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Adoption of aquaculture technology by fish farmers in Jashore Sadar Upazilla, Jashore, Bangladesh

Syeda Maksuda Yeasmin[1], Moumita Choudhury[2], Md. Habibur Rahman[1], Md. Almamun Farid[1], Anusree Biswas[1], Md. Anisur Rahman[1*]

[1]*Department of Fisheries and Marine Bioscience, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Bangladesh*

[2]*Department of Environmental Science and Technology, Faculty of Applied Science and Technology, Jashore University of Science and Technology, Bangladesh*

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Abstract

Technological change has been the major driving force for increasing fish production and promoting fisheries development. Determining the extent of adoption of modern aquaculture technologies by the fish farmers was the main focus of the study. The study was conducted at Sadar Upazilla of Jashore district. Fifty respondents were randomly selected as a sample for data collection from ten unions. A pre-tested interview schedule was used to collect data from the respondents during January 2020 to June 2020. For assessing the adoption of modern aquaculture technologies by the fish farmers, 11 technologies on fish production were considered. Adoption of "pond preparation with lime", "acclimatization of fish fry before stocking", "appropriate stocking density", "monosex tilapia cultivation", "use of formulated feed", "use of urea" " use of TSP" and "pangus cultivation" were found high while adoption of "poly culture of carp", "Thai koi cultivation" and "catfish cultivation" were comparatively low. Overall mean adoption scores of 11 modern aquaculture technologies by the farmers indicated that 56 % of the respondent fish farmers had high adoption of "modern aquaculture technologies" compared to 24% having medium adoption and 20% low adoption. Among the technologies highest adaption (84.35) was found in "use of TSP in fish pond". Age, education, use of information sources, farm size, fish farming area, annual family income, commercialization, social participation, innovativeness and knowledge on fish culture of the farmers had positive and significant relationship with their overall mean adoption of modern aquaculture technologies.

* **Corresponding Author:** Md. Anisur Rahman ✉ anis.fmb@just.edu.bd

Introduction

Bangladesh is considered one of the most suitable regions for fisheries in the world, with the world's largest flooded wetland and the third largest aquatic biodiversity in Asia after China and India. The favorable geographic position of Bangladesh comes with a large number of aquatic species and provides plenty of resources to support fisheries potential. The fisheries sector plays a very important role in the national economy, contributing 3.69% to the Gross Domestic Product (GDP) of the country and 22.60% to the agricultural GDP (FRSS, 2016). More than 2% of Bangladeshi export value comes from the inland fisheries sector. Given proper government support, the fisheries sector has an ample potential in creating various types of ancillary industries in rural areas that often have a high rate of economic return. These employment opportunities for poor rural citizens would also stem their migration to urban areas. Fish supplements about 60% of Bangladeshi people's daily animal protein intake (DoF, 2016). More than 17 million people including 1.4 million women depend on fisheries sector for their livelihoods through fishing, farming, fish trading, fish handling, and processing (BFTI, 2016). Different surveys revealed that more than 80% of labors are engaged in the fish processing industries were women (DoF, 2015).

Bangladesh is one of the world's leading fish producing countries with a total production of 42.77 lakh MT in FY 2017-18, where aquaculture production contributes 56.24% of the total fish production. Average growth performance of this sector is 5.26% for last 10 years. Aquaculture shows a sturdy and consistent growth, average growth rate is almost 10 percent during the same timeframe. It is believed that if the increasing trend of fish production continues, it will be possible to achieve the projected production target of 45.52 lakh MT by 2021 in conformity with the targets of Vision-2021 of the present government (Fisheries statistical yearbook, 2017-18).Until recently, the choice of technologies available to farmers was largely determined by the need to increase production, profits and productivity. The main constraints were the availability of capital, knowledge of how to use the technology and market risks. Assimilation and adoption of new and available technology at the farm level is a function of science, economics and human behavior. One or more of the physical sciences or biology serves as the foundation for technology development, and economics usually serves as a strong motivator for adoption. The adoption process involves an interrelated series of personal, cultural, social and institutional factors, including awareness, further information and knowledge, evaluation, trial, and adoption. Characteristics of a technology, such as simplicity, visibility of results, usefulness towards meeting an existing need and low capital investment promote its eventual adoption and should be considered when transferring any technology. Profitability is a major concern to farmers. But given the vast array of available technologies, the uncertainty of their effects and the policy and market context, it is difficult to decide where and in what to invest. The opportunity to witness an investment in profitable technology by a fellow producer with similar facilities and resources often helps in decision making and can guide the changes ultimately adopted. Modern technologies can aid in the growth of an aquaculture sector through (1) greater farm productivity, (2) increased fish supply and reduction in consumer prices (Asche 2008), (3) increased trade and export of fish, and (4) employment generation that benefits overall development (Dey *et al.*, 2006). Dissemination of technologies such as artificial spawning of commercially important species, improved feeds and feeding technologies, enhanced production systems, disease management, and genetically improved fish strains were shown to have triggered aquaculture development in shrimp, salmon, and tilapia industries (Kumar and Engle 2016).

