

Adoption of Modern Aquaculture Technologies by the Fish Farmers in Bogra District of Bangladesh

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Abstract – The main objective of this study was to assess the adoption of modern aquaculture technologies by the fish farmers'. The study was conducted in Kahaloo and Sherpur upazilas of Bogra district. Respondent fish farmers were selected using proportionate random sampling technique. Quantitative data were collected using predesigned interview schedule during August to September 2011. Focus group discussions were conducted for obtaining qualitative information. 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 and TSP” and “pangus cultivation” were found high while adoption of “poly culture of carp”, “Thai koi and catfish cultivation” were comparatively low. Overall mean adoption scores of 11 modern aquaculture technologies by the farmers indicate that 58 % of the respondent fish farmers had medium adoption of “modern aquaculture technologies” compared to 25% having high adoption and 17% low adoption. 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. “Lack of technical knowledge”, “unavailability of credits in time”, “lack of quality fish fry” and “unavailability of quality fish feed”, were the main hindrances for adoption of modern aquaculture technologies as identified by the respondents in the study area.

Keywords – Adoption, Aquaculture, Technologies, Practice, Farmer.

I. INTRODUCTION

Capture fisheries and aquaculture are playing vital role in the world providing 142 million tons of fish as human food of 145 million tons total production, become the source of income and livelihood for 45 million people through direct employment and provides more than 180 million jobs as a whole in the global fish industry. Globally, fish provides 20 percent of animal protein to the 2.9 billion people. Yearly availability of fish in developing countries is 16 kg per person per annum compared to world average 18 kg per capita. Capture fisheries is dominating world fish production than aquaculture. But growth of aquaculture is rising from a share of 4 percent in 1970 to 38 percent in 2009. So, employment in aquaculture is increasing at a faster rate than world population growth and now accounts for one-quarter of the total number of workers directly involved in the fisheries sector (FAO, 2012).

In Bangladesh, the total fish production was 2701 thousand metric tons (MT) in 2008-09 which contributed 4.18 percent of total gross domestic product (BBS, 2010). In 2009, around 17.3 million US dollars were spent to import fish compared to 1.1 million US dollars in 1999. Again, in 2007, the total fish export earned was 630.8 million US dollars that decreased to 516.0 million US dollars in 2009 (FAO, 2012). People of Bangladesh fulfill their increased demand of fish only through capturing from open water bodies. Thus, fish production of open water bodies showed decreasing trend and availability of some species have greatly reduced. Even though, in the early 1980s, more than 80 percent of animal protein requirement were met from fish (Ahmad and Hassan, 1983).

Total area of capture fisheries was 4,047,316 ha with the production of 1123925 MT covering 41.61% of total fish production in Bangladesh during 2008-09 while the culture fisheries production was 1062801 MT (39.34%) from 258,390 ha in the same year (BBS, 2010). Hence, productivity as well efficiency of culture fisheries is much higher than capture fisheries. The projected demand (4.79 million MT) for fish in Bangladesh is higher than the projected supply (3.79 million MT) in the year of 2015 (Karim *et al.* 2010). In this context, aquaculture can play better role than capture fisheries to fulfill projected demand. To achieve the target of projected demand of 4.79 MT fish production, precise use of modern aquaculture technologies by the farmers are essential. Hence, it is essential to ascertain the adoption status of modern aquaculture technologies along with their constraints at farm level for necessary remedies. Initially farmers are trying to adopt different aquaculture techniques at various degrees which are not enough for optimum production. It is essential to adopt the appropriate modern aquaculture technologies for optimum production. Variability of use of aquaculture technologies may be due to lack of capitalization, inefficient and outdated techniques and poor marketing that contribute to the lack of commercial success in aquaculture. Another factor limiting production is the lack of suitable domesticated species. In this context, precision use of aquaculture technologies is needed for the improvement fish production. In view of the above circumstances, the researcher was motivated to conduct this study to i) determine the socio-demographic characteristics of the respondents, ii) find out the extent of adoption of aquaculture technologies by the respondent fish farmers and iii) explore the relationships between socio-demographic traits of the fish farmers' with their adoption of modern aquaculture technologies.

