
Use of dried pituitary from Common Carp	25	16.7	125	83.3	Low
Use of ovaprim	46	30.7	104	69.3	Low
Use of HCG hormone	25	16.7	125	83.3	Low
Use of kakaban	38	25.3	112	74.7	Low
Flow through water system	122	81.3	28	18.7	High
Re-circulatory water system	26	17.3	124	82.7	Low
Use of mechanical aerators/air stones	116	77.3	34	22.7	High
Water temperature regulators	89	59.3	61	40.7	High
Water quality management	115	76.7	35	23.3	High
Use of indigenous floating pellets	108	72.0	42	28.0	High
Use of hammock for brood stock transport	18	12.0	132	88.0	Low
Effluent waste management	108	72.0	42	28.0	High

*Percentage mean adoption score: 59.4

producing fingerlings population such as less than 1000, 1000-2000 and 2000-4000 reduced from 6.0%, 18.0% and 16.0% respectively to 2.6%, 6.7% and 10.0%, the frequency of farmers producing higher populations increased. Production levels such as 8000-10000, 10000-12000 and greater than 12000 increased from 16.7%, 11.3% and 5.3%, respectively to 20.0%, 16.7% and 12.0%.

Table 5 shows the relationship that exists between personal characteristics of respondents and level of adoption of improved hatchery techniques. The table reveals that only sex had no significant relationship with the level of adoption of improved hatchery techniques, while other socio-economic variables such as age, marital status, educational level and year of farm establishment had significant relationship ($P<0.05$) with the level of adoption of improved hatchery techniques.

Going by the results as presented in Table 5, there was a significant difference ($P<0.05$) between the adoption of hatchery technology and fingerling production before adoption of improved hatchery management practices. Similarly, there was a significant difference ($P<0.05$) between the adoption of hatchery technology and fingerling production after the adoption of the improved hatchery management practices.

Table 4: Production levels of fingerlings before and after adoption of improved technology and management practices among fish farmers

Number of fingerlings produced	Before adoption		After adoption	
	Number of farmers	Percentage (%)	Number of farmers	Percentage (%)
< 1,000	9	6.0	4	2.6
1,000 - 2,000	27	18.0	10	6.7
2,000 - 4,000	24	16.0	15	10.0
4000 - 6,000	21	14.0	23	15.3
6,000 - 8,000	19	12.7	25	16.7
8,000 - 10,000	25	16.7	30	20.0
10,000 - 12,000	17	11.3	25	16.7
>12,000	8	5.3	18	12.0
Total	**150**	**100**	**150**	**100**

Table 5: Relationship between personal characteristics of respondents and level of adoption of improved hatchery techniques

Personal Characteristics	**X^2**	**df**	**P**	**Remark**
Age	21.606	30	0.000	S
Sex	1.386	15	0.239	NS
Marital Status	22.529	15	0.000	S
Educational Level	80.587	30	0.000	S
Year of Establishment	15.222	45	0.000	S
Farm Size	5.657	30	0.017	S

Discussion

The fact that majority of the respondents were males implies that more males engaged in fisheries activity in the study area. This is in agreement with findings of Alfred and Fagbenro (2007) who evaluated the perception of tilapia farmers on information sources in the coastal region of Ondo State, another south-western state of Nigeria. Considering that the respondents are mainly middle-aged shows that they are within the active age range and will therefore be willing to try new innovations and take risks unlike older farmers who are accustomed to conventional practices. This is in line with findings of Lemchi *et al*. (2003). Similarly, a greater number of married people among the respondents indicated that fish farming can support families, and remains a stable form of income. This is in consonance with the findings of Okunlola and Olofinsawe (2007) that farmers bear a lot of family responsibilities with fish farming. Also, it can be inferred that respondents' family members, children and dependents, may have provided a cheap source of labour since majority (90.6%) of the respondents had at least a household size of 5 with 3 or more children which can assist in the daily activities on the farm. All the farmers were literate, having one form of formal education or the other, which implies that farmers will easily adopt modern technology since level of education is known to influence the adoption process. This is in agreement with the findings of Nwachukwu and Onuegbu (2007). The predominant farm size (less than 1 acre of land) among the farmers may be attributed to the peculiarity of the study area, being a commercial hub, with lots of land covered with swamps, lagoon and the Atlantic Ocean.