The main objective of the study was to i) determine the socio-demographic characteristics of the respondents, ii) find out the extent of adoption of aquaculture technologies by the fish farmers and iii) explore the relationships between socio-demographic traits of the fish farmers' with their adoption of modern aquaculture technologies.

Material and methods

Study area and sample design

The location of the study was Jashore Sadar Upazilla, Jashore.The survey was conducted on 50 fish farmers of 10 unions randomly selected from 15 unions of Jashore Sadar Upazilla in Jashore district. Ten unions viz. Arabpur, Upasahar, Kachua, Kashimpur, Chanchra, Churamankati, Noapara, Fathehpur, Basundia and Lebutala unions wereselected by using simple random technique procedurefrom a total 15 unions of Jashore Sadar Upazilla. By the help of Upazilla Fisheries Officer a list of fish farmers from ten unions was prepared. Resultant 50 fish farmers constituted the sample of this study.

Technology adoption index

In order to collect valid and reliable information from the farmers an interview schedule containing both open and closed form questions was developed considering the objectives of the study. Eleven selected characteristics viz. age, education, family size, farm size, fish farming area, information sources use, annual family income, use of agricultural credit, commercialization, social participation and innovativeness of the respondents were the independent variables were measured and categorized by following standard methodology used by Hoque and Haque (2011), Ali (2004), Islam (2000) and Muttaleb (2006). Adoption of aquaculture technologies was the dependent variable of this study which consists of eleven selected technologies viz. (i) pond preparation with lime, (ii) acclimatization of fish fry before stocking, (iii) appropriate stocking density(iv) monosex tilapia cultivation, (v) pangus cultivation,(vi) catfish cultivation, (vii) poly culture of carp, (viii) Thai koi cultivation, (ix) use of formulated feed, (x) use of urea and (xi) use of TSP. Adoption of aquaculture technologies like, monosex tilapia cultivation, pangus cultivation, catfish cultivation, poly culture of carp, Thai koi cultivation were computed by using following formula of Kashem (2004):

$$\text{Adoption Index} = \frac{Ej}{Pj} \times 100$$

Where,

Ej = Extent of adoption (actual area under practice) expressed in terms of summation of obtained adoption score of the practice under study. Pi = Potential adoption (possible area of practice) expressed in terms of possible maximum obtainable adoption score of the practice under study.

Adoption index of modern aquaculture technologies namely, pond preparation with lime, appropriate stocking density, use of urea, use of TSP, use of formulated feed were computed by using the following formula:

$$\text{Adoption Index} = \frac{\text{Maintained unit}}{\text{Recommended unit}} \times \frac{\text{Covered area}}{\text{Total area}} \times 100$$

On the other hand, computed adoption index of acclimatization of fish fry before stocking was computed by a formula is given below:

$$\text{Adoption Index} = \frac{\text{Actual time}}{\text{Recommended time}} \times \frac{\text{Covered area}}{\text{Total area}} \times 100$$

Adoption of different modern aquaculture technologies was ranked on the basis of mean as accordance with the methodology of Sendilkumar (2010). Data were collected using predesigned interview schedule during 1st July, 2019 to 31 December, 2019.

Statistical analysis

The statistical measures such as, number and percentage and rank order were used for describing the variables of the study. In order to explore the relationships of adoption of aquaculture technologies with the selected characteristics of respondents Pearson's product Moment correlation co-efficient was computed.

Results and discussion

Aquaculture production can be increased through sustainable intensification, which is producing more food from the same area of land and water while reducing the environmental impacts. Age of the farmers ranged from 20 to 64 years with an average of 49.85±7.65 years. Table 1 indicated that approximately 50% of the farmers were in middle age

category, whereas young category was 18% and 32% in old category. The age of the fish farmers was found to have significant relationship with their aquaculture knowledge. Jadav *et al.*, (2016) and Sarma *et al.*, (2011) found significant relationship between age and adoption of modern aquaculture technology.

Table 1. Salient feature of the selected socio-demographic characteristics of the respondents.