II. METHODOLOGY

Kahaloo and Sherpur upazilas of Bogra district were the locale of this study. Bogra district consists of 12 upazilas from which Kahaloo and Sherpur were selected using simple random technique. Kahaloo is located at western part of Bogra district whereas Sherpur is located at the southern part. Six unions viz. Kahaloo, Jamgaon, Malancha, Kusumbi, Bishalpur, Khanpur unions were selected by using simple random technique procedure from a total 18 unions of Kahaloo and Sherpur upazilas. Then a list of fish growers of these six unions was prepared with the help of the Upazila Fisheries Officer (UFO). Total number of fish farmers of these unions was 366. Only heads of these 366 fish farmers constituted the population. Thirty percent of the fish growers were selected from villages of six unions by using proportionate random sampling technique. Resultant 110 fish farmers constituted the sample of this study. 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 (2010), Ali (2004), Islam (2000) and Muttaieb (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):

$$\text{Adoption Index} = \frac{E_j}{P_i} \times 100$$

Where,

E_j = Extent of adoption (actual area under practice) expressed in terms of summation of obtained adoption score of the practice under study.

P_i = 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 02 August 2011 to 26 September 2011. 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.

III. FINDINGS AND DISCUSSION

Findings contained in Table 1 on socio-demographic characteristics of the respondents indicate that big majority of the respondents (80%) were young to middle aged in concordance with those of Afrin (2011) and Ali(2007). Besides, an appreciable proportion of the respondents (54%) had competency to sign only or primary level education which is akin to those of Afrin (2011) and Ali (2007). Majority of the respondents (76%) belonged to medium to large familyand, overwhelming majority of them (80%) had used low to medium level information sources which is concordance with the findings of Afrin (2011). Most of the respondents (87%) and (82%) had medium to high farm size and fish farming area, accordingly. Besides, the proportion of the respondents who had the medium to high annual income is 87 percent similar to Chawdhury (2011). Moreover, overwhelming majority of the respondents(77%) showed medium to high commercialization and interestingly almost all the respondents(98%) used zero to low use of agricultural credits. In addition, 90 percent of the respondents had low to medium participation with social organization which supported those of Afrin (2011) and Afrad (2009). In addition, most of the respondents (89%) had low to medium innovativeness, this result in support with the findings of Ferouque (2004).

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

Characteristics	Categories	Respondents		Mean	SD
		No.	%		
Age	Young (up to 32)	26	24	43.52	11.05
	Middle (33 - 54)	62	56		

	Old (above 54)	22	20		
Education	Can sign only(0.5)	44	40		
	Primary (1-5)	16	14	5.96	5.08
	Secondary (6-10)	26	24		
	Above secondary (above 10)	24	22		
Family Size	Small (up to 4.00)	26	24		
	Medium (5.00-6.00)	55	50	5.65	1.73
	Large (above 6.00)	29	26		
Use of Information Sources	Low (up to 25.00)	29	26		
	Medium (26.00-43.00)	59	54	32.94	9.90
	High (above 43.00)	22	20		
Farm Size	Small (up to 1.00)	14	13		
	Medium (1.01-3.00)	74	67	2.23	0.95
	Large (above 3.00)	22	20		
Fish Farming Area	Small (up to 1.00)	20	18		
	Medium (1.01-3.00)	78	71	1.89	0.94
	Large (above 3.00)	12	11		
Annual Income	Low (up to 187.45)	14	13		
	Medium (187.46-755.57)	71	64	471.51	284.06
	High (above 755.57)	25	23		
Commercialization	Low (up to 75.00%)	25	23		
	Medium (75.10-85.00%)	59	54	79.26	8.61
	High (above 85.00%)	26	23		
Use of Agricultural Credit	No (00.00)	79	72		
	Low (1-1000)	29	26		
	Medium (1001 -2000)	1	1	121.82	348.09
High (above 2000)	1	1			
Social Participation	Low (up to 1.00)	63	57		
	Medium (2.00 - 3.00)	36	33	2.04	1.78
	High (above 3.00)	11	10		
Innovativeness	Low (up to 8)	21	19		
	Medium (9-21)	77	70	14.87	6.49
	High (above 21)	12	11		

IV. ADOPTION OF DIFFERENT MODERN AQUACULTURE TECHNOLOGIE

Results presented in Table 2 mean that regarding pond preparation with lime, the highest proportion of the respondents (81%) belonged to high adoption category. Overwhelming majority of respondents (87%) had high adoption of acclimatization of fish fry. Big majority of the respondents (90%) belonged to high adoption category of maintaining appropriate stocking density and in case of monosex tilapia cultivation more than four-fifths respondents (82%) fell into the medium to high adoption categories. On the other hand, regarding pangus cultivation about three-fourths of the respondents (73%) had medium to high adoption but considerable number of respondents (27%) were not interested to pangus cultivation. Regarding catfish cultivation, 33 percent of respondents belonged to no adoption category as compared to each of 20 percent low to medium adoption categories whereas about half (47%) of them had high

adoption. About half of the respondents (49%) had no adoption of poly culture of carp similarly the amount was 46 percent regarding adoption of Thai koi cultivation. In case of formulated feed use in to the pond, surprisingly 99 percent respondent farmers belonged to very high adoption category. Huge majority of the respondents (88.18%) were in high adoption category for adopting urea for fish farming. Amazingly, using TSP into the pond was popular and all the respondents fell into high adoption category.