Based on calculated average adoption score of 59.4%, all the hatchery technologies had high adoption levels except use of graders, pituitary hormone, ovaprim, HCG hormones, kakaban, re-circulatory water system and use of hammock for brood stock transportation with lower adoption percentage scores which were less than 59.4%. From the adoption level as measured in percentage, it can be deduced that the adopted technologies may have eased various hatchery processes and improved hatchery production, hence, their adoption by majority of the farmers.

Improved brood stock was widely adopted (95.3%) among the fish farmers. This may not be unconnected with the improvement in fingerling production. The quality of brood stock is known to affect the fingerling quality and quantity from a breeding process. Hatching troughs may have been found to be effective, as it reflected in the 96% adoption rate. Although more farmers adopted the use of Daphnia (82.7%) than Artemia (68%), both Daphnia and Artemia are live feed which are commonly used to raise fish frys. While the use of sorting trays was adopted by 90.7% of the respondents, early sorting of fry was adopted by all the respondents (100%) because the fish farmers have been able to identify that early fry sorting does not only increases survival rate, it also improves growth rate. This is in line with the findings of Ofuoku *et al.* (2008) that management practices such as early sorting of fry, use of hatching troughs and siphoning of hatchlings improve survival rates of fry and fingerlings. Although the use of graders was poorly adopted (16%), the use hatching jars and siphoning hoses was adopted by 76.7% of the respondents Substitution of fish meal with trash fish as protein source was adopted by 76.7% of the respondents. This may have been as a result of the cheaper price it commands when compared with fish meal. This is in line with findings of Digun-Aweto (2011) that fish farmers prefer the trash fish to fish meal due to its cheaper cost despite its seasonal availability.

The use of hormones was poorly accepted by the respondents. Respondents' population, as low as 20.7%, 16.7% 30.7% and 16.7% adopted the use of pituitary hormone, dried pituitary from common carp, ovaprim and HCG hormone, respectively. The cost of buying these synthetic hormones may have led to poor adoption recorded among the fish farmers. Also, flow-through water system was adopted by 81.3% as against 17.3% adoption level of re-circulatory water system. This may be attributed to the availability of water for frequent water exchange. Also, the higher cost of setting up and maintenance of re-circulatory water system may have also contributed to this adoption level. The use of mechanical aerators was adopted by 77.3% respondents' population, while a lower adoption level of 59.3% was observed in the use of water temperature regulators, even though a majority of 76.7% respondents adopted water quality management. The reason for this may not be farfetched since water quality management plays important role in fish growth and performance (Falaye, 2013). The use of indigenous floating pellets was adopted by 72.0% respondents' population. This may be attributed to the cheap cost of indigenous fish feed as against the expensive imported feed products. This is in line with Ifejika *et al.* (2007) who reported that farmers use indigenous fish feed to intensify fish production and increase profit.

The increase in production of fingerlings observed as a result of adoption of improved hatchery management practices may have led to increase in farmers' income since most farmers invest their personal funds in aquaculture in preference to other sources of fund (Adesehinwa and Bolorunduro, 2007). Although the adoption may have been accompanied with rise in production cost, it has led to increase in availability of fingerlings for culture and/or sales. Therefore, it can be inferred that farmers are ready to invest more in improved technologies and practices in order to achieve greater production of fish fingerlings among other benefits accruable to them.

The significant relationship between farmers' personal characteristics and level of adoption of improved hatchery management practices are shown in Table 5. The significant relationship between farmers' age, marital status, educational level and year of farm establishment is in consonance with the findings of Ofuoku *et al.* (2008) that age and marital status, among other personal parameters, are positively related to adoption of hatchery techniques.

Conclusion

Majority of the improved hatchery management practices measured among fish farmers in the study area were adopted. The dependence of respondents on fish farming, as a means of livelihood, showed the importance for dissemination of improved hatchery practices as a tool for boosting fish and aquaculture production. Adoption of the improved practices increased fingerling production in hatcheries where lower production has previously been recorded. The significant relationship between the adoption of hatchery techniques and fingerling production affirms that further improvement of these technologies and management practices will lead to increased productivity of the hatcheries. More extension efforts should be aimed at fish farmers who specialize in hatchery operations in order to boost fish seed production to a level capable of meeting and surpassing the domestic demand. Hence, there is the need for government to encourage more farmers to adopt improved hatchery management practices through timely intervention, policies and programmes.

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