Characteristics	Categories	Respondents		Mean	SD
		No.	%		
Age	Young (up to 32)	9	18	49.85	7.65
	Middle (33 - 54)	25	50		
	Old (above 54)	16	32		
Education	Can sign only(0.5)	11	22	6.92	4.15
	Primary (1-5)	13	26		
	Secondary (6-10)	15	30		
	Above secondary (above 10)	11	22		
Family Size	Small (up to 4.00)	9	18	5.84	1.38
	Medium (5.00-6.00)	27	54		
	Large (above 6.00)	14	28		
Use of Information Sources	Low (up to 25.00)	13	26	34.03	8.75
	Medium (26.00-43.00)	24	48		
	High (above 43.00)	13	26		
Farm Size	Small (up to 1.00)	14	28	1.49	.85
	Medium (1.01-3.00)	27	54		
	Large (above 3.00)	9	18		
Fish Farming Area	Small (up to 1.00)	11	22	2.37	.69
	Medium (1.01-3.00)	31	62		
	Large (above 3.00)	8	16		
Annual Income	Low (up to 187.45)	11	22	495.26	210.12
	Medium (187.46-755.57)	35	70		
	High (above 755.57)	4	8		
Commercialization	Low (up to 75.00%)	14	28	81.85	7.25
	Medium (75.10-85.00%)	25	50		
	High (above 85.00%)	11	22		
Use of Agricultural Credit	No (00.00)	21	42	145.19	327.41
	Low (1-1000)	19	38		
	Medium (1001 -2000)	6	12		
	High (above 2000)	4	8		
Social Participation	Low (up to 1.00)	22	44	.89	.34
	Medium (2.00 - 3.00)	17	34		
	High (above 3.00)	11	22		
Innovativeness	Low (up to 8)	11	22	17.62	6.79
	Medium (9-21)	33	66		
	High (above 21)	6	12		

The educational status of the farmers varied from .5 to 12 with an average of 6.92 ± 4.15 years of schooling. About 22% only could sign, 26% of the farmers had primary level education, while 30% had secondary level. About 22% of the farmers had the higher secondary level of education. In the present study aquaculture knowledge of the fish farmers was positively correlated with farmers' educational status. Similar results have been reported by Jaganathan *et al.*, (2016) and Singh *et al.*, (2011). The family size of the fish farmers varied from 2 to 10 with an average of 5.84±1.38 members. Data furnished in Table 1 indicate about 54% of the respondents had medium family whereas, 18% and 28% having small size family and large family, respectively and majority of them (74%) had used low to medium level

information sources which is concordance with the findings of Afrin *et al.,* (2011).

Among the respondents 82% and 84% had small to medium farm size and fish farming area, accordingly. Besides, the proportion of the respondents who had the small to medium annual income is 92% similar to Chawdhury *et al.,* (2012). Moreover, overwhelming majority of the respondents (78%) showed low to medium commercialization and interestingly almost all the respondents (80%) used no to low use of agricultural credits.

Table 2. Distribution of the respondents regarding adoption of modern aquaculture technologies and ranking among the technologies.

Technologies	Adoption categories (scores)	Respondents		Mean	Rank
		No.	%		
Pond preparation with lime	Medium (33.10-66.00)	13	26	72.16	5
	High (above 66.00)	37	74		
Acclimatization of fish fry	Medium (33.10-66.00)	17	34	69.35	6
	High (above 66.00)	33	66		
Appropriate stocking density	Medium (33.10-66.00)	9	18	77.27	4
	High (above 66.00)	41	82		
Monosex tilapia cultivation (*Oreochromis mossambicus*)	No (0)	6	12	67.13	7
	Low (1.00-33.00)	1	2		
	Medium (33.10-66.00)	3	6		
	High (above 66.00)	40	80		
Pangus cultivation (*Pangasius hypophthalmus*)	No (0)	12	24	53.64	8
	Medium (33.10-66.00)	12	24		
	High (above 66.00)	26	52		
Catfish cultivation (*Heteropneustes fossilis, Clarias batrachus*)	No (0)	11	22	52.48	9
	Low (1.00-33.00)	5	10		
	Medium (33.10-66.00)	7	14		
	High (above 66.00)	27	54		
Poly culture of carp	No (0)	19	38	35.74	11
	Low (1.00-33.00)	7	14		
	Medium (33.10-66.00)	9	18		
	High (above 66.00)	15	30		
Thai koi cultivation (*Anabas testudineus*)	No (0)	18	36	38.60	10
	Low (1.00-33.00)	5	10		
	Medium (33.10-66.00)	11	22		
	High (above 66.00)	16	32		
Formulated feed use	No (0)	2	4	78.72	3
	High (above 66.00)	48	96		
Use of urea into the pond	Medium (33.10-66.00)	6	12	81.23	2
	High (above 66.00)	44	88		
Use of TSP into the pond	Medium (33.10-66.00)	1	2	84.35	1
	High (above 66.00)	49	98		