Further more, 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, “appropriate stocking density” ranked third followed by, “formulated feed use” “pond preparation with lime”, “acclimatization of fish fry”, “monosex tilapia cultivation”, “pangus cultivation”, “catfish cultivation”, “poly culture of carp” and “Thai koi cultivation”.

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)	21	19	77.94	5
	High (above 66.00)	89	81		
Acclimatization of fish fry	Medium (33.10-66.00)	14	13	77.41	6
	High (above 66.00)	96	87		
Appropriate stocking density	Medium (33.10-66.00)	11	10	81.45	3
	High (above 66.00)	99	90		
Monosex tilapia cultivation (<i>Oreochromis mossambicus</i>)	No (0)	16	15	74.08	7
	Low (1.00-33.00)	3	3		
	Medium (33.10-66.00)	9	8		
Pangus cultivation (<i>Pangasius hypophthalmus</i>)	High (above 66.00)	82	74	59.85	8
	No (0)	30	27		
	Medium (33.10-66.00)	19	17		
Catfish cultivation (<i>Heteropneustes fossilis</i> , <i>Clarias batrachus</i>)	High (above 66.00)	61	56	50.11	9
	No (0)	36	33		
	Low (1.00-33.00)	11	10		
Poly culture of carp	Medium (33.10-66.00)	11	10	39.35	10
	High (above 66.00)	52	47		
	No (0)	54	49		
Thai koi cultivation (<i>Anabas testudineus</i>)	Low (1.00-33.00)	5	5	41.47	11
	Medium (33.10-66.00)	9	8		
	High (above 66.00)	42	38		
Formulated feed use	No (0)	51	46	80.41	4
	High (above 66.00)	1	1		
Use of urea into the pond	Medium (33.10-66.00)	109	99	86.04	2
	High (above 66.00)	13	12		
Use of TSP into the pond	High (above 66.00)	97	88	88.42	1

V. EXTENT OF OVERALL MEAN ADOPTION OF MODERN AQUACULTURE TECHNOLOGIES

Extent of overall mean adoption of modern aquaculture technologies has been measured in three categories. Findings in Table 3 clue that about three-fifths of respondents (58%) had medium adoption of modern aquaculture practices followed by more than one-fourth

(25%) high adoption. Therefore, more than four-fifths (83%) of the respondents had medium to high adoption of modern aquaculture technologies which might be due to continuous extension activities and healthy profile of using these technologies. Findings reported by Goswami *et al.* (2010), Islam (2005), Kashem and Podder (2000), Hossain (1983) are similar to this one while contradicts with the findings of Islam (1993).

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 (upto58.24)	19	17	68.78	10.54
	Medium adoption (58.24-79.32)	64	58		
	High adoption (above79.32)	27	25		
Total		110	100.00		

VI. RELATIONSHIP BETWEEN THE SELECTED CHARACTERISTICS OF THE RESPONDENTS AND THEIR ADOPTION OF SELECTED AQUACULTURE TECHNOLOGIES

Attempt has been done to specify the relationship between selected characteristics of the respondents and their adoption of selected aquaculture technologies. Results indicate that except family size and use of agricultural credit, all the selected characteristics of the respondents had positive and significant relationship with 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 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	0.210*	Adoption of modern aquaculture technologies
Education	0.650**	
Family size	0.073 NS	
Use of information sources	0.722**	
Farm size	0.408**	
Fish farming area	0.412**	
Annual family income	0.625**	
Commercialization	0.275**	
Use of agricultural credit	0.010 NS	
Social participation	0.307**	
Innovativeness	0.411**	

* = significant at 5% level of significance, ** = significant at 1% level of significance, NS = Not significant

Sarma *et al.* (2011) and Jadav *et al.* (2010) found similar relationship between age and adoption, Sivashankar and Shashidhar (2011) and Singh *et al.* (2011) reported alike findings between education and adoption, Sarma *et al.* (2011) and Singh *et al.* (2011) observed same results between use of information sources by respondents and their adoption of aquaculture technologies. Shashidhar (2011) and Singh *et al.* (2011) found identical relationship between farm size of respondents and their adoption of aquaculture technologies, Deshmukh *et al.* (2010) and Sarker's (2002) findings were akin to relationship between fish farming area of the respondent fish farmers and their adoption of modern aquaculture technologies. Goswami *et al.* (2010) showed alike relationship between annual family income of respondent fish farmers and their adoption of aquaculture technologies. Muttaleb (2006) and Karim (1973) reported same relationship between commercialization of the farmers and their adoption of

aquaculture technologies. However, relationship between use of agricultural credit of respondent farmers and their adoption of aquaculture technologies was not significant, this results support the findings of Reddy and Kivlin (1968). Singh *et al.* (2011) and Jadav *et al.* (2010) found identical result between social participation of the respondent and their adoption of modern aquaculture technologies. Relationship between innovativeness of the respondents and their adoption of modern aquaculture technologies was positive and significant which is similar to those of Goswami *et al.* (2010).

VII. FOCUS GROUP DISCUSSION

A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards a product, service, concept, advertisement, idea, or packaging (Henderson and Naomi, 2009). A focus group discussion was conducted to find out the reason and problems related to adoption of modern aquaculture technologies and the possible solution of those major problems. 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' (Table 6).

In addition, all the participants in FGD identified some problems affecting the adoption of 'catfish cultivation', 'Thai koi cultivation' and 'poly culture of carp'. In order to find out the solutions of those problems, participants imparted some appropriate suggestions like farmers faced lack of technical knowledge, which can be solve by circulating information through mass media frequently about technology and provide adequate training facilities by aquaculture experts. In addition, farmers had a suffering in getting credit. So, participants suggested that bank loan should be flexible for creating more provision to get high yield in aquaculture sector.

'Lack of quality fish fry', 'high price of fish fry' and 'high production cost' were the problems faced by catfish cultivating farmers. These problems can be reduced through activating upazila public fish hatcheries and use more modern techniques to increase hatching rate of catfish. Adequate quality feed supply should be ensured for optimum production. Maintaining optimum fish fry density can reduce competition for food and space among fish. Thai koi can't cultivate with walking catfish because the skin damage of walking catfish may occur with the spine of Thai koi at the time of harvesting.

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 stimulates algal production
		TSP triggers up fish production
		Most of the farmers are innovative
		Personal contact with knowledgeable neighbors and local leaders
		Most of the farmers are the member of fish farmers' association
		Group discussion among farmers at the time of falling technical obstacle 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 take part in meeting with GOs and NGOs members
		Prolonged efforts of upazila fisheries officers (UFOs) and their team work
Appropriate stocking density	High	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 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 nutrients into the pond
		Urea provides nitrogen to procreate phytoplankton and zooplankton
		Prolonged efforts of upazila fisheries officers (UFOs) and their team work
		Farmers take part in meeting with GOs and NGOs members
		Most of the farmers are innovative
Acclimatization of fish fry before stocking	Medium	Posters and leaflets are shown in the upazila fisheries office
		Participation in the demonstration program
		Attend group meeting
		Get in touch with GOs, NGOs officials
Pond preparation with lime	Medium	Lime makes pond as a nutrient reservoir
		Act as an insect repellent by increasing P ^H
		Lime triggers up fish yield
		Farmers take part in meeting with GOs and NGOs members
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

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 circulate 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 more modern technique to increase hatching rate of catfish
Thai koi cultivation in pond	Low	High production cost	Government should take stern action to keep control on market
		Unavailability of credits in time	Organizations should provide loan facilities with soft and simple condition
		Cannot cultivate with others	Further research should be conducted

		Lack of quality fish fry	Species specific fish hatcheries should be developed
Poly culture of carp	Low	Lack of fish 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

VIII. CONCLUSION

Majority of the respondents had competency to sign only with poor level of involvement with the social organization and found to have low to medium contact with the sources of information. Besides, maximum respondents did not receive credit facilities having medium to high annual income. Technologies namely “pond preparation with lime”, “acclimatization of fish fry before stocking”, “appropriate stocking density”, “monosex tilapia”, “pangus cultivation”, “formulated feed supply into the pond”, “urea use” and “use of TSP” were adopted by the respondents at the high level. Comparatively low level of adoption had found in the adoption of “Thai koi cultivation”, “catfish cultivation” and “poly culture of carp”. Majority of the respondents had medium to high level of overall mean adoption of modern aquaculture practices. Among the selected characteristics age, education, use of information sources, farm size, fish farming area, annual family income, commercialization, social participation and innovativeness had positive and significant relationship with adoption of modern aquaculture technologies.

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