In addition, 78 percent of the respondents had low to medium participation with social organization which supported those of Afrin *et al.,* (2011) and Afrad (2010). In addition, most of the respondents (88%) had low to medium innovativeness, this result in support with the findings of Ferouque (2004). Results presented in Table 2 mean that regarding pond preparation with lime, the highest proportion of the respondents (74%) belonged to high adoption category. Overwhelming majority of respondents (66%) had high adoption of acclimatization of fish fry. Big majority of the respondents (82%) belonged to high adoption category of maintaining appropriate stocking density and in case of monosex tilapia cultivation more than four-fifths respondents (86%) fell into the medium to high adoption categories.

Table 3. Distribution of the respondents according to their overall mean adoption of modern aquaculture technologies.

Overall mean adoption	Adoption categories (scores)	Farmers		Mean	SD
		Number	Percent		
Modern aquaculture technologies	Low adoption (upto 58.24)	12	24	71.08	12.32
	Medium adoption (58.24-79.32)	28	56		
	High adoption (above79.32)	10	20		
Total					

On the other hand, regarding pangus cultivation about three-fourths of the respondents (76%) had medium to high adoption but considerable number of respondents (24%) were not interested to pangus cultivation. Regarding catfish cultivation, 22 percent of respondents belonged to no adoption category as compared to each of 24 percent low to medium adoption categories whereas about half (54%) of them had high adoption. About 38 percent respondents had no adoption of poly culture of carp similarly the amount was 36 percent regarding adoption of Thai koi cultivation. In case of formulated feed use in to the pond, surprisingly 96 percent respondent farmers belonged to very high adoption category. Huge majority of the respondents (88%) were in high adoption category for adopting urea for fish farming.

Using TSP into the pond was popular and 98% respondents fell into high adoption category. Furthermore, based on mean adoption index of the different modern aquaculture technologies “use of TSP into the pond” ranked first, “use of urea into the pond” ranked second, “formulated feed use” ranked third followed by, “appropriate stocking density” “pond preparation with lime”, “acclimatization of fish fry”, “monosex tilapia cultivation”, “pangus cultivation”, “catfish cultivation”, “Thai koi cultivation” and “poly culture of carp”.

Table 4. Relationship between the selected characteristics of the respondents and their adoption of selected aquaculture technologies.

Independent variables	Coefficient of correlation (r)	Dependent variable
Age	0.225*	Adoption of modern aquaculture technologies
Education	0.685**	
Family size	0.065NS	
Use of information sources	0.768**	
Farm size	0.510**	
Fish farming area	0.452**	
Annual family income	0.650**	
Commercialization	0.281**	
Use of agricultural credit	0.016NS	
Social participation	0.321**	
Innovativeness	0.462**	

* = significant at 5% level of significance,

** = significant at 1% level of significance, NS = Not significant.

Mean adaption of modern aquaculture technologies has been measured in three groups. About half of the respondents (56%) had medium adaption of modern aquaculture technologies practices followed by about one fourth (24%) low adaption and one fifth (20%) high adaptation. Therefore, over third-fourth (76%) of the respondents had medium to high adaption of modern aquaculture technologies which might be due

to regular extension services and healthy profile of using these technologies. Findings from Goswami *et al.*, (2010), Islam (2005), Podder and Kashem (2000), Hossain (1983) are similar to this one while contradicts with the findings of Islam (1993).

Since either parametric or non-parametric test used, the test of hypothesis by coefficient of correlation are shown in Table 4. Results showed that education, use of information sources, farm size, fish farming area, annual family income, commercialization, social participation and innovativeness has 1% level of significant relation and age has 5% level of significant relation with the adoption of modern aquaculture technologies. It means that if there is any increase in their age, education, use of information sources, farm size, fish farming area, annual family income, commercialization, social participation and innovativeness, there would be an increase in their adoption of selected aquaculture technologies.

Table 5. Possible reasons influencing the adoption of different modern aquaculture technologies (Based on FGD, n=10).

Practices	Extent of adoption	Reasons
Use of TSP in the pond	High	TSP increases the availability of major nutrients and promotes the development of planktonic algae, which provide food for many fishes.
		Most of the farmers are innovative
		Influenced by the leaf, knowledgeable neighbors and local leaders
		Suggestion from the fish farmer's association
		Group discussion among farmers at the time of facing technical problem during fish production
Use of formulated feed into the pond	High	Posters, leaflets of different feed industries
		Fish become healthy and expected size in time
		Farmers were inspired from GOs and NGOs members
		Suggestions from Upazilla fisheries officers (UFOs) and their team work
Appropriate stocking density	High	Decreasing fish fry mortality rate
		Most of the farmers are innovative
		Knowledge from fish farmers association
		Farmers take part in meeting with GOs and NGOs members
		Production rate become high due to less competition for spacing
Use of Urea into the pond	High	Urea enhance productivity into the pond
		Urea provides nitrogen to procreate phytoplankton and zooplankton
		Directions from Upazilla fisheries officers (UFOs) and their team work
		Farmers were inspired from GOs and NGOs members
Acclimatization of fish fry before stocking	Medium	Posters and leaflets from Upazilla fisheries office
		Participation in the demonstration program
		Attend group meeting
		Get contact with GOs, NGOs officials
Pond preparation with lime	Medium	Lime makes pond as a nutrient reservoir
		Act as an insect repellent by increasing pH
		Lime triggers up fish yield
Monosex tilapia cultivation	Medium	High growth rate of Thai koi
		Farmers take suggestion from neighbors
		Group discussion about new ideas among farmers
Pangus cultivation	Medium	High growth rate of pangus
		Most of the farmers are innovative

Sarma *et al.*, (2011), Jadav *et al.*, (2010) observed similar relationship between ages, use of information and social participation with adaption of aquaculture technologies. Singh *et al.*, (2011) reported alike results between education, use of information sources, social participation and farm size with adaption of aquaculture technologies. Deshmukh *et al.*, (2010) and Sarker (2002) found alike relationship

between fish farming area of the respondent fish farmers and their adoption of modern aquaculture technologies. Relationship between innovativeness of the respondents and annual family income with adoption of modern aquaculture technologies were positive and significant which is similar to those of Goswami *et al.*, (2010). Muttaleb (2006) reported same relationship between commercialization of the farmers and their adoption of aquaculture technologies.

Table 6. Problems along with possible solutions of low adoption of catfish, Thai koi, carp poly culture practices (Based on FGD, n=10).

Practices	Extent of adoption	Problems	Possible solutions
Catfish cultivation	Low	Lack of technical knowledge	Information disseminate through mass media
		Lack of quality fish fry	Government should facilitate different upazilas public fish hatcheries
		Unavailability of credits	Bank loan with easy terms and condition
		Fish fry price is high	Should explore and develop more modern technique to increase breeding performances of fish
Thai koi cultivation in pond	Low	Insufficient credit facilities in Time	GO and NGOs should provide loan facilities with soft and simple condition
		Lack of quality fish fry	Species specific fish hatcheries should be developed
Poly culture of carp	Low	Good quality fry in time	Establishment of good carp hatcheries
		Sometimes growth becomes stunted	Adequate feed supply should be ensured
		High production cost	Provision of fund should be ensured by the cooperative association of farmers
		Lack of technical knowledge	Training facilities have to ensure by aquaculture experts
		Competition for food and space among fish	Prohibit to excessive release of different size fish species in a small area

Ten members including school teacher, imam (religious leader), local leaders, and commercial farmers were selected for obtaining qualitative information. Information obtained from Focus Group Discussion is presented in Table 5. 'Posters and leaflets of different feed industries', 'farmers contact with GOs and NGOs members' and 'prolonged efforts of UFO and his team work' were the main reason to change the adoption of formulated feed use into the pond at high level. Reasons helped maintaining appropriate stocking density of fish by the farmer were 'lowering the mortality rate of fish fry', 'most of the farmers are innovative', 'most of the farmers are the member of fish farmers association', 'farmers participated in meeting with GOs and NGOs members'.

Conclusion

Knowledge on scientific fish culture plays a very important role to improve fish production by assisting farmers to make appropriate decision upon adoption of aquaculture technologies. Among the eleven aspects of knowledge, respondents had appreciable knowledge on "pond preparation with lime", "acclimatization of fish fry before stocking", "appropriate stocking density", "monosex tilapia cultivation", "use of formulated feed", "use of urea and TSP" and "pangus cultivation" that were found high values while adoption of "poly culture of carp", "Thai koi and catfish cultivation" were comparatively low. Majority of the respondents had medium to high level of overall mean adoption of modern aquaculture practices. Age, education, use of information sources, farm size, fish farming area, annual family income, commercialization, social participation and innovativeness of the respondents had a positive and significant relationship with the adaption of aquaculture technologies. Therefore it is recommended that modern technology and its compatibility, viability and application have to

telecast frequently in order to generate knowledge on fish farming technology to the relevant farmers.